Weapon of War

BY

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37 mm Flare

37mm Flare Launcher
Origin Place United States

The 37 mm flare or "1.5 inch" caliber is the specification for a common launching system for non - lethal and less - lethal ammunition. Such launchers are also often known as "gas guns" due to their original use by police for launching tear gas projectiles. 37 mm systems are typically smoothbore as rifling is unnecessary or even detrimental to the performance of the usual projectiles.

37 mm rounds can be fired from a variety of devices, including standalone launchers, and M203 - style launchers mounted on rifles using clamping systems or rail mounting systems.

In the United States, 37mm launchers are exempted from the National Firearms Act of 1934 so long as no anti-personnel rounds are in the user's possession. Only non – anti - personnel rounds may be possessed or used. Such rounds include :

flares
Smoke rounds, to include irritating "smoke"
Noise effect ("bird bomb") rounds

Where anti - personnel rounds are to be fired from a 37 mm launcher, the launcher must be registered with the BATFE as a destructive device. Possession of a destructive device is also restricted or banned by some local and state laws. The specific wording of the BATFE rule is:

ATF Ruling 95-3:

"37/38 mm gas/flare guns possessed with cartridges containing wood pellets, rubber pellets or balls, or bean bags are classified as destructive devices for purposes of the Gun Control Act, 18 U.S.C. Chapter 44, and the National Firearms Act, 26 U.S.C. Chapter 53."

Rounds that are considered anti - personnel include :

Less - lethal rounds:

rounds loaded with rubber pellets

rounds loaded with plastic or wooden batons

"bean bag" rounds consisting of a cloth bag filled with lead pellets

Lethal rounds:

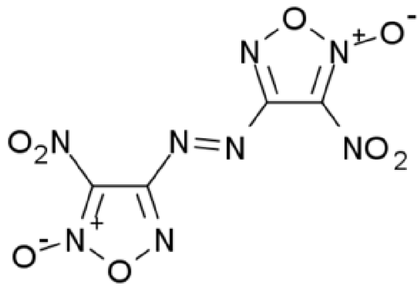
Buckshot

Flechette rounds

Such rounds are not considered destructive devices, but are not readily available to non - government purchasers.

A round containing an explosive payload of over 0.25 ounces would itself be classified as a destructive device, requiring BATFE registration.

4,4'- Dinitro -3,3'- diazeno furoxan
(DDF)



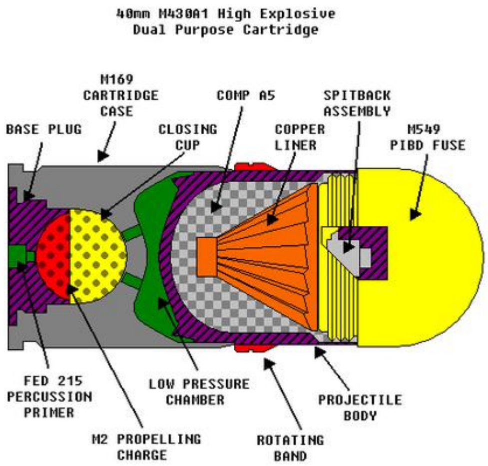
IUPAC name :4,4'- dinitro-3,3'- diazeno furoxan	
Other names : DDF	
Molecular formula	$C_4 N_8 O_8$
Molar mass	288 g / mol
Density	2.02 g / cm^3
Main hazards	Highly Explosive
Explosive velocity	10,000 m / s

4,4'-Dinitro -3,3'- diazeno furoxan (DDF) is a powerful experimental high explosive with performance comparable to that of other high - density high - explosives such as octa nitro cubane. It is synthesized by oxidative coupling of 4 - amino -3- (azido carbonyl) furoxan followed by Curtius rearrangement and further oxidation.[1][2]

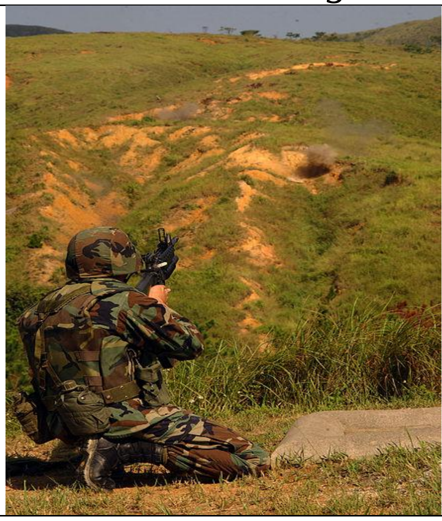
40 mm Grenade

Marines load a belt of 40×53mm grenades into the Mk 19 launcher.

A U.S. Marine feeding the Milkor MGL-140 grenade launcher with 40mm grenades



M430A1 HEDP.



M203 qualification range : a 40×46mm training round can be seen hitting the hill.

Contents

1 - Introduction

The 40 mm grenade is a military grenade caliber for grenade launchers in service with many armed forces. There are two main types in service: the 40×46mm, which is a low - velocity round used in hand - held grenade launchers; and the high - velocity 40 × 53mm, used in mounted and crew - served weapons. The cartridges are *not* interchangeable. Both 40mm cartridges use what the US Army during the Vietnam War called the High-Low Propulsion System.

The less powerful 40×46mm is used in hand - held weapons such as the M 79 , M 203, the M 320 grenade launcher, and the multi - shot M32 MGL or Zakłady Mechaniczne "Tarnów" SA RGP- 40.

The more powerful 40×53mm is used in automatic grenade launchers mounted on tripods, vehicles or helicopters, such as the Mk 19 grenade launcher, the Mk 47 "Striker" 40 mm Grenade Machine Guns (GMGs), the Heckler & Koch GMG or the South African Vektor Y3 AGL. In these roles, the rounds are linked together with a metallic disintegrating link.

A new 40×51mm cartridge recently (2007) developed in South Africa provides a more powerful alternative for hand-held weapons without increased recoil. A new version of the Milkor MGL chambered for the new round remains backward compatible with existing 40×46mm rounds.

2 - 40 × 46 mm

2 – 1 – M 79

U.S. military rounds designated specifically for the M79 launcher includes :

High Explosive (HE): M381, M386

Airburst : M 397, M 397A1
Twenty 24 grain metal pellets: M576
CS gas : M 651
Practice : M 781

2 – 1 – M 320 / M 203

U.S. military rounds designated specifically for the M 203 launcher includes :

High Explosive (HE): M 381, M 386, M 406, M 441
High Explosive Dual Purpose (HEDP): M433
Airburst : M 397, M 397A1
Buckshot : M 576 (Twenty 24g metal pellets)
Thermo baric : XM 1060
Star parachute (flare): M 583A1
Star cluster (flare): M 585 (white), M661 (green), M662 (red)
CS gas: M 651
Smoke Canopy: M 676 (yellow), M 680 (white), M 682 (red)
Ground Marker (smoke): M 713 (red), M 714 (white), M 715 (green), M 716 (yellow)
Practice : M 781
Infra - red illumination: M 992
Non lethal (crowd control)
Sponge Grenade (crowd control)

3 - 40 × 47 mm

It is a grenade caliber designed in Poland, and used in Pallad wz. 74 under barrel grenade launchers (used with AK family rifles in use in Polish Army like the AKM / AKMS, Tantal and Beryl) and Pallad-D wz. 83 Grenade launcher (standalone variant fitted with standard pistol grip and folding stock from AKMS assault rifle). The construction is similar to one used in 40×46 but grenades are not fully inter change able.

4 - 40 ×51mm

The Milkor USA, Inc. M 32A1 Multi - Shot Grenade Launcher (MSGL) is the premier Multiple Grenade Launcher in the shoulder fired 40 mm market today. The M 32A1 has been qualified with all munitions in 40 mm family, from Less – Than - Lethal (LTL) through the Low Velocity (LV) and Medium Velocity (MV) categories. The M32A1 is produced in the USA, under the stringent requirements of both ISO 9001, as well as, the more rigorous AS 9100 (Aerospace cousin to ISO). The M32A1 is in use in the US DOD with the USMC and Special Operations Groups around the world.

There is no connection between Milkor USA, Rippel Effect, and Milkor PTY (South Africa), though their histories once crossed paths.

Rippel Effect — formerly Milkor Marketing previously tasked by Milkor (Pty) Ltd the South African designers of the Milkor MGL—developed a new "Extended Range Low Pressure" (ERLP) 40×51mm cartridge. This round extends the range of the 40mm grenade from 400 m to 800 m . The XRGL40 is chambered for the new round, but can still fire the regular 40×46mm grenade.

5 - 40 × 53 mm

5 – 1 - Mk 19 Mod 3

U.S. military rounds designated specifically for the Mk 19 grenade launcher includes:

High Explosive (HE): M383, M384
High Explosive Dual Purpose (HEDP): M430I
High Velocity Canister Cartridge (HVCC): M1001[2]
Practice: M 385I, M918
Dummy: M 922/M922A1

5 – 2 - Mk 47 Mod 0

U.S. military rounds designated specifically for the Mk 47 grenade launcher include :

MK 285, Programmable Prefragmented High Explosive / Self-Destructible (PPHE/SD)

The MK 285 consists of an electronic programmable fuze, a prefragmented warhead and a propulsion system. the fuze is programmed through the fire control of the gun. the fuze is mechanically armed at approximately 23 meters.

The round is programmed to airburst over the target and the fuze counts down the programmed time via its built in electronics. If an unprogrammed round is fired, it will detonate on impact.

The projectile has a built in self-destruct and can be fired by any automatic grenade launcher.

6 – Other

Other weapons using 40mm rounds are the Corner Shot 40 grenade launcher, the Defcpm LLC XL 201 A1 rail mounted launcher (Defcom sales brochure, dated 2010), the Milkor MGL Mk-1S Multiple Grenade Launcher, the Penn Arms PGL 65 - 40 "Fourkiller Tactical Model" 40mm Multiple Grenade Launcher, the Heckler & Koch AG36, Heckler & Koch AG-HK416, the Heckler & Koch GMG grenade auto cannon and the Heckler & Koch HK69A1. There is also the CIS 40 AGL and 40 LWAGL from Singapore's ST Kinetics. The Daewoo K4 Grenade Machine Gun is in service with the South Korean Armed Services.

The Russian GP-30 Obuvka, GP-25 Kastyor, and BG-15 Mukha use a unique type of 40 mm grenade. These grenades are caseless, holding their own propellant within the body of the grenade. The Russian 40mm grenades are not interchangeable with U.S. 40×46 mm and 40×53mm weapons. They also developed a silenced 30 mm grenade launcher, the BS-1 "Tishina", using a multi-round blank cartridge magazine meant to ignite the 30mm HE-DP caseless grenade.

The Metal Storm 40 mm Weapon System is a four-barrel, 16-round weapon system that also uses 40 mm grenades (stacked), and is designed for mounting on an unmanned ground vehicle. Initial trials are under way to determine suitability for mounting on unmanned aerial vehicles.

7 – Multi - caliber grenade launchers

As one of the earliest barrel - mounted grenade launchers reaching mass production, the M 203 has a major problem: it cannot be loaded with high - powered or specialized grenades, such as Milkor ERLP or 40×53 mm grenades, because of its slide - locking barrel. The manufacturers working on replacements of the M 203 had to come up with new ideas so this would be possible with new issued grenade launchers. This resulted in two innovative designs, like the side-loading M320 grenade launcher and the FN SCAR's Mk13 Mod0 EGLM. The EGLM opens like the M203 but the barrel can also be pivoted right or left, allowing left and right - handed shooters to load it quickly with any ammunition. The HK AG 36 launcher has a similar setup where the barrel turns so that the breech is facing the user.

8 - Green ammunition

The MK 281 is a new type of 40 mm target practice grenade ammunition that has been accepted for use into the United States Marine Corps and the United States Army. It is "green" because it is non-toxic and non - dud producing (since it is a training round), meaning that there is no unexploded ordnance left to clean up on the range and heavy metals in the fuse do not leak into the ground. The MK281 was introduced into parts of the U.S. Armed Forces because of an executive order mandating that they buy green ammunition. The MK281 is manufactured by an American subsidiary of the Rheinmetall Group.

7.62 mm Caliber

SSA 7.62 mm 143 gr AP rifle cartridge , bullet

Contents

1 - Introduction

7.62 mm caliber is a nominal caliber used for a number of different cartridges. Historically, this class of cartridge was commonly known as .30 caliber, the Imperial unit equivalent, and was most commonly used for indicating a class of full power military main battle rifle (MBR) cartridges. The measurement equals 0.30 inches or 3 decimal lines, written .3" and read as *Three-Line*.

7.62 mm refers to the internal diameter of the barrel at the lands (the raised helical ridges in rifled gun barrels). The actual bullet caliber is normally .308 in (7.82 mm), although Soviet weapons commonly use a .311 in (7.91 mm) bullet, as do older British (.303 British) and Japanese cartridges.

2 - Pistol cartridges in 7.62 mm caliber

There are many pistol cartridges in this caliber, but most common are:

7.62×25 mm Tokarev, also known as 7.62 mm TT, used in the Tokarev pistol, and many of the WWII Soviet submachine guns.

7.63×25 mm Mauser, which was the basis for, and has nearly identical dimensions to the Tokarev, but has different loading specifications.

7.65×21 mm Para bellum

7.65×25 mm Borchardt, from which both the Mauser and Para bellum cartridges were developed.

7.65×17 mm Browning, also known as the .32 ACP.

3 - Revolver cartridges in 7.62 mm caliber

Some of the revolver cartridges in this caliber are:

7.62×38 mm R used only in the Nagant M 1895 revolver

.32 Long Colt Originally chambered in small frame Colt revolvers and the Marlin model 1892 rifle, this cartridge used a heeled bullet with a case the same diameter as the major diameter of the bullet. It shared dimensions with the .32 rimfire cartridge of the same length. Not to be confused with the .32 Colt's New Police cartridge.

.32 S&W Long Also known as the .32 "Colt's New Police" when chambered in Colt revolvers. The original loading for this cartridge used a round nose, or flattened round nose (in the case of the .32 Colt's N.P.) and was chambered widely in revolvers made in the US and Europe through WWII. This cartridge is used in several modern target pistols (not revolvers) with flush seated wadcutters. The short version of this cartridge (.32 S&W) was chambered in many break-top revolvers at the end of the 19th and beginning of the 20th centuries in the US and Europe.

.32 H&R Magnum Is the only revolver cartridge in this caliber which is in wide use today, mostly in small-frame revolvers. This is an extended version of the much earlier .32 S&W long, which is an extended version of the .32 S&W.

.327 Federal Magnum Is a new cartridge developed jointly by Ruger and Federal. This cartridge is an extended version of the .32 H&R Magnum.

4 - Rifle cartridges in 7.62 mm caliber

The most common & historical rifle cartridges in this caliber are :

300 AAC Blackout (7.62x35mm), also known as 300 BLK, designed for the M4 carbine platform and STANAG magazine;

Soviet 7.62 x 39 mm, also known as the 7.62 mm Soviet, M43, or occasionally .30 Short Combloc, designed for the SKS and used in the AK - 47 and AKM assault rifles and RPK and RPD light machine guns ;

7.62 x 45 mm vz. 52, made solely for the Czechoslovakian vz. 52 rifle, replaced by 7.62 x 39mm

7.62 x 51mm NATO and its civilian variant .308 Winchester, sometimes incorrectly described as .308 NATO by persons mixing English measurements, used by some civilians, with metric measurements used by NATO;

7.62 × 54 mmR, another Russian cartridge that was first used in the Mosin - Nagant rifle since 1891. The modern versions of the cartridges, to this day, are in wide use in numerous world armies as sniper rifles (particularly the SVD family) and machine guns (numerous types, many developed from AK family, such as the PKM);

.30 - 06 Springfield, US Military cartridge for both World Wars and Korea, known as the 7.62x63mm in metric measurement;

.30 Carbine, used in the M1/M2/M3 Carbines, sometimes called the 7.62x33mm;

.303 British, used in Lee-Metford and Lee-Enfield rifles, known as 7.7×56mmR in metric measurement;

7.7×58mm Arisaka, used in the Type 99, Type 2 and Type 4 rifles;

7.65×53mm Argentine, used in various Mauser bolt-action rifles, primarily in Belgium, Turkey and Argentina;

.308 Norma Magnum;

.300 Winchester Magnum, used by many hunting/sniper rifles, sometimes called the 7.62x67mm;

.300 Lapua Magnum, 7.62x70mm;

.30-378 Weatherby Magnum;

.30-30 Winchester, a popular deer hunting cartridge, typically used in lever-action rifles, such as the Winchester Model 1894 and Marlin Model 336, also adapted to European sporting guns as 7.62x51mmR;

.30 R Blaser, used in break-action rifles for hunting medium to large game;

30TC.

9 K 114 Shturm

A Shturm missile on display.

Contents

1 - Introduction

9K114 *Shturm* (Russian: 9К114 «Штурм»- "shturm" means storm (assault) in English) is a SACLOS radio guided anti-tank missile system of the Soviet Union. Its GRAU designation is 9 K114. Its NATO reporting name is AT- 6 *Spiral*. The missile itself is known as the 9 M114 *Kokon* (Cocoon).

2 - Development[edit source

The missile was developed by the Kolomna Machine Design Bureau, which was also responsible for the AT-1 Snapper and AT-3 Sagger. Work on the missile began in 1967, with the hope of using the missile on Mi - 24s. However, delays forced the design of an upgraded Falanga system (AT-2 Swatter) using SACLOS guidance as a stopgap. Testing of the missile was completed in 1974, and it was accepted into service in 1976. The missile has no direct western counterpart, though, in role, it is closest to the AGM-114 Hellfire, and in guidance method, to the MGM-18 Lacrosse.

3 – Description

	
9P149 Shturm-S in Saint Petersburg Artillery Museum	*Shturm launch tubes(right) on the wing of an Mi-24*

9P149 vehicle with 9M114 missiles of anti-tank complex «Shturm-S» is firing

The missile can be deployed on a variety of platforms, including the Mi-24V and from 1979 - onwards the MT- LB based 9P149 tank destroyer. There is also a ship borne version of the missile, with the launcher holding six missiles.

The missile is transported and launched from a glass-reinforced plastic tube. The missile uses a Soyuz NPO solid - rocket sustainer, with a small booster stage to launch the missile from its tube.

The missile is SACLOS with a radio command link. The use of a radio link allows the missile to travel much faster and further than if it were wire guided. The radio link is a VHF system with five frequency bands and two codes to minimize the risk of jamming. The system comprises a KPS - 53AV 8x daylight-only direct vision sight with an integrated laser rangefinder. After the missile is launched, the gunner has to keep the sight's crosshairs on the target until impact.

Appropriate steering commands are transmitted to the missile via the radio link.

The missile flies above the gunner's line of sight to the target. With the range of the target determined by the laser rangefinder, the missile descends onto the target just before impact. This is done primarily to clear obstacles, instead of achieving a top-attack, and can be switched off. It is possible to engage low and slow moving helicopters with the system; however, since the missile only has a contact fuze, a direct hit would be needed.

Soviet sources report kill ratios of 75 – 85 % during the Soviet invasion of Afghanistan. Also a Mil demonstration in Sweden in late 1995 using a Mi - 28A firing Shturm and Ataka missiles also showed good results: from a hovering helicopter, a Shturm was fired at a target 900 m away; and from level flight at 200 km/h an Ataka was fired at a target 4,700 m away. Both missiles passed within 1 m of their targets.

It is possible there were problems with early models of the missile — Soviet stocks of the missile were rebuilt to AT - 6B and C standard by 1994.

4 - General characteristics (AT- 6A Spiral)

Length: 1625 mm
Wingspan: 360 mm
Diameter: 130 mm
Launch weight: 31.4 kg
Speed: 345 m/s
Range: 400 m to 5 km
Guidance: Radio command link SACLOS
Warhead: 5.3 kg HEAT 560 mm vs RHA

5 – Models

9 M114 AT- 6 *Spiral* Entered service in 1976.
9 M114 AT- 6A *Spiral* Shturm SACLOS
9 M114M HEAT warhead.

9 M 114 F Thermobaric warhead.

9 M 114 M1 AT-6B *Spiral* Shturm SACLOS 6 km Range. 7.4 kg warhead.

9 M114 M2 AT- 6 C *Spiral* Shturm SACLOS 7 km Range. 7.4 kg warhead.

9 M 120 /9 M 120 F / 9 M220O AT- 9 *Spiral-2 Shturm-VM* - see 9 M120 Ataka-V

6 – Users

Brazil
Armenia
Azerbaijan
Bulgaria
Czechoslovakia *(former user)*
Czech Republic
Cuba
Georgia
Indonesia - installed in Mi-35P attack helicopters
Moldova
Peru
Poland
Russia
Slovakia
Belarus
Tajikistan

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9 K115 Metis

	
Croatian 9K115 Metis	*NATO reporting name: AT-7 Saxhorn*

Contents

1 - Introduction

The 9 K115 Metis ("mongrel") (NATO reporting name AT - 7 Saxhorn) is a man - portable SACLOS wire - guided anti - tank missile system of the Soviet Union.

Type	Anti-tank missile
Place of origin	Soviet Union
Service history	
In service	1979 – present
Used by	Russia
Production history	
Manufacturer	KBP Instrument Design Bureau
Produced	1978 – present

Variants	9K115-2 Metis-M
Specifications	
Weight	5.5 kg ; 6.3 kg w / container
Length	740 mm
Diameter	94 mm (
Warhead	HEAT shaped charge
Warhead weight	2.5 kg
Wingspan	300 mm
Operational range	40 – 1,000 m
Speed	223 m / s
Guidance system	Wire - guided SACLOS

2 – Development

The missile was developed by the Tula KBP. It is very similar to the AT - 4 Spigot in external appearance - having 3 main fins - however, the missile is much lighter - primarily because of the reduced fuel load. This reduced load cuts the maximum range to 1,000 meters .

During the 1980s, an upgraded version of the missile was developed - the *Metis-M* 9 M131 (sometimes labelled *Metis-2*). Fired from the same launcher, the new missile is much larger and heavier, with an increased range and a larger warhead. NATO labelled this missile the AT-13 Saxhorn-2.

3 – History

The missile was introduced into the Russian army in 1979 to supplement the AT- 4 Spigot at company level. The system is lighter than the AT- 4 Spigot system, due to a less complicated launcher tripod and a lighter missile.

In Russian service, the AT-7 is deployed with motor rifle companies, with three launchers per company. The missile is operated by two man teams, with the gunner carrying the 9P151 launching post and one missile, his assistant carries an additional 3 missiles.

The export prices of the missile and firing post in 1992 were:

9 M131 Missile $ 13,500
9 P151 Firing post $ 70,000

4 – Models
AT-7 *Saxhorn* - Entered service in 1979.
AT-13 *Saxhorn-2* - 9K115-2 Metis-M

5 – Description

The missile is fired from the 9 P 151 launching post, which has a simple tripod for support. It can also be fired from the shoulder - but, this apparently requires more skill on the part of the operator. The launching post weighs 10.2 kilograms . The missile is launched from the tube by a booster rather than the gas generator used on the AT- 4 Spigot system, despite both missiles being designed by the same design bureau. The 9S816 guidance system is powered by a thermal battery attached to the launch tube shortly before launch - the missile itself is remotely powered along the guidance wires.

The missile can be launched from an enclosed space, such as a building or cave, but requires at least 6 meters behind the launcher, and a total internal volume of at least 100 cubic meters . The missile has a short minimum range of 40 meters and can engage targets moving at up to 60 kilometers per hour .

The missiles warhead is a single HEAT shaped charge.

6 – Operators

Bulgaria - Producer only
Hungary
Iran
Moldova
Poland
Russia
Syria
Croatia

9 K115 - 2 Metis – M

Metis-M

Contents

1 - Introduction

The 9 K115-2 *Metis-M* is a Russian anti-tank missile system. "9K115-2" is the GRAU designation of the missile. Its NATO reporting name is AT-13 *Saxhorn-2*.

The system is designed to augment the combat power of company - level motorized units.

Type	Anti-tank missile
Place of origin	Russia
Service history	
In service	1992 – present
Production history	

Manufacturer	KBP Instrument Design Bureau
Specifications	
Weight	13.8 kg
Length	980 mm
Diameter	130 mm
Warhead	HEAT tandem warhead, Armor penetration behind ERA 950 mm. Thermo baric anti – personnel / anti-material warhead is also available.
Engine	Solid - fuel rocket
Operational range	0.08 - 2 km
Speed	200 m / s
Guidance system	SACLOS wire

2 – Overview

The Metis - M system adds to the usual positive qualities of a man-portable anti-tank guided missile with significant improvements in range, accuracy and lethality. Owing to the small dimensions and light weight of its components, this man portable system can be carried by its crew in compact packs over any distance and over a wide variety of terrain types, including stream crossing. The three-man crew carries personal weapons and an ammunition load of five missiles. One crew member carries a pack with a missile-loaded launcher, which considerably reduces the time of fire preparation and allows the crew to engage targets whilst moving. In the event of sudden appearance of a target, the operator can fire from the shoulder with the launcher rested against a local object. Two other crew members carry packs with two missiles each.

3 – Features

changes from the traveling to the firing position — and vice versa — in 15 – 20 seconds;

firing rate of 3 - 4 rounds per minute;

can be shipped by any type of transport and can be air-dropped.

fired from organized and deployed sites in the prone and standing foxhole positions as well as from combat vehicles;

The Metis-M system comprises:
combat assets;
maintenance facilities;
training aids.
The combat assets of the Metis-M system include:
9M131 (9M131F) ATGM;
9P151 launcher;
1PBN86-VI thermal sight.

4 – Guidance

The Metis-M ATGM system has a semi-automatic guidance system, with commands transmitted over a wire link. The guidance system is constructed so that the most sophisticated and costly components, such as a gyroscopic coordinator, electronic units and an onboard battery, are excluded from the missile.

5 - Combat history

5 – Lebanon

According to accounts by Israeli military, weapons seized from Hezbollah and journalists accounts from Lebanon, the Metis-M was used successfully by Hezbollah fighters during the 2006 Lebanon war against Merkava tanks . Russia released a press statement disputing the claim that it had been supplying modern anti-tank weapons to Hezbollah; the Israelis' original claim, however, was in fact that Russian weapons which were sold to Syria which in turn smuggled the weapons to Hezbollah. Israel has sent a team of officials to Moscow to show the Russians the evidence of what they say can only be Syrian weapons transfers. To date, Russia has not commented on the weapon proliferation, although it has moved to tighten control over the use of Russian - made weapons by the importing states.

5 – 2 – Syria

On 7 March 2012, Syrian rebels used a 9 K115 - 2 Metis - M anti - tank guided missile to damage a Syrian Air Force MiG - 23MS while parked at Abu - Dhahur air base . These missiles most probably originated from looted Syrian army depots.

6 – Users

Armenia
Bangladesh
Cameroon
Croatia
Hungary
Ukraine
South Korea
Georgia
Iran
Russia
Syria
Malaysia
Hezbollah
Morocco

9 M 123 Khrizantema

	
9 P157-2 "*Khrizantema-S*" variant of the BMP-3	*The 9 M123 missile*

Contents

1 - Introduction

The Khrizantema (English : Chrysanthemum) is a Russian supersonic anti - tank missile . Khrizantema was designed to deal with current and future generations of main battle tanks , such as the M1A2 and Leopard 2A5 and later, and can also be used to engage slow and low flying aerial targets like helicopters . The missile carries the GRAU designation 9 M 123 and the NATO reporting name AT-15 Springer.

9 M 123 Khrizantema	
Type	Anti - tank missile
Place of origin	Russia
Service history	
In service	2005 - present

Used by	Russia
Production history	
Designer	KBM (Kolomna)
Manufacturer	KBM
Variants	9 M123 , 9 M123 - 2, 9 M123 F, 9 M 123 F - 2
Specifications	
Weight	46 kg (54 kg with launch tube)
Length	2057 mm
Diameter	150 mm
Warhead	Tandem HEAT (9 M 123) , Thermo baric (9 M 123 F)
Warhead weight	8 kg (9 M 123) , 6 kg (9 M 123 F)
Detonation mechanism	Impact fuze
Wingspan	310 mm
Propellant	Solid - fuel rocket
Operational range	400 - 6000m
Speed	400 m / s
Guidance system	ACLOS radar beam riding , SACLOS laser beam riding
Steering system	Two control surfaces
Accuracy	< 5 m
Launch platform	9 P157 - 2 tank destroyer, Mi - 28 Attack helicopter

2 – Development

The Khrizantema anti - tank missile was unveiled in July 1996 by the Konstruktorskoye Byuro Mashynostroyenia (KBM) Engineering Design Bureau . The missile had started development in the 1980s and was designed as an all weather, multi-purpose missile system that could defeat current and future armoured units equipped with advanced armour protection like explosive reactive armour (ERA). Khrizantema was envisaged as a replacement for a variety of different types of anti-tank missile that remained in service with the Soviet military, such as the 9K114 Shturm and the 9 M120 Ataka - V. The system was expected to enter service with the Russian armed forces in 2004.

3 – Description

The 9 M 123 missile is supersonic, flying at an average speed of 400 m / s or Mach 1.2 and has a range of between 400 and 6,000 meters. Propulsion is by way of a single solid fuel rocket motor with two exhausts on either side of the missile. The off - set exhausts cause the missile to spin during flight. Guidance control is provided by two pop-out control surfaces at the rear of the missile (four additional surfaces help stabilise the missile during flight). The Khrizantema is unique among Russian anti-tank guided missiles as, depending on the variant the missile, it can either be guided by laser or radar. The radar unit uses the millimeter wave band and the system automatically tracks the target and guides the missile in the radar beam. This form of guidance is LOSBR (Line - Of - Sight Beam Riding) that is ACLOS. When guided using a laser, a continuous laser beam is generated towards the target and a sensor in the rear section enables the missile to ride the laser beam to the target. This form of guidance is LOSBR (Line – Of - Sight Beam Riding) that is SACLOS. This dual guidance system allows two missiles to be fired at two separate targets at once, with one missile guided by laser and the other by radar. Each missile carries a tandem HEAT warhead with a reported penetration of 1100 –1250 mm RHA behind explosive reactive armour (ERA) , alternatively a thermobaric warhead can be carried to engage soft - skinned targets, fortifications and manpower.

The 9 M123 missile together with its associated guidance system forms the 9 K123 missile system. It is currently launched from the 9 P157-2 Khrizantema-S tank destroyer, Mi-28 Havoc attack helicopter and most likely in the near future from the KA-52 Alligator attack helicopter as well. The 9 P 157-2 Khrizantema - S is based on the BMP-3 chassis. The 9 P 157-2 carries two 9 M 123 missiles on launch rails, which are extended from a stowed position, the radar is also stowed during transit. Missile are re-loaded automatically by the tank destroyer from an internal magazine with 15 rounds (missiles are stored and transported in sealed canisters) and can also accept munitions manually loaded from outside the vehicle.[1] The manufacturer claims that three 9P157-2 tank destroyers are able to engage 14 attacking tanks and destroy at least sixty percent of the attacking force . The dual guidance system ensures protection against electronic countermeasures and operation in all climatic conditions, day or night. NBC protection is provided for the crew (gunner and driver) of each 9 P 157-2 in addition to full armour protection equivalent to the standard BMP-3 chassis and entrenching equipment.

4 – Variants

9 M123 - Laser guidance with tandem HEAT warhead.
9 M123-2 - Radar guidance with tandem HEAT warhead.
9 M123F - Laser guidance with thermobaric warhead.
9 M123F-2 - Radar guidance with thermobaric warhead.

5 – Operators

Libya - 3 machines
Russia - 16 machines
Syria

9 M 133 Kornet

9 M 133 missile with launcher

Contents

1 - Introduction

The Kornet (English: Cornet) is a Russian anti - tank guided missile (ATGM). It is intended to deal with main battle tanks and to engage slow and low flying helicopters, but is not intended to fully replace previous systems, due to the cost.[3] The missile carries the GRAU designation 9M133 and the NATO reporting name AT-14 Spriggan.

9 M 133 Kornet	
Type	Anti - tank missile
Place of origin	Russia

Service history	
In service	1994 – present
Used by	See *users*
Production history	
Designer	KBP Instrument Design Bureau
Manufacturer	KBP Instrument Design Bureau
Variants	9 M123, 9 M123 - 2, 9 M123 F, 9 M123 F - 2
Specifications	
Weight	27 kg (29 kg with launch tube)
Length	1200 mm
Diameter	152 mm
Warhead	1000 – 1200 mm RHA penetration after ERA with Tandem HEAT, Thermo baric
Warhead weight	7 kg HEAT, 10 kg TNT equivalent Thermo baric
Detonation mechanism	Impact fuze
Wingspan	460 mm
Propellant	Solid - fuel rocket
Operational range	Kornet 100 - 5,500 m Kornet - EM 8,000 m (anti - tank), 10,000 m (thermobaric)
Guidance system	SACLOS laser beam riding
Steering system	Two control surfaces
Accuracy	< 5 m

2 – Development

The Kornet anti - tank missile was unveiled in October 1994 by the KBP Instrument Design Bureau . The missile started development in 1988 as a modular, universal system able to engage any target from a mix of platforms using a reliable laser beam guidance system that was simple to use. It is a heavy ATGM, superior to the earlier 9 K111 Fagot (NATO: AT- 4 Spigot) and 9K113 Konkurs (NATO: AT-5 Spandrel) wire - guided ATGMs, but not to replace them (due to the cost) . The missile is believed to have entered service in the Russian army in 1994 . Its export designation is the Kornet - E.

3 – Description

The Kornet Anti Tank Missile system is an advanced ATGM with spiral trajectory.

The 9 M133 missile together with its 9P163-1 tripod launcher and 1 PN 79 - 1 thermal sight forms the 9 K 123 missile system , the 9 K123 can be carried and operated by a two - person infantry crew. In addition to an infantry portable version, the 9 K133 the system has been integrated into a variety of other vehicles and weapons systems as either an upgrade package or a new weapon system. The 9K133 has been fitted into a BMP-3 to form the 9 P 163M-1 tank destroyer and is similar in function to the Khrizantema missile system. The 9P163M-1 carries two 9 M 133 missiles on launch rails, which are extended from a stowed position during transit. Missile are re-loaded automatically by the tank destroyer from an internal magazine with 16 rounds (missiles are stored and transported in sealed canisters).[8] NBC protection is provided for the two crew (gunner and driver) of each 9 P 163M-1 in addition to full armour protection equivalent to the standard BMP-3 chassis. The guidance system of the 9 P 163M-1 allows two missiles to be fired at once, the missiles operating on different guidance (laser) channels.

The KBP Instrument Design Bureau has also marketed the 9K133 system as part of the Kvartet for mounting on vehicles and boats, the system has four missiles on ready to launch rails along with associated guidance and sighting system all packaged in a single turret. The turret has space for an additional five rounds and is operated by a single individual, the guidance system also allows two missiles to be fired at once. Another upgrade possibility is the Kliver missile and gun turret, seen as an upgrade option for the BTR series of APC, BMP-1 IFV and patrol boats. It has similar capabilities as the Kvartet turret, but also carries a 30 mm 2A72 cannon; the turret weight is 1,500 kg.[10] Finally the 9 M 133 is also available in the BEREZHOK turret upgrade also made available by KBP.

4 - Combat history

During the 2003 invasion of Iraq, Kornets were used by some groups of Iraqi special forces to attack American armoured vehicles, "disabling at least two Abrams tanks and one Bradley armored troop carrier in the opening week of the war".

The second verified episode of the Kornet ATGM in combat use occurred during the 2006 Lebanon War, where the missiles, reportedly supplied by Syria, were successfully used by Hezbollah fighters to destroy up to four Israeli Merkava tanks, and damage a number of others. One of the first detailed accounts of IDF's successful capture of Kornet ATGMs on Hezbollah positions in the village of Ghandouriyeh appeared in the Daily Telegraph article, which also reported that the boxes were marked with "Customer: Ministry of Defense of Syria. Supplier: KBP, Tula , Russia".] Several months after the cease - fire, reports have provided sufficient photographic evidence that Kornet ATGMs were indeed both in possession of, and used by, Hezbollah in this area.

Israel claims that Russian weapons were smuggled to Hezbollah by Syria, and Israel has sent a team of officials to Moscow to show Russia the evidence of what they say can only be Syrian weapons transfers . Despite initial public denials by the Russian officials that any proof of actual use of Kornet by Hezbollah has been presented, the Russian government in fact has moved to tighten control over the use of Russian-made weapons by the importing states, suggesting that the visit of the Israeli delegation did bear fruit, although it might have nothing to do with Kornet . On 6 December 2010, a Kornet launched from the Gaza strip penetrated the armour of a Merkava Mark III tank on the Israeli side of the border, but it caused no injuries in this instance due to a technical failure.

4 – 1 - In attacks against civilians

On 7 April 2011 Hamas claimed responsibility for a missile strike on an Israeli yellow school bus which killed a 16-year old boy, Daniel Viflic, and wounded another civilian (all the other children who were on the bus got out few minutes earlier). According to Israeli military spokesman, the bus was hit by a Kornet missile.

5 – Variants

9 M133-1 – 9M133 missile with Tandem HEAT warhead.

9 M133F-1 – 9M133 missile with Thermobaric warhead.

Kornet-D

6 - Operators[edit source | editbeta]

Algeria – 218 missiles ordered in 2006

Azerbaijan – 60 launchers with 540 missiles

Bangladesh - unknown amount of Kornet-E ordered on 14 January 2013.

Greece – 196 launchers with 1100+ missiles, in service as of 2008

Hamas – Used in 2010–2011 / 2012

Hezbollah – Used in 2006 Lebanon war

Iran – Produced locally under the name Dehlavie

India – 250 Kornet-E in service as of 2008

Jordan – 200 Kornet-E launchers with 2000 missiles.

Syria – 50 Kornet-E launchers with 1500 missiles as of 1998.

Libya – Used in 2011 Civil War by Qaddafi loyalists

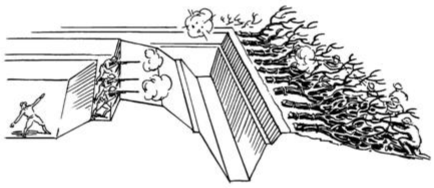
Morocco

Russia – 750 missiles were produced, quantity of the launchers is unknown (2009)

Turkey – 80 launchers with 800 missiles

Peru – 288 missiles and 24 launchers plus training simulators and technical support. The contract (worth on US $ 24 million) was signed in 2008. All missiles delivered in January 2010. As of June 2013, it is currently negotiating the purchase of aditional units.

Abatis



Abatisses are used in war to keep the approaching enemy under fire for as long as possible.

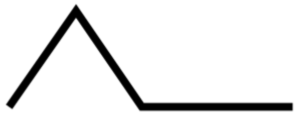
Abatis, abattis, or abbattis is a term in field fortification for an obstacle formed (in the modern era) of the branches of trees laid in a row, with the sharpened tops directed outwards , towards the enemy. The trees are usually interlaced or tied with wire. Abatis are used alone or in combination with wire entanglements and other obstacles.

There is evidence it was used as early as the Roman Imperial period, and as recently as the American Civil War . Abatis is rarely seen nowadays, having been largely replaced by wire obstacles. However, it may be used as a replacement or supplement when barbed wire is in short supply. A form of giant abatis, using whole trees instead of branches, can be used as an improvised anti-tank obstacle.

A classic use of an abatis was found at the Battle of the Chateauguay, 26 October 1813, when approximately 1,300 Canadian voltigeurs, under the command of Charles-Michel de Salaberry, defeated an American corps of approximately 4,000 men. Another striking example was its use by Alexander Macomb in the stunning victory at the Battle of Plattsburgh.

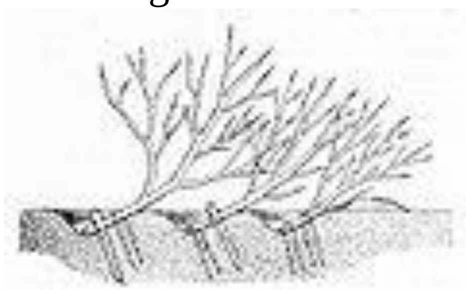
An important weakness of abatis, in contrast to barbed wire, is that it can be destroyed by fire. Also, if laced together with rope instead of wire, the rope can be very quickly destroyed by such fires, after which the abatis can be quickly pulled apart by grappling hooks thrown from a safe distance.

An important advantage is that an improvised abatis can be quickly formed in forested areas. This can be done by simply cutting down a row of trees so that they fall with their tops toward the enemy. An alternative is to place explosives so as to blow the trees down.



United States military symbol for an abatis

Though rarely used by modern conventional military units, abatises are still officially maintained in United States Army and Marine Corps training. Current training instructs engineers or other constructors of such obstacles to fell trees, leaving a 1 or 2 yard stump, in such a manner as the trees fall interlocked pointing at a 45-degree angle towards the direction of approach of the enemy. Furthermore, it is recommended that the trees remain connected to the stumps and the length of roadway covered be at least 80 yards. US military maps record an abatis by use of an inverted "V" with a short line extending from it to the right.



Abatis improvised by Japanese troops during World War II

Giant abatis, made from entire trees, can make an effective anti-vehicle obstacle. This formation can be achieved by use of

ABC Dry Chemical

An ABC Dry Chemical Fire Extinguisher

Contents

1 - Introduction

ABC Dry Chemical, tri - class or multi - purpose dry chemical is a dry chemical extinguishing agent used on class A, B, and C fires. It uses a specially fluidized and siliconized mono ammonium phosphate powder. ABC dry chemical is usually a mix of mono ammonium phosphate and ammonium sulfate, the former being the active one. The mix between the two agents is usually 40 – 60 %, 60 – 40 %, or 90 – 10 % depending on local standards worldwide.

2 - Uses[edit source

2 – 1 - Class A fires

It insulates Class - A fires by melting at approximately 350–400 degrees F. Class A fires consist of combustible materials such as wood and paper.

2 – 2 - Class B fires

The powder breaks the chain reaction of Class - B fires by coating the surface to which it is applied. Class B fires consist of flammable liquid or gas which include gasoline, oil, propane, and natural gas.

2 – 3 - Class C fires

It is safe and effective for Class - C fires since it is a non-conductor of electricity. Class C fire deals with live electrical equipment and need to be put out with equipment that will not conduct its energy back to the user as in the case with water. Electricity can also cause Class A and B fires.

3 - Inappropriate Uses

ABC dry chemical is inappropriate for chlorine or oxidizer fires. The resulting chemical reaction can cause an explosion or a breakdown of the chemicals releasing toxic gases. Water should be used . ABC dry chemical is inappropriate for certain metal fires (Class - D) as well as cooking oil fires (Class - K) . Due to the corrosive properties of ABC Dry chemical, it is not recommended for use around aircraft or sensitive equipment.

4 - Fire Extinguishers

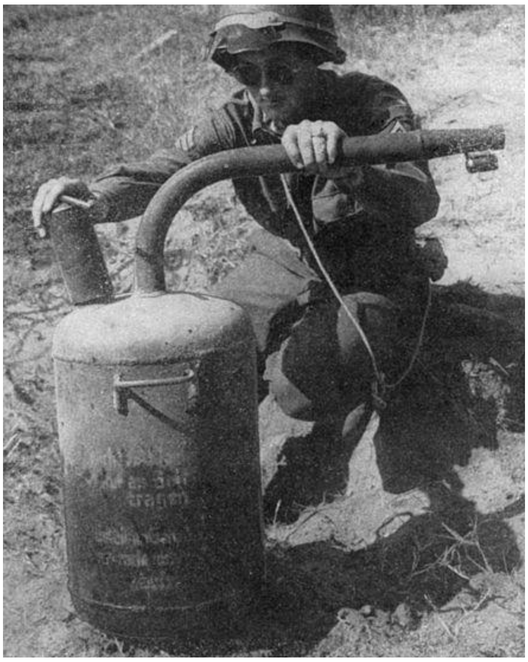
Sizes of these handheld fire extinguishers range in US customary sizes from 2½ lb., 5 lb., 6 lb., 10 lb., 20 lb. and "Fast Flow" and cartridge operated 30 lb. extinguishers. Wheeled extinguishers used in high hazard areas range from 150 lb. – 350 lb. For stationary hand line systems the capacities range from 500 lb. – 3000 lb. units. In EN 3 European standards, the range is 1 kg to 12 kg; wheeled models containing 30, 50, 75 and 100 kg are also used.

5 - Chimney bombs

Chimney bombs are zip - lock bags or other small bags filled with ABC dry chemical powder. Chimney bombs are used by fire service personnel to help extinguish chimney fires . Creosote, which is the by - product of the incomplete burning of wood (typically due to chronic combustion - air insufficiency) , is extinguished by the chain reaction caused by the chimney bombs. Chimney bombs work by first being dropped directly down a chimney, where upon contact with the flue bottom and heat of the fire, they explode, thereby releasing the powder. Then, the natural chimney draft will carry the dry chemical powder up the shaft of the chimney, thus coating the creosote and eventually neutralizing the fire. Use of multiple chimney bombs may be necessary, depending on how severe the fire is. Chimney bombs are also ineffective if they are opened and then dropped down the chimney. It should be kept in mind that, in order for chimney bombs to be effective, it may be necessary to first unclog the chimney.

Fire Class	Geometric Symbol	Pictogram	Intended Use	Mnemonic	compatibility
A	Green Triangle		Ordinary solid combustibles	A for "Ash"	Compatible
B	Red Square		Flammable liquids and gases	B for "Barrel"	Compatible
C	Blue Circle		Energized electrical equipment	C for "Current"	Compatible
D	Yellow Decagon (Star)		Combustible metals	D for "Dynamite"	Not compatible
K	Black Hexagon		Oils and fats	K for "Kitchen"	Not compatible

Abwehrflammenwerfer 42



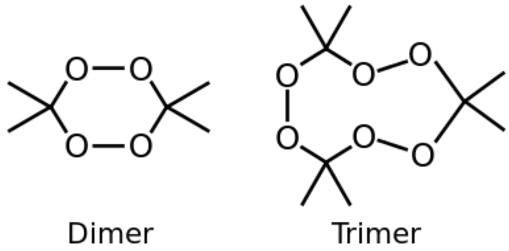
A US soldier holds up a German static flame thrower, probably an Abwehrflammenwerfer 42.

The Abwehrflammenwerfer 42 was a German static defensive flamethrower, flame fougasse or flame mine used during the Second World War. The design was copied from Russian FOG - 1 mines that were encountered in 1941 during Operation Barbarossa. These were usually buried at intervals of 11 to 27 m covering road blocks, landing beaches, harbour walls and other obstacles. They were normally mixed in with other mines or emplaced behind barbed wire and could be command detonated or triggered by tripwires or other devices.

The mine consisted of a large fuel cylinder 53 centimeters high and 30 centimeters with a capacity of 29.5 liters containing a black viscid liquid; a mix of light, medium, and heavy oils. A second, smaller cylinder, 67 millimeters in diameter and 25 centimeters high, was mounted on top of the fuel cylinder; it contained the propellant powder, which was normally either black powder or a mixture of nitro cellulose and di ethylene glycol di nitrate. A flame tube was fixed centrally on top of the fuel cylinder, it was a 50 millimeters diameter pipe that rose from the center of the fuel cylinder and curved to extend horizontally approximately 50 centimeters . When the mine was buried, only the flame tube was normally above ground.

When the mine was triggered, a squib charge ignited the propellant, creating a burst of hot gas which forced the fuel from the main cylinder and out of the flame tube. A second squib ignited the fuel as it passed out of the end of the tube. The projected stream of burning fuel was 4.5 meters wide and 2.7 meters high with a range of about 27 meters . and lasted about 1.5 seconds.

Acetone Peroxide



Contents

1 - Introduction

Acetone peroxide (tri acetone tri peroxide, per oxy acetone, TATP, TCAP) is an organic peroxide and a primary high explosive. It takes the form of a white crystalline powder with a distinctive bleach - like odor.

It is susceptible to heat, friction and shock. The instability is greatly altered by impurities, including its own oligomers. It is not easily soluble in water. It is more stable and less sensitive when wet .

IUPAC name :
3,3-Dimethyl-1,2- di oxa cyclo propane (monomer)
3,3,6,6 -Tetra methyl-1,2,4,5-tetra oxane (dimer)
3,3,6,6,9,9 - Hexa methyl-1,2,4, 5,7,8 - hexa oxa cyclo nonane (trimer)
3,3,6,6,9,9,12,12- Octamethyl-1,2,4, 5,7,8,10,11- octa oxa cyclo do decane

(tetramer)	
Other names : Acetone peroxide Peroxy acetone Mother of Satan	
Molecular formula	$C_6H_{12}O_4$ (di mer) $C_9H_{18}O_6$ (tri mer)
Molar mass	148 g / mol (di mer) 222 g / mol (tri mer)
Appearance	White crystalline solid
Melting point	91 °C
Boiling point	97 – 160 °C
Solubility in water	insoluble
Main hazards	Explosive
Explosive data	
Shock sensitivity	High / moderate when wet
Friction sensitivity	High / moderate when wet
Explosive velocity	5300 m / s
RE factor	0.83

2 – History

Acetone peroxide was discovered in 1895 by Richard Wolffenstein . He was the first chemist to use inorganic acids as catalysts. He was also the first researcher to receive a patent for using the peroxide as an explosive compound. In 1900 Bayer and Villiger described in the same journal the first synthesis of the dimer and also described use of acids for the synthesis of both peroxides. Information about these procedures including the relative proportions of monomer, di mer, and tri mer is also available in an article by Milas and Golubović. Other sources include crystal structure and 3d analysis in *The Chemistry of Peroxides* edited by Saul Patai (pp. 396 –7), as well as the *Textbook of Practical Organic Chemistry* by Vogel.

3 – Chemistry

"Acetone peroxide" most commonly refers to the cyclic trimer TCAP (tri - cyclic acetone peroxide, or tri - cyclo, $C_9H_{18}O_6$) obtained by a reaction between hydrogen peroxide and acetone in an acid-catalyzed nucleophilic addition . The dimer ($C_6H_{12}O_4$) and open monomer are also formed, but under proper conditions the cyclic trimer is the primary product. A tetrameric form was also described.[6] In mildly acidic or neutral conditions, the reaction is much slower and produces more monomeric organic peroxide than the reaction with a strong acid catalyst. Due to significant angle strain of the chemical bonds in the dimer and especially the monomer, they are even more unstable than the tri mer.

At room temperature, the trimeric form slowly sublimes, reforming as larger crystals of the same peroxide.

Acetone peroxide is notable as one of the few high explosives not containing nitrogen. This is one reason it has become popular with terrorists , as it can pass through scanners designed to detect nitrogenous explosives .

TCAP generally burns when ignited, unconfined, in quantities less than about 4 grams. More than 4 grams will usually detonate when ignited; smaller quantities might detonate when even slightly confined. Completely dry TCAP is much more prone to detonation than the fresh product still wetted with water or acetone. The oxidation that occurs when burning is :

$$2\ C_9H_{18}O_6 + 21\ O_2 \rightarrow 18\ H_2O + 18\ CO_2$$

Theoretical examination of the explosive decomposition of TCAP, in contrast, predicts "formation of acetone and ozone as the main decomposition products and not the intuitively expected oxidation products." This result is in good agreement with the results of 60 years of the study of controlled decompositions in various organic peroxides. It is the rapid creation of gas from a solid that creates the explosion. Very little heat is created by the explosive decomposition of TCAP. Recent research describes TCAP decomposition as an entropic explosion.

The high sensitivity to shock, heat and friction are due to the instability of the molecule. Big crystals, found in older mixtures, are more dangerous, as they are easier to shatter — and initiate — than small ones.

Due to the low cost and ease with which the precursors can be obtained, acetone peroxide can be manufactured by those without the resources needed to manufacture or buy more sophisticated explosives. When the reaction is carried out without proper equipment the risk of an accident is significant. Simply mixing sulfuric acid, hydrogen peroxide, and acetone can create the substance . Crystals of AP soon precipitate out.

There is a common myth that the only "safe" acetone peroxide is the trimer, made at low temperatures :

The mixture must be kept below 10 degrees Celsius. If the crystals form at this temperature, it forms the isomer called tri cyclo acetone peroxide, which is relatively stable and safe to handle. If the crystals form above this temperature, the dimeric form, called di cyclo acetone peroxide. This isomer is much more unstable, and could go off at the touch, making it not safe enough to be considered a practical explosive. As long as the temperature is kept below 10 degrees Celsius, then there is little to worry about.

The tri mer is the more stable form, but is not much more so than the dimer. All forms of acetone peroxide are sensitive to initiation. Organic peroxides are sensitive, dangerous explosives; due to their sensitivity they are rarely used by well funded militaries . Even for those who synthesize explosives as a hobby there are far safer explosives with syntheses nearly as simple as that of acetone peroxide .

Acetone peroxide is commonly combined with nitrocellulose by dissolving the nitrocellulose in acetone and then mixing in the acetone peroxide and letting it dry, which results in a mixture that is both more stable and somewhat more powerful than acetone peroxide by itself. This mixture is commonly referred to as APNC.

Tetrameric acetone peroxide is more chemically stable (heating to 120 °C for 4 hours) , although it is still a very dangerous primary explosive. It can be prepared using tin (IV) chloride (without acid present) as a catalyst with up to 40 % yield if a radical inhibitor such as hydroquinone, or a chelator such as EDTA is added.

Acetone peroxide evaporates 6.5 % in 24 hours at 14 – 18 °C. In open air at 25 °C it has a loss by sublimation of 68.6 % in 14 days. Many accidents have resulted from the fact that acetone peroxide detonates due to sublimation. Keeping it wet stops the sublimation and can prevent this type of accident.

4 - Industrial occurrence

Acetone peroxides are common and unwanted by - products of oxidation reactions, such as those used in phenol syntheses. Due to their explosivity , they are hazardous. Numerous methods are used to reduce their production — shifting the pH to more alkaline, adjusting the reaction temperature, or adding a soluble copper (II) compound.

Acetone peroxide and benzoyl peroxide are used as flour bleaching agents to bleach and "mature" flour.

Ketone peroxides, including acetone peroxide, methyl ethyl ketone peroxide, and benzoyl peroxide, find applications as initiators for polymerization reactions of e.g. silicone or polyester resins, often encountered when making fiberglass-reinforced composites. For these uses, the peroxides are typically in the form of a dilute solution in an organic solvent, though even commercial products with higher concentrations of organic peroxides can form crystals around the lid when older, making the can shock-sensitive. Methyl ethyl ketone is more common for this purpose, as it is stable in storage.

5 - Accidental byproduct

Acetone peroxide can also occur accidentally, when suitable chemicals are mixed. For example, when methyl ethyl ketone peroxide is mixed with acetone while making fiberglass composites, and left to stand for some time, or when a mixture of peroxide and hydrochloric acid from printed circuit board etching is mixed with waste acetone from cleaning the finished board and allowed to stand. While amounts obtained this way are typically much smaller than from intentional production, they are also less pure and prepared without cooling, and hence very unstable.

It is also a hazardous by - product of iso safrole oxidation in acetone, a step in the synthesis of MDMA.

6 - Use in improvised explosive devices

TATP is relatively easy to make and has been used in suicide attacks and in improvised explosive devices.[15][16] Due to its high susceptibility to accidental detonation by shock, friction, or sparks, acetone peroxide has earned the nickname "Mother of Satan" among certain Islamist militant groups.

Active Denial System

Humvee with ADS mounted

Contents

1 - Introduction

The Active Denial System (ADS) is a non-lethal, directed - energy weapon developed by the U.S. military , designed for area denial, perimeter security and crowd control . Informally, the weapon is also called the heat ray since it works by heating the surface of targets, such as the skin of targeted human subjects. Raytheon is currently marketing a reduced - range version of this technology. The ADS was deployed in 2010 with the United States military in the Afghanistan War, but was withdrawn without seeing combat. On August 20, 2010, the Los Angeles Sheriff's Department announced its intent to use this technology on prisoners in the Pitchess Detention Center in Los Angeles, stating its intent to use it in "operational evaluation" in situations such as breaking up prisoner fights . The ADS is currently only a vehicle-mounted weapon, though U.S. Marines and police are both working on portable versions. ADS was developed under the sponsorship of the DoD Non - Lethal Weapons Program with the Air Force Research Laboratory as the lead agency. There are reports that Russia is developing its own version of the Active Denial System.

2 – Effects

The ADS works by firing a high - powered beam of 95 GHz extremely high frequency waves at a target, which corresponds to a wavelength of 3.2 mm . The ADS millimeter wave energy works on a similar principle as a microwave oven, exciting the water and fat molecules in the skin, and instantly heating them via dielectric heating. One significant difference is that a microwave oven uses the much lower frequency (and longer wavelength) of 2.45 GHz. The short millimeter waves used in ADS only penetrate the top layers of skin, with most of the energy being absorbed within 0.4 mm . whereas microwaves will penetrate into human tissue about 17 mm .

The ADS's repel effect in humans occurs at slightly higher than 44°C , though first- degree burns occur at about 51°C , and second-degree burns occur at about 58°C . In testing, pea - sized blisters have been observed in less than 0.1% of ADS exposures, indicating that second degree surface burns have been caused by the device.[14] The radiation burns caused are similar to microwave burns, but only on the skin surface due to the decreased penetration of shorter millimeter waves. The surface temperature of a target will continue to rise so long as the beam is applied, at a rate dictated by the target's material and distance from the transmitter, along with the beam's frequency and power level set by the operator. Most human test subjects reached their pain threshold within 3 seconds, and none could endure more than 5 seconds.

A spokesman for the Air Force Research Laboratory described his experience as a test subject for the system:

"For the first millisecond, it just felt like the skin was warming up. Then it got warmer and warmer and you felt like it was on fire.... As soon as you're away from that beam your skin returns to normal and there is no pain."

Like all focused energy, the beam will irradiate all matter in the targeted area, including everything beyond/behind it that is not shielded, with no possible discrimination between individuals, objects or materials. Anyone incapable of leaving the target area (e.g., physically handicapped, infants, incapacitated, trapped, etc) would continue to receive radiation until the operator turned off the beam. Reflective materials such as aluminum cooking foil should reflect this radiation and could be used to make clothing that would be protective against this radiation.

Many human tests have been performed[17] on over 700 volunteers and including over 10,000 exposures by ADS.[15] A Penn State Human Effects Advisory Panel (HEAP) concluded that ADS is a non-lethal weapon that has a high probability of effectiveness with a low probability of injury :

no significant effects for wearers of contact lenses or other eyewear (including night vision goggles)

normal skin applications, such as cosmetics, have little effect on ADS’s interaction with skin

no age - related differences in response to ADS exposures

no effect on the male reproduction system

the limit of damage was the occurrence of pea - sized blisters in less than 0.1 % of the exposures (6 of 10,000 exposures).

In April 2007, one airman in an ADS test was overdosed and received second-degree burns on both legs, and was treated in a hospital for two days . There was also one laboratory accident in 1999 that resulted in a small second - degree burn.

2 – 1 - Possible long - term effects

Many possible long - term effects have been studied, with the conclusion that no long - term effects are likely at the exposure levels studied.[12] However, overexposures of either operators or targets may cause long-term damage including cancer. According to an official military assessment, "In the event of an overexposure to a power density sufficient to produce thermal injury, there is an extremely low probability that scars derived from such injury might later become cancerous. Proper wound management further decreases this probability, as well as the probability of hypertrophic scarring or keloid formation."

Cancer: A mouse cancer study was performed at two energy levels and exposures with a 94 GHz transmitter: a single 10 second, 1 W/cm exposure; and repeated 10 second exposures over 2 week period at 333 m W / cm. At both energy levels, no increase in skin cancers were observed. No studies of higher energy levels, or longer exposure times have been performed on millimeter wave systems.

Cornea damage: tests on non-human primate eyes have observed no short - term or long - term damage as the blink reflex protects the eye from damage within 0.25s.

Birth defects: millimeter waves only penetrate 0.4mm (1/64") into the skin, making direct damage to the testes or ovaries impossible.

Blisters and scarring: pea-sized blistering due to second degree burns occurred in a very small (less than 0.1 %) of tested exposures, which have a remote potential for scarring.

ADS operators would be exposed to more than the standard maximum permissible exposure (MPE) limits for RF energy, and military use requires an exception to these exposure limits .
]

3 – History

3 – 1 – Development

Two Active Denial Systems were developed under a Defense Department "Advanced Concept Technology Demonstration" Program (now known as Joint Concept Technology Demonstration Program) from 2002 to 2007. Unlike typical weapons development programs in the Defense Department, ACTDs / JCTDs are not focused on optimizing the technology; rather they are focused on rapidly assembling the technology in a configuration suitable for user evaluation.

3 – 2 – Contracts

On September 22, 2004 , Raytheon was granted an FCC license to demonstrate the technology to "law enforcement, military and security organizations ".

On October 4, 2004, the United States Department of Defense published the following contract information:

Communications and Power Industries (CPI), Palto Alto [*sic*], Calif., is being awarded a $ 6,377,762 costs-reimbursement, cost-plus fixed-price contract. The contractor shall design, build, test, and deliver a two to 2.5 megawatt, high efficiency, continuous wave (CW) 95 gigahertz millimeter wave source system. The contractor shall perform extensive modeling, simulation, experiments, and testing to the maximum capabilities of their facilities (which shall no less than one megawatt peak RF output) that will ascertain the final CW capabilities of the source. The contractor also shall provide input for the requirements for the government's test stand, which will serve as a full power facility in the future. At this time, $900,000 of the funds has been obliged. This work will be complete by January 2009. Negotiations were completed September 2004. The Air Force Research Laboratory, Kirtland Air Force Base, New Mexico, is the contracting activity (FA9451- 04 - C- 0298) .

3 – 3 – Demonstration

The military has made the ADS available to the media for demonstrations on a number of occasions. A fully operational and mounted version of the system was demonstrated on January 24, 2007, at Moody Air Force Base, Georgia, United States. A Reuters correspondent who volunteered to be shot with the beam during the demonstration described it as "similar to a blast from a very hot oven – too painful to bear without diving for cover."· An Associated Press reporter who volunteered to be engaged stated "They certainly convinced me that the system could help save the lives of innocent civilians and our young service members" CBS News correspondent did an in - depth story on ADS in March 2008 . A demonstration was conducted for the media on March 9, 2012, at Marine Corps Base Quantico, Virginia.

3 – 4 - Afghanistan deployment

On June 21, 2010, Lt. Col. John Dorrian, a spokesman for the NATO forces commander Gen. Stanley Mc Chrystal, confirmed in an e-mail to Wired Magazine reporter Noah Shachtman that the ADS was deployed in Afghanistan. The spokesman added however that the system has not yet been used operationally.

The ADS has been removed from service in Afghanistan as of July 25, 2010. A spokesperson for the United States Department of Defense said "The decision to recall the weapons back to the US was made by commanders on the ground in Afghanistan " ·

A former Principal Deputy Assistant Secretary of Defense noted that the recall of ADS from Afghanistan was an "opportunity missed" and "the non-lethality of the ADS system could prove useful in a counterinsurgency operation where avoidance of civilian casualties is essential to mission success"

3 – 5 – Problems

There have been speculations in open literature for why the ADS has not been used in a theater of operations. Some of the 'claimed problems' expressed have included :

(1) that a potential unreliability in certain environmental conditions, because precipitation (rain / snow / fog / mist) often commonly dissipates RF energy, which may moderate the ADS's sensation to "warm and comfortable";

(2) that ADS may only work successfully against exposed skin, implying that heavier clothing may reduce its effectiveness; (Video of ADS being used against people holding up a mattress with multiple layers of thick clothing have proved this wrong) .

(3) that its tactical usefulness may potentially be limited in striking specific personnel hiding in crowds of civilians, because this 'hiding' situation has not been seen in all recent theaters of operation (was reportedly observed in Somalia and Iraq, but reportedly not Afghanistan). What the actual performance of ADS is relative to these concerns is not presently known to be published in Open Literature.

3 – 6 - Active Denial System II

In 2011, the ADS was redesigned to make it smaller, more reliable, and able to be used on the move. ADS II is being designed to operate from moving aircraft, as well as moving ground vehicles. The redesign does not address problems in different environmental conditions.

4 - Concepts for use

ADS was developed as a non - lethal weapon. According to Department of Defense policy , non - lethal weapons “are explicitly designed and primarily employed so as to incapacitate personnel or material, while minimizing fatalities, permanent injury to personnel, and undesired damage to property and the environment". ADS has applications for crowd control and perimeter defense, and filling "the gap between shouting and shooting." Other crowd control methods – including sound cannons Acoustic Hailing Device, tear gas, water cannons, slippery foam and rubber bullets – carry implicit dangers of temporary or permanent injury or accidental death, and often leave residue or residual material. Combinations of acoustic and optical system platforms with ADS can be used to effectively communicate to, warn of escalation of force, introduce optical and auditory deterrents and step function the escalation of transmitted force from relatively benign to ultimately forced dispersal of a crowd, or to deny them from an area or access to an area. A group of people can theoretically be dispersed or induced to leave an area in a manner unlikely to damage personnel, non-involved civilians (no stray bullets), or to nearby buildings or the environment.

Non-lethal weapons are intended to provide options to U.S. troops, for example, “to stop suspicious vehicles without killing the drivers”. Although the ADS millimeter wave frequency does not affect a car’s electronic components, it can be used to deter a driver in an approaching vehicle.[36] In a broader strategic context, non-lethal weapons such as ADS have the potential to offer 'precision, accuracy, and effective duration that can help save military and civilian lives, break the cycle of violence by offering a more graduated response, and even prevent violence from occurring if the opportunity for early or preclusionary engagement arises.”

The Council on Foreign Relations noted that ”wider integration of existing types of nonlethal weapons (NLW) into the U.S. Army and Marine Corps could have helped to reduce the damage done by widespread looting and sabotage after the cessation of major conflict in Iraq”.

In Afghanistan, the need to minimize civilian casualties have led to restrictive rules of engagement on the use of lethal force by US troops. A National Public Radio correspondent in Afghanistan “witnessed troops grappling with the dilemma of whether to shoot”. Non - lethal weapons such as ADS provide an option for US forces in those situations.

5 – Controversy

The effects of this radio frequency on humans have been studied by the military for years, and much, but not all of the research has been published openly in peer-reviewed journals.

A news article criticized the sheer amount of time it is taking to field this system, citing the potential it had to avert a great deal of pain and suffering in volatile areas around the world.

Although the effects are described as simply 'unpleasant', the device has the ‘Potential for Death’.

While it is claimed not to cause burns under 'ordinary use',[43][44] it is also described as being similar to that of an incandescent light bulb being pressed against the skin , which can cause severe burns in just a few seconds. The beam can be focused up to 700 meters away, and is said to penetrate thick clothing although not walls. At 95 GHz, the frequency is much higher than the 2.45 GHz of a microwave oven. This frequency was chosen because it penetrates less than of an 0.4 mm , which – in most humans, except for eyelids and babies – avoids the second skin layer (the dermis) where critical structures are found such as nerve endings and blood vessels.

The early methodology of testing, in which volunteers were asked to remove glasses, contact lenses and metallic objects that could cause hot spots, raised concerns as to whether the device would remain true to its purpose of non - lethal temporary incapacitation if used in the field where safety precautions would not be taken. However, these tests were early in the program and part of a thorough and methodical process to demonstrate the safety and effectiveness of the technology, which has now involved more than 600 volunteer subjects and some 10,200 exposures. As safety was demonstrated in each step of the process, restrictions were removed, and now, according to ADS proponents, there are no restrictions or precautions necessary for volunteers experiencing the effect.[47] Long-term exposure to the beam may cause more serious damage, especially to sensitive tissues, such as those of the eyes. Two people have received second degree burns after exposure to the device.[44][48] (The actual number of injuries, according to Dr. Stephanie Miller of AFRL/RDHR, is a total of eight – the two previously mentioned, and six others, who healed without medical intervention) .

In addition, some claim that subjects who have body piercings, jewelry, or tattoos are likely to suffer serious skin damage. Tattooed people can become ill due to high amounts of toxic substances released from heated/melted tattoo pigment . Human effects testing on the large - scale version of ADT included more than 11,000 exposures on over 700 volunteers. Both laboratory research and full-scale test results demonstrated that there is only a 0.1% chance of injury from a System 1 or System 2 exposure.

Critics cite that, although the stated intent of the ADS is to be a non - lethal device designed to temporarily incapacitate, modifications or incorrect use by the operator could turn the ADS into a more damaging weapon that could violate international conventions on warfare (although at this time, ADS has gone through numerous treaty compliance reviews and legal reviews by AF / JAO, and in all cases complies with every treaty and law).

Some have focused on the lower threshold of use which may lead those who use them (especially civilian police) to become "trigger - happy", especially in dealing with peaceful protesters. Others have focused on concerns that weapons whose operative principle is that of inflicting pain (though "non - lethal") might be useful for such purposes as torture, as they leave no evidence of use, but undoubtedly have the capacity to inflict horrific pain on a restrained subject. According to Wired Magazine, the Active Denial System has been rejected for fielding in Iraq due to Pentagon fears that it would be regarded as an instrument of torture.

6 - Silent Guardian

Defense contractor Raytheon has developed a smaller version of the ADS, the Silent Guardian. This stripped - down model is primarily marketed for use by law enforcement agencies, the military and other security providers. The system is operated and aimed with a joystick and aiming screen. The device can be used for targets up to 550 m away.

LA County jail is now installing the smaller-sized unit on the ceiling of their jail.

Michael Hanlon – who volunteered to experience its effects – described it as "a bit like touching a red-hot wire, but there is no heat, only the sensation of heat." Raytheon says that pain ceases instantly upon removal of the ray; still, Hanlon reported that the finger he subjected "was tingling hours later."

Active Fire Protection

Contents

1 - Introduction

Active fire protection (AFP) is an integral part of fire protection. AFP is characterised by items and/or systems, which require a certain amount of motion and response in order to work, contrary to passive fire protection.

2 - Categories of Active Fire Protection

2 – 1 - Fire suppression

Fire can be controlled or extinguished, either manually (fire fighting) or automatically. Manual includes the use of a fire extinguisher or a Standpipe system. Automatic means can include a fire sprinkler system, a gaseous clean agent, or firefighting foam system. Automatic suppression systems would usually be found in large commercial kitchens or other high - risk area.

2 – 2 - Sprinkler systems

Fire sprinkler systems are installed in all types of buildings, commercial and residential. They are usually located at ceiling level and are connected to a reliable water source, most commonly city water. A typical sprinkler system operates when heat at the site of a fire causes a glass component in the sprinkler head to fail, thereby releasing the water from the sprinkler head. This means that only the sprinkler head at the fire location operates - not all the sprinklers on a floor or in a building. (This is a common misconception which stems from action movie scenes). Sprinkler systems help to reduce the growth of a fire, thereby increasing life safety and limiting structural damage.

2 – 3 - Fire detection

Fire is detected either by locating the smoke, flame or heat, and an alarm is sounded to enable emergency evacuation as well as to dispatch the local fire department. An introduction to fire detection and suppression can be found here. Where a detection system is activated, it can be programmed to carry out other actions. These include de-energising magnetic hold open devices on Fire doors and opening servo-actuated vents in stairways.

2 – 4 - Hypoxic air fire prevention

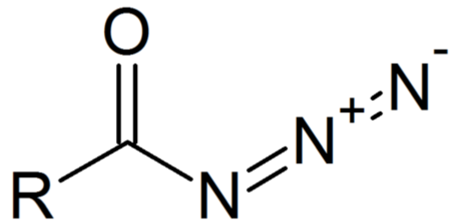
Fire can be prevented by hypoxic air. Hypoxic air fire prevention systems, also known as oxygen reduction systems are new automatic fire prevention systems that reduce permanently the oxygen concentration inside the protected volumes so that ignition or fire spreading cannot occur. Unlike traditional fire suppression systems that usually extinguish fire after it is detected, hypoxic air is able to prevent fires.

3 - Construction and maintenance

All AFP systems are required to be installed and maintained in accordance with strict guidelines in order to maintain compliance with the local building code and the fire code. An example treatise on code compliance in Miami Dade County can be seen here. Code authorities can encourage compliance through open communications, such as an invitation for code questions or an invitation to participate or an explanation of the code development process

AFP works alongside modern architectural designs and construction materials and fire safety education to prevent, retard, and suppress structural fires.

Acyl Azide



A general acyl azide

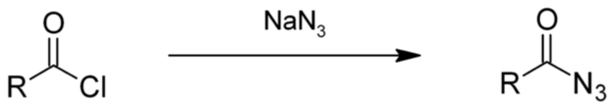
Contents

1 - Introduction

Acyl azides are carboxylic acid derivatives with the general formula $RCON_3$.

2 - Preparation

Alkyl or aryl acyl chlorides react with sodium azide in aqueous solution to give acyl azides.

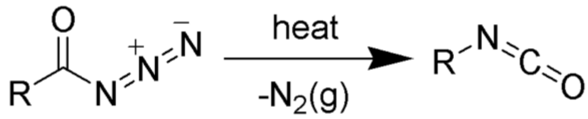


R = alkyl or aryl

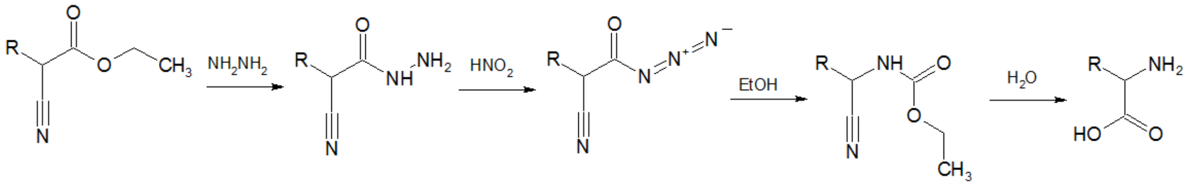
They can also be synthesized from various carboxylic acids and sodium azide in presence of tri phenyl phosphine and tri chloro aceto nitrile catalysts in excellent yields at mild conditions. Another route starts with aliphatic and aromatic aldehydes reacting with iodine azide which is formed from sodium azide and iodine monochloride in acetonitrile.

3 - Uses

Acyl azides are used as chemical reagents. On Curtius rearrangement acyl azides yield iso cyanates.



Acyl azides are also formed in Darapsky degradation,



Ad hoc

Contents

1 - Introduction

Ad hoc is a Latin phrase meaning "for this". It generally signifies a solution designed for a specific problem or task, non - generalizable, and not intended to be able to be adapted to other purposes (compare *a priori*). Common examples are organizations, committees, and commissions created at the national or international level for a specific task. In other fields the term may refer, for example, to a military unit created under special circumstances, a tailor-made suit, a handcrafted network protocol, or a purpose-specific equation. *Ad hoc* can also mean makeshift solutions, shifting contexts to create new meanings, inadequate planning, or improvised events.

2 - Ad hoc hypothesis

In science and philosophy, *ad hoc* means the addition of extraneous hypotheses to a theory to save it from being falsified. *Ad hoc* hypotheses compensate *for* anomalies not anticipated by the theory in its unmodified form. Scientists are often skeptical of theories that rely on frequent, unsupported adjustments to sustain them. *Ad hoc* hypotheses are often characteristic of pseudoscientific subjects. *Ad hoc* hypotheses are not necessarily incorrect. However, an interesting example of an apparently supported *ad hoc* hypothesis was Albert Einstein's addition of the cosmological constant to general relativity in order to allow a static universe. Although he later referred to it as his "greatest blunder" as it has been found to correspond quite well to the theories of dark energy.

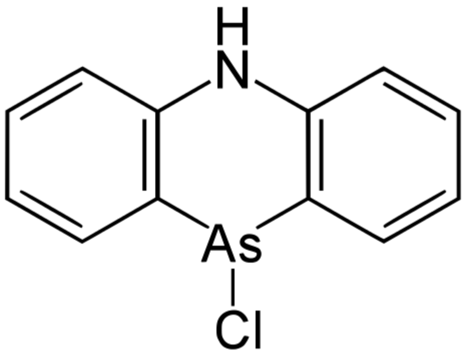
***3 - Ad hoc* military**

In military, *ad hoc* units are created during unpredictable situations, when the cooperation between different units is needed for fast action. An example would be a military breakout.

***4 - Ad hoc* networking**

The term *ad hoc* networking typically refers to a system of network elements that combine to form a network requiring little or no planning.

Adamsite



Preferred IUPAC name : Di benzo -1- chloro-1,4 - arsenine	
Systematic name : 10 - Chloro -5,10- di hydro phen arsazinine	
Other names : 10- Chloro -5*H*- phen arsazinine Di phenyl amine chlor arsine	
Molecular formula	$C_{12}H_9AsClN$
Molar mass	277.5 g mol^{-1}
Appearance	Yellow - green crystals
Melting point	195 °C
Boiling point	410 °C
Solubility in water	0.064 g dm^{-3}

Adamsite or DM is an organic compound; technically, an arsenical di phenyl amine chlor arsine, that can be used as a riot control agent. DM belongs to the group of chemical warfare agents known as vomiting agents or sneeze gases. First synthesized in Germany by Heinrich Otto Wieland in 1915, it was independently developed by the US chemist Roger Adams (for whom it is named) at the University of Illinois in 1918.

DM was produced and stockpiled by the United States at the end of World War I, but not deployed on the battlefield then. It was used against the Bonus Army who demonstrated in Washington, DC, in

1932, reportedly causing the death and serious injury of several children who had accompanied their parents on the protests. It was again used in the Vietnam War.

DM is an odourless crystalline compound with a very low vapour pressure. The colour of the crystals ranges from bright yellow to dark green depending on the purity. It is readily soluble in some organic solvents (e.g., acetone, dichloromethane), but nearly insoluble in water. In vaporous form it appears as a canary yellow smoke.

Adamsite is usually dispersed as an aerosol, making the upper respiratory tract the primary site of action. Although the effects are similar to those caused by typical riot control agents (e.g. CS), they are slower in onset and longer in duration, often lasting several hours. After a latency period of 5 –10 minutes irritation of the eyes, lungs and mucous membranes develops followed by headache, nausea and persistent vomiting.

DM is now regarded as obsolete. It has been widely replaced by riot control agents such as CS which are less toxic and more rapid in onset of symptoms. Early battlefield use was intended to be via "Adamsite candles". These were large metal cans or tubes (weighing approximately 5 pounds) which contained a smoke composition made of Adamsite plus a slow burning pyrotechnic composition. A series of candles were lit and the Adamsite-laden smoke allowed to drift towards the enemy.

North Korea has been accused of producing Adamsite at its Aoji-ri Chemical Complex for stockpiling.

Admiralty Scaffolding

	
Extant remains at Salthouse, North Norfolk, England.	*A section of Admiralty scaffolding prepared for testing*

Admiralty scaffolding, also known as Obstacle Z.1 or sometimes simply given as beach scaffolding[1] or anti-tank scaffolding , was a British design of anti - tank and anti - boat obstacle made of tubular steel. It was widely deployed on beaches of southern England, eastern England and the south western peninsula during the invasion crisis of 1940 - 1941. Scaffolding was also used, though more sparingly, inland.

Of a number of similar designs, by far the most common was designated obstacle *Z.1*. This design comprised upright tubes 2.7 m high and 1.5 m apart , these were connected by up to four horizontal tubes. Each upright was braced by a pair of diagonal tubes, at about 45°, to the rear. 6 m wide sections were preassembled and then carried to the sea to be placed in position at the half tide mark as an obstacle to boats.

However, trials found that a 250 ton barge at $5\frac{1}{2}$ knots (6.3 mph ; 10 km / h) or an 80 ton trawler at $7\frac{1}{2}$ knots (8.6 mph; 14 km / h) would pass through the obstacle as if it were not there and a trawler easily pulled out one bay with an attached wire rope. Tests in October 1940, confirmed that tanks could only break through with difficulty, as a result Z.1 was adopted as an anti-tank barrier for beaches thought suitable for landing tanks. As an anti-tank barrier it was placed at or just above the high water point[6] where it would be difficult for tanks to get enough momentum to break through the barrier. In some places, two sets of scaffolding were set up, one in the water against boats and one at high water against tanks.

The problem of securing the barriers on sand were overcome by the development of the *sword picket* by Stewarts & Lloyds – this device was later known at the Admiralty as the *Wallace Sword*.

Barriers varying in length from a couple of hundred feet to three miles were constructed consuming 50% of Britain's production of scaffolding steel at an estimated cost of £6,600 per mile (equivalent to £ 310,000 today) . Despite this, many miles of Admiralty scaffolding were erected using more than 24,000 km) of scaffolding tube.

After the war, the scaffolding got in the way of swimmers.[11][12] Very soon, the scaffolding was removed for scrap and any remaining traces are now very rare, but are occasionally revealed by storms.

Advanced Disaster Management Simulator

Contents

1 - Introduction

The ADMS (advanced disaster management simulator) is an emergency and disaster management training simulation system designed to train incident commanders, first responders, and incident command teams in a real - time, interactive virtual reality (VR) environment . ADMS was first introduced by Environmental Tectonics Corporation (ETCC : US) in 1992. The development of ADMS was in response to the crash of British Air tours Flight 28M at the Manchester airport in 1985, in which 55 people died. Following the accident research indicated that first responder training should include realistic scenarios. The first ADMS system was produced for the UK Ministry of Defense, and delivered to Royal Air Force's (RAF) Manston Facility. Since its inception, ADMS has evolved into a modular, expandable disaster simulation platform, with systems in use worldwide.

2 – History

2 – 1 - Virtual reality and emergency management training

The successful use of virtual reality simulation in disaster management training initiatives is a popular area for research. It has been found that when trainees are able to participate, both verbally and physically in a training exercise, retention is 90%, in great contrast to a 10 % retention rate of what they hear, and 50% retention rate of what they see and hear.

Traditionally classroom lectures, tabletop exercises and live-training drills have been utilized for training. While these teaching methodologies are effective, virtual reality simulation seems to have bridged the gap between them. Virtual reality offers the opportunity to create an emergency situation that could not otherwise be experienced due to safety, cost and environmental factors. From a safety standpoint, training in a synthetic environment allows the student to experiment while carrying out dangerous actions, and offers the ability to repeat the exercise until the trainee feels confident and prepared for real - life incidents.

3 - Technology

The ADMS relies on a physics engine and built in artificial intelligence to provide realistic, 3D emergency situations. The Disaster scenarios include algorithms which take into account: type of threat, time of day, precipitation, wind, visibility, condition of casualties, terrain, and traffic and bystander behavior[4] ADMS training exercises are unscripted and open - ended, requiring interactive decision making[1] and participation from the users to affect the outcome of the training exercise. The development, escalation, or resolution of the situation is determined by the trainees' decisions and the use of intelligent resources they command.

ADMS is a networked framework and a family of applications which may be run on a single station or as a multi-user system with several networked stations giving independent access to several viewpoints and control interfaces within the same environment and scenario. ADMS projects its simulations using panoramic high-definition multimedia interface, visual displays and directional sound. The simulation engine includes key models including: artificial intelligence, physics, logic, and messaging and applications comprising a visual engine, sound engine, messaging daemon and graphical user interface.

3 – 1 – Environments

ADMS environments are developed in either geo - typical or geo-specific environments. Geo - specific environments are created using exact 3D modeling of the specified location, and can include buildings, streets, vehicles, terrain and people, specific airports or schools, or entire cities.

4 - Products and applications

ADMS - COMMAND Designed for training incident commanders in a diverse range of emergency scenarios, ranging from car accidents to low - frequency, high casualty situations, either in single or multi - agency operations. Trainees make decisions and give verbal commands, enabling the real-time action of the simulator.[5] The system can be expanded to include additional simulation elements, including vehicle controls and cabs, and 180 degree immersive visual displays.

ADMS - DRIVE Designed to train, assess and recertify drivers in safe and effective driving procedures. It is also utilized as a training platform to train emergency responders to drive under stressful situations, and by airport snow removal teams to train in snow removal operations during winter conditions. ADMS-DRIVE immerses the user in a realistic, virtual environment in which dynamic elements such as traffic, signal lights, people and weather create a realistic and challenging representation of the situation.

ADMS - ARFF Designed as an aircraft rescue and firefighting vehicle simulator which focuses on correct turret operation, driving and communication, vehicle positioning, firefighting with turrets and Command and Control. The trainee uses controls and joysticks to maneuver the vehicle in an airport environment and deals with airplane disaster.

ADMS - HRET HRET (High - reach extendable turret) is intended to be a training aid for operators to become familiar with, and enhance the skills necessary for actual hands on operation of the Rosenbauer HRET. HRET is a portable desktop system that comes with a console that includes a real HRET-joystick and relevant switches. Trainees can drive to the scene, train various external and internal fire scenarios, and penetrate the aircraft by using the piercing device.

ADMS - BART The behavioral assessment research tool (BART) was developed initially for the Netherlands Institute for Safety, Research Department. BART focuses on human behavior and the effect it has in a real-life incident. ADMS - BART creates an environment where virtual human subjects act as they would in a live situation. This system made it possible to use virtual reality for studying virtual behaviors in fires, allowing for changes in the live environment to mitigate the damages in the event of a live incident.

ADMS-US Is a standardized simulation system, programmed with ten (10) geo - typical situation environments which resemble Anytown USA. ADMS - US is a portable, laptop based simulator which is utilized for either individual or multi-agency training who do not require geo-specific capabilities.

5 – Compliance

On January 27, 2009, the U.S. Army Program Executive Office for Simulation, Training and Instrumentation (PEO STRI) awarded ETC STOC II eligibility for the ADMS . STOC II is an ID/IQ (Indefinite Delivery / Indefinite Quantity) contract vehicle with a ceiling of $ 17.5 billion over a period of 10 years. All branches of the military are eligible to utilize STOC II to quickly obtain simulation and training solutions from a panel of pre - qualified companies. The purpose of this contract vehicle was to provide an efficient method for the U.S. military and its coalition service members to acquire what they need.

Additionally, ADMS was designed to be NIMS compliant. The National Incident Management System has developed a unified approach to allow governmental agencies to work in unison with the private sector with the common goal of preparing for, preventing, responding to, recovering from, and mitigating the effects of incidents of any cause, size, location, or complexity.

6 – Users

New York City Office of Emergency Management
Minneapolis – St. Paul International Airport

Florida State Fire College
Netherlands Institute for Safety (NIFV)
South Korea National Fire Service Academy (SFNFSA)
Pennsylvania Southeast Region Counter Terrorism Task Force
Aurora Community College
Butler County Community College
Pinnellas Park High School
Rosenbauer

Aerial Bomb

German WWII bombs: explosive to left, rest concrete practice bombs (250 kg and 50 kg)

An F-100 Super Sabre of the 308th TFS, being loaded with Mk 117 750 lb bombs at Tuy Hoa, South Vietnam in 1966

Royal Air Force "Grand Slam" bomb, early 1945

A British Cooper 20 pound bomb used during WWI

Modern JDAM guided GBU-31 bombs

Contents

1 - Introduction

An aerial bomb is a type of explosive weapon intended to travel through the air with predictable trajectories, usually designed to be dropped from an aircraft. Aerial bombs include a vast range and complexity of designs, from unguided gravity bombs to guided bombs, hand tossed from a vehicle, to needing a large specially built delivery vehicle; or perhaps *be* the vehicle itself such as a glide bomb, instant detonation or delay-action bomb. The act is termed aerial bombing. As with other types of explosive weapons aerial bombs are designed to kill and injure people and destroy materiel through the projection of blast and fragmentation outwards from the point of detonation.

2 - Early bombs

The first bombs delivered to their targets by air were launched on unmanned balloons, carrying a single bomb, by the Austrians against Venice in 1849.

The first bombs dropped from a heavier-than-air aircraft were grenades or grenade - like devices. Historically, the first use was by Giulio Gavotti on 1 November 1911, during the Italo - Turkish War.

In 1912, during the First Balkan War, Bulgarian Air Force pilot Christo Toprakchiev suggested the use of aircraft to drop "bombs" (called grenades in the Bulgarian army at this time) on Turkish positions. Captain Simeon Petrov developed the idea and created several prototypes by adapting different types of grenades and increasing their payload.

On 16 October 1912, observer Prodan Tarakchiev dropped two of those bombs on the Turkish railway station of Karağaç (near the besieged Edirne) from an Albatros F.2 aircraft piloted by Radul Milkov, for the first time in this campaign.

After a number of tests, Petrov created the final design, with improved aerodynamics, an X- shaped tail, and an impact detonator. This version was widely used by the Bulgarian Air Force during the siege of Edirne. A copy of the plans was later sold to Germany and the bomb, codenamed "Chataldzha" ("Чаталджа"), remained in mass production until the end of World War I. The weight of one of these bombs was 6 kilograms. On impact it created a crater 4-5 meters wide and about 1 meter deep .

3 - Technical description

Aerial bombs typically use a contact fuze to detonate the bomb upon impact.

Aerial Fire Fighting

Contents

1 - Introduction

Aerial firefighting is the use of aircraft and other aerial resources to combat wildfires. The types of aircraft used include fixed - wing aircraft and helicopters. Smokejumpers and rappellers are also classified as aerial firefighters, delivered to the fire by parachute from a variety of fixed-wing aircraft, or rappelling from helicopters. Chemicals used to fight fires may include water, water enhancers such as foams and gels, and specially formulated fire retardants.

2 – Terminology

A wide variety of terminology has been used in the popular media for the aircraft (and methods) used in aerial firefighting. The terms Air tanker or air tanker generally refer to fixed-wing aircraft based in the United States; "air tanker" is used in official documentation.[2] The term "water bomber" is used in Canadian government documents for the same class of vehicles.

Air attack is an industry term used for the actual application of aerial resources, both fixed - wing and rotorcraft, on a fire. Within the industry, though, "air attack" may also refer to the supervisor in the air (usually in a fixed-wing aircraft) who supervises the process of attacking the wildfire from the air, including fixed-wing airtankers, helicopters, and any other aviation resources assigned to the fire. The Air Tactical Group Supervisor (ATGS), often called "air attack," is usually flying at an altitude above other resources assigned to the fire, often in a fixed - wing plane but occasionally (depending on assigned resources or the availability of qualified personnel) in a helicopter.

Depending on the size, location, and assessed potential of the wildfire, the "air attack" or ATGS person may be charged with initial attack (the first response of firefighting assets on fire suppression), or with extended attack, the ongoing response to and management of a major wildfire requiring additional resources including engines, ground crews, and other aviation personnel and aircraft needed to control the fire and establish control lines or firelines ahead of the wildfire.

3 – Equipment

A wide variety of helicopters and fixed - wing aircraft are used for aerial firefighting. In 2003, it was reported that "The U.S. Forest Service and Bureau of Land Management own, lease, or contract for nearly 1,000 aircraft each fire season, with annual expenditures in excess of US $ 250 million in recent years".

3 – 1 – Helicopters

Helicopters may be fitted with tanks (helitankers) or they may carry buckets. Some helitankers, such as the Erickson Air Crane, are also outfitted with a front - mounted foam cannon. Buckets are usually filled by submerging or dipping them in lakes, rivers, reservoirs, or portable tanks. The most popular of the buckets is the flexible Bambi Bucket. Tanks can be filled on the ground (by water tenders or truck-mounted systems) or water can be siphoned from lakes, rivers, reservoirs, or a portable tank through a hanging snorkel. Popular firefighting helicopters include variants of the Bell 204 and the Erickson S - 64 Air crane helitanker, which features a sea snorkel for filling from a natural water source while in flight. Currently the worlds biggest helicopter Mil Mi-26 uses a bambi - bucket.

	
S - 64 Erickson Air-Crane photographed at Ioannina airport, Greece	*Kern County (California) Fire Department Bell 205 dropping water during a training exercise at the Mojave Spaceport*
	
PBY Catalina flying boat	*Los Angeles County Fire Department's Sikorsky S -70 C Firehawk during a water drop demonstration at Station 129 in Lancaster, California*

3 – 2 - Air tankers

Air tankers or water bombers are fixed - wing aircraft fitted with tanks that can be filled on the ground at an air tanker base or, in the case of flying boats and amphibious aircraft, by skimming water from lakes, reservoirs, or large rivers.

Various aircraft have been used over the years for firefighting. In 1947, shortly after World War Two ended, the United States Air Force and United States Forest Service did an experiment in which World War Two aircraft dropped *water bombs* similar to those used in wartime napalm attacks. It was not found successful, and internal water tanks were found the solution . Though World War II and Korean War - era bombers were for a long time the mainstay of the aerial firefighting fleet, and are still in use[7] newer purpose-built tankers are coming online. The smallest are the Single Engine Air Tankers (SEATs). These are agricultural sprayers that generally drop about 3,000 l of water or retardant. An example is the Air tractor AT- 802 F, which can deliver around 3,000 l of water or fire retardant solution each drop. Another is the Ukrainan Antonov An - 2 biplane which can be fitted with floats that can scoop water from the surface of a body of water. An advantage of the biplane is that it has a lower stall speed than a monoplane meaning it a can fly more slowly over a fire which enhances the accuracy of water or retardant drops. Medium aircraft include the S-2 Tracker (retrofitted with turboprop engines as the S-2T) as used by the California Department of Forestry & Fire Protection (CDF), as well as Conair Group Inc. of Abbotsford, British Columbia, while the Douglas DC-4, the DC-7, the Lockheed C-130 Hercules, P-2V Neptune, Lockheed P-3 Orion and, commercial equivalent, the L188 Electra as used by Air Spray Ltd., of Red Deer, Alberta and others have been used as heavy tankers.

The largest aerial firefighter currently in use is a Boeing 747 aerial firefighter, known as the Evergreen Supertanker that can carry 90,800 l fed by a pressurized drop system. The Supertanker entered service for the first time in 2009, fighting a fire in Cuenca, Spain.[8] The tanker made its first American operation on August 31, 2009 at the Oak Glen Fire.

The next largest aerial firefighters currently in use include two converted Martin Mars flying boats in British Columbia (one of which was brought to southern California in September 2007 to help battle the wildfires there). Each Martin Mars can carry approximately 27,300 l of water or fire retardant each, and the Tanker 910, a converted McDonnell Douglas DC-10 that can carry 12,000 US gallons (45,400 l)[12] of water or retardant. The Russian Ministry of Emergency Situations operates convertible - to - cargo IL - 76 air tankers that can carry up to 15,000 US gallons (56,800 l) but have been operating with 41,600 l tanking systems, and a few of Beriev Be-200 amphibians.

Bombardier's Dash 8 Q Series aircraft are the basis of new, next-generation air tankers. Cascade Aerospace has converted two pre-owned Q400s to act as part-time water bomber[13] and part-time transport for France's Sécurité Civile, one of which is registered F-ZBMC, while Neptune Aviation is converting a pre-owned Q300 as a prototype to augment their P2V aircraft. Air Spray Aviation is also in the process of converting a BAe146 to the role of air tanker at its maintenance facility in Chico, California . Another modern-era passenger jet now being considered for conversion to aerial firefighting in the US, is the McDonnell Douglas MD-80 series.

Similar in configuration to the World War II – era PBY Catalina, the Canadair CL-215 Scooper, and Bombardier CL - 415 Super Scooper are designed and built specifically for firefighting. The "Super Scoopers" are not common in the United States where only 2 operate seasonally in southern California. Los Angeles County leases two CL- 415s from the Province of Quebec during the fall when the Santa Ana winds are at their worst. 6 American owned CL-215s operate for various State and Federal agencies. Critics of scoopers in the US claim that there is not enough suitable water in fire prone states. CL-215s have been employed with success in North Carolina, Minnesota, Michigan, Wisconsin, Washington, Alaska, Northern Idaho, and Montana.

French "Sécurité Civile" owns 12 Canadair CL- 415, 9 Conair Turbo-Firecat and 2 Dash 8. Most pilots are retired naval aviators, less often regular air force pilots or even ex members of acrobatic teams like "La Patrouille de France". It is a high-risk job that requires very skilled pilots.

Croatian Air Force uses six CL-415 planes, as well as the six AT 802s for (mainly) firefighting purposes.

Another amphibian is the Russian Beriev Be-200. It can carry a maximum payload of about 12,000 l of water, making "scoops" in suitable stretches of water in 14 seconds. It was successfully used to fight fires in the southern European countries such as Greece and Portugal. Also in Asian countries like Israel.

A PZL M-18 Dromader drops water near Mobridge, SD

Lockheed P-3A Orion N920AU Operated by Aero Union

An IL-76TD of IRGC performs maneuver in 2012 Iran Kish Air Show

Spanish Canadair CL415

3 – 3 - Comparison table of fixed – wing , firefighting tanker airplanes

All links, citations and data sources are listed in the paragraph above. For accident and grounding citations, see paragraph below table.

Make and model	Country of origin	Category	Water / Retardant capacity
PZL - Mielec M - 18 Dromader	Poland	Light	2,200 L
Air Tractor AT - 802F	USA	Light	3,050 L
Air Tractor AT - 1002	USA	Medium	3,800 L
Grumman S - 2 Tracker	USA	Medium	4,500 L
Douglas B - 26	USA	Medium	no longer in service
Douglas DC-4	USA	Medium	no longer in service

Douglas DC-6	USA	Medium	11,000 L
Douglas DC-7	USA	Medium	11,000 L
Lockheed C-130 Hercules	USA	Medium	National Guard MAFFS units ; 11,000 L
Lockheed L-188 Electra	USA	Medium	11,000 L
P-2V Neptune	USA	Medium	8,940 L
P-3 Orion	USA	Medium	11,000 L
Evergreen 747 Supertanker	USA	Super Heavy	78,000 L
Martin Mars	USA	Medium	27,000 L
Douglas DC - 10	USA	Heavy	45,000 L
Ilyushin Il - 76	Russia	Heavy	43,230 L
Beriev Be - 200	Russia	Medium	12,010 L
Bombardier Dash 8 Q 400 - MR	Canada	Medium	9,800 L
PBY Catalina	USA	Medium	3,800 L or 5,700 L for the Super model
Canadair CL - 215	Canada	Medium	4,900 L
Bombardier CL - 415	Canada	Medium	6,140 L
BAe 146	United Kingdom	Medium	11,000 L
AN-32P Firekiller	Ukraine	Medium	8,000 L

Category legend: Light: under 3,800 L ,
Medium: under 38,000 l ,
Heavy: under 76,000 L ,
Super Heavy: Over 76,000 L - currently only used for the B747 Supertanker.

3 – 4 – Lead planes

The Lead Plane function directs the activities of the air tankers by both verbal target descriptions and by physically leading the air tankers on the drop run. The leadplane is typically referred to as a

"Bird Dog" in Canada or "Supervision" aircraft in Australia. The O-2 Skymaster, Cessna 310 and OV-10 Bronco have been used as spotter and lead plane platforms. The Ontario Ministry of Natural Resources has also used the Cessna 337. The Beechcraft Baron was long used as a leadplane or air attack ship, but most were retired in 2003; more common now is the Beechcraft King Air and the Twin Commander 690. A Cessna Citation 500 jet owned by Air Spray Aviation was used by the British Columbia Ministry of Forests beginning in 1995 and used for two fire seasons to lead the very fast, Electra L188 air tanker to the fires. This was the first time a jet aircraft was used as an lead plane or "bird dog". The Department of Environment and Conservation (DEC), in Western Australia operates a fleet of nine American Champion Scouts 8GCBC during the summer months as spotter aircraft and Air Attack platforms. The Provinces of Alberta and British Columbia contract Air Spray Aviation to supply Twin Commander 690 as bird dog aircraft for their air tanker fleets. Air Spray owns 9 Twin Commander 690 for use as bird dog aircraft.

3 – 5 - Fleet grounding

In the United States, most of these aircraft are privately owned and contracted to government agencies, and the National Guard and the U.S. Marines also maintain fleets of firefighting aircraft. On May 10, 2004, The U.S. Forest Service (USFS) and the Bureau of Land Management (BLM) announced that they were cancelling contracts with operators of 33 heavy air tankers. They cited liability concerns and an inability to safely manage the fleet after the wing failure and resulting crash of a C-130A Hercules in California and a PB4Y-2 in Colorado during the summer of 2002. Both aged aircraft broke up in flight due to catastrophic fatigue cracks at the wing roots. After subsequent third - party examination and extensive testing of all USFS contracted heavy air tankers, three companies were awarded contracts and now maintain a combined fleet of 23 aircraft.

4 - Fire retardant

Borate salts used in the past to fight wild fires have been found to sterilize the soil and be toxic to animals so are now prohibited.[18] Newer retardants use ammonium sulfate or ammonium polyphosphate with attapulgite clay thickener or di ammonium phosphate with a guar gum derivative thickener. These are not only less toxic but act as fertilizers to help the regrowth of plants after the fire. Fire retardants often contain wetting agents, preservatives and rust inhibitors and are colored red with ferric oxide or *fugitive* color to mark where they have been dropped. Brand names of fire retardants for aerial application include Fire - Trol and Phos - Chek.

Some water - dropping aircraft carry tanks of a guar gum derivative to thicken the water and reduce runoff.

	
A helicopter dips its bucket into a river to drop water on a wildfire in California	*A MAFFS - equipped Air National Guard C-130 Hercules drops fire retardant on wildfires in southern California*

5 - Tactics and capabilities

Helicopters can hover over the fire and drop water or retardant. The S - 64 Helitanker has microprocessor - controlled doors on its tank. The doors are controlled based on the area to be covered and wind conditions. Fixed - wing aircraft must make a pass and drop water or retardant like a bomber. Spotter (Air Tactical Group Supervisor) aircraft often orbit the fire at a higher altitude to coordinate the efforts of the smoke jumper, helicopter, media, and retardant-dropping aircraft; while lead planes fly low-level ahead of the air tankers to mark the trajectory for the drop, and ensure overall safety for both ground-based and aerial firefighters.

Water is usually dropped directly on flames because its effect is short-lived. Fire retardants are typically dropped ahead of the moving fire or along its edge and may remain effective for two or more days. This can create artificial firebreaks where the terrain is too rugged or remote for ground crews to cut fire line.

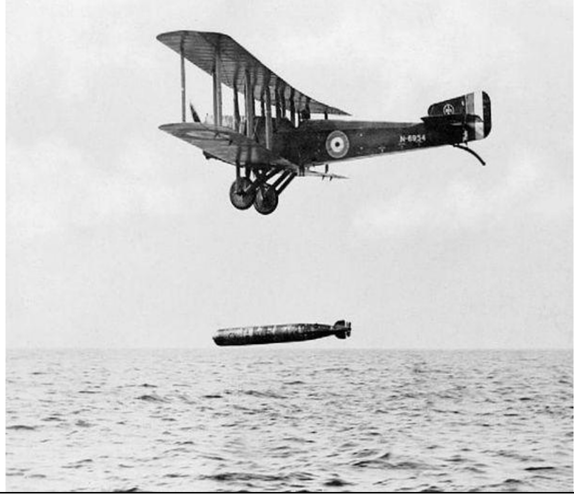
Aerial firefighting is most effectively used in conjunction with ground - based efforts, as aircraft are only one weapon in the firefighting arsenal. However, there have been cases of aircraft extinguishing fires long before ground crews were able to reach them.

Some firefighting aircraft can refill their tanks in mid - flight, by flying down to skim the surface of large bodies of water. One example is the Bombardier CL- 415. This is particularly useful in rural areas where flying back to an airbase for refills may take too much time. In 2002 an Ontario CL - 415 crew was able to refill 100 times within a 4- hour mission, delivering an astounding 612 ton of water on a fire near Dryden Ontario . { June 1, 2002 Dryden fire }

6 - Urban legends about aerial firefighting

An urban legend arises sometimes about a water bomber, or a helicopter with a dangling water bucket, scooping up a scuba diver and dumping him on a wildfire site. Urban legend debunking site Snopes.com reports there are no proven cases of this happening in reality.

Aerial Torpedo

	
In 1915, Admiral Bradley A. Fiske imagined that an aerial torpedo attack would be carried out close to the water and at night.	*An aerial torpedo dropped from a Sop with Cuckoo during World War I*

Contents

1 - Introduction

An aerial torpedo, airborne torpedo or air - dropped torpedo is a naval weapon, the torpedo, designed to be dropped into water from an aircraft (fixed - wing aircraft or helicopter) after which it propels itself to the target . First used in World War I , air - dropped torpedoes were used extensively in World War II, and remain in limited use today. Aerial torpedoes are generally smaller and lighter than submarine - and surface-launched torpedoes.

Historically, the term "aerial torpedo" was used to describe flying bombs and pilotless drone aircraft intended as weapons, the precursor to modern cruise missiles. Today, the term refers primarily to water - borne torpedoes launched from the air.

2 – Design

A successful aerial launched torpedo design needs to account for
The distance it travels through the air before entering the water
The heavy impact with the water

The Japanese Type 91 torpedo used aerodynamic tail stabilizers in the air. These stabilizers (introduced in 1936) were shed off when it entered the water. And a new control system (introduced in 1941) stabilized the rolling motion by counter steering both in the air and the water. The Type 91 torpedo could be released at speed of 180 knots (333 km / h) from 20 m into shallow water but also at 204 knots (the Nakajima B5N2's maximum speed) into choppy waves of a rather heavy sea.

3 - Tactics and usage

The idea of dropping lightweight torpedoes from aircraft was conceived in the early 1910s by Bradley A. Fiske, an officer in the United States Navy . Awarded a patent in 1912 , Fiske worked out the mechanics of carrying and releasing the torpedo from a bomber, and defined tactics that included a night-time approach so that the target ship would be less able to defend itself. Fiske determined that the notional torpedo bomber should descend rapidly in a sharp spiral to evade enemy guns, then when about 10 to 20 feet (3 to 6 m) above the water the aircraft would straighten its flight long enough to line up with the torpedo's intended path. The aircraft would release the torpedo at a distance of 1,400 to 1,800 m from the target. Fiske reported in 1915 that, using this method, enemy fleets could be attacked within their own harbors if there was enough room for the torpedo track.

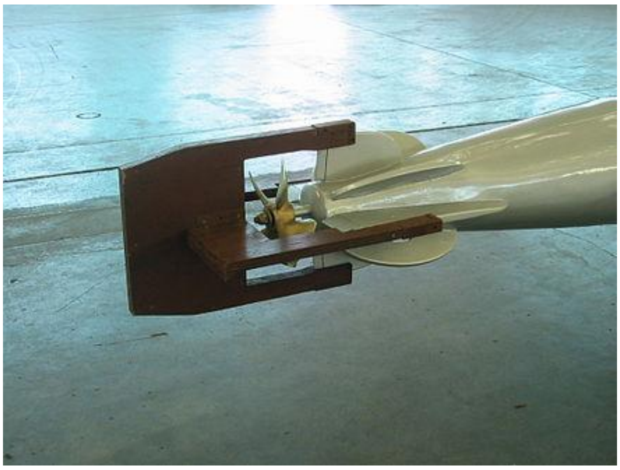
3 – 1 - World War I

In July 1914, the first British aerial torpedo was dropped in trials performed in a Short "Folder" by Lieutenant (later Air Chief Marshall Sir) Arthur Longmore . In November 1914, Germans were reportedly experimenting at Lake Constance with the tactic of dropping torpedoes from a Zeppelin . In December 1914, Squadron Commander Cecil L'Estrange Malone commented following his participation in the Cuxhaven Raid that "One can well imagine what might have been done had our seaplanes, or those which were sent out to attack us, carried torpedoes or light guns."

On August 12, 1915, a Short Type 184 piloted by Flight Commander Charles H. K. Edmonds from HMS *Ben-my-Chree* operating in the Aegean Sea took off with a 360 mm - diameter , 370 kg torpedo to fly over land and sank a Turkish supply ship in the Sea of Marmara . Five days later, a Turkish steamship was sunk by a torpedo aimed again by Edmonds. His formation mate, Flight Lieutenant G. B. Dacre, sank a Turkish tugboat after being forced to land on the water with engine trouble. Dacre taxied toward the tugboat, released his torpedo and was then able to take off and return to *Ben-My - Chree*. A limitation to using the Short more widely as a torpedo bomber was that it could only take off carrying a torpedo in conditions of perfect flying weather and calm seas, and, with that load, could only fly for a little more than 45 minutes before running out of fuel.

On May 1, 1917, a German seaplane loosed a torpedo and sank the 2,829 ton British steam ship *Gena* off Suffolk. A second German seaplane was downed by gunfire from the sinking *Gena*. German torpedo bomber squadrons were subsequently assembled at Ostend and Zeebrugge for further action in the North Sea . Later in 1917, the U.S. Navy began to perform trials using a 180 kg dummy torpedo which, in its first air drop, porpoised from the water back up in the air and almost hit the aircraft . Several British torpedo bombers were built, including the Sopwith Cuckoo, the Short Shirl and the Blackburn Blackburd, but a squadron was assembled so late in the war that it achieved no successes.

3 – 2 - Interwar years



Breakaway wooden fins help stabilize the torpedo in the air. They grip the metal fins only by friction, and are forced off upon entry into the water.

The United States bought its first 10 torpedo bombers in 1921, variants of the Martin MB-1. The squadron of U.S. Navy and Marine fliers was based at Naval Weapons Station Yorktown. General Billy Mitchell suggested arming the torpedo bombers with live warheads as part of Project B (the anti-ship bombing demonstration) but the Navy was only curious about aerial bomb damage effects. Instead, a trial using dummy heads on the torpedoes was carried out against a foursome of battleships steaming at 17 knots. The torpedo bombers scored well.

In 1931, the Japanese Navy developed the Type 91 torpedo, intended to be dropped by a torpedo bomber from a height of 100 m and a speed of 190 km / h . In 1936, the torpedo was given wooden attachments to the tail to increase its aerodynamic qualities — these attachments were shed upon hitting the water. By 1937, with the addition of a breakaway wooden damper at the nose, the torpedo could be dropped from 200 m and a speed of 220 km / h. Tactical doctrine determined in 1938 that the Type 91 aerial torpedo should be released at a distance of 1,000 m from the target . As well, the Japanese Navy developed night attack and massed day attack doctrine, and coordinated aerial torpedo attacks between land- and carrier-based torpedo bombers .

The Japanese divided their bomber squadrons into two groups so as to attack an enemy battleship from both frontal quarters and make it extremely unlikely for it to be able to avoid the torpedoes by maneuvering, and more difficult for it to direct anti-aircraft fire at the bombers. Even so, Japanese tactical experts predicted that, against a battleship, the attacking force would be able to score hits at a rate of only one-third that observed during peacetime exercises.

Beginning in 1925, the United States began designing a special torpedo for purely aerial operations. The project was discontinued and revived several times, and finally resulted in the Mark 13 torpedo which went into service in 1935 . The Mark 13 differed from aerial torpedoes used by other nations in that it was wider and shorter. It was slower than its competitors but it had longer range . The weapon was released by an aircraft traveling lower and slower 15 m high , 200 km / h than its Japanese contemporary.

3 – 3 - World War II

On the night of November 11–12, 1940, Swordfish biplane torpedo bombers of the British Fleet Air Arm sank three Italian battleships at the Battle of Taranto using a combination of torpedoes and bombs. In the course of the chase of the German battleship *Bismarck* torpedo strikes were attempted in very bad seas, and one of these damaged her rudder allowing the British fleet to catch her. The standard British airborne torpedo for the first half of World War II was the Mark XII, an 460 mm - diameter model weighing 702 kg with an explosive charge of 176 kg of trinitrotoluene (TNT).

German aerial torpedo development lagged behind other belligerents — a continuation of neglect of the category during the 1930s. At the beginning of World War II, Germany was making only five aerial torpedoes per month , and half were failing in air-drop exercises. Instead, Italian aerial torpedoes made by Fiume were purchased, with 1,000 eventually delivered .

A Japanese Nakajima B5N1 torpedo bomber takes off from the aircraft carrier Akagi with a battered dummy torpedo.

In August 1941, Japanese aviators were practicing dropping torpedoes in the shallow waters of Kagoshima Bay, testing improvements in the Type 91 torpedo and developing tactics for the attack of ships in harbor. They discovered that the Nakajima B5N torpedo bomber could fly 160 knots (296 km/h; 184 mph), faster than expected, without the torpedoes striking the bottom of the bay 100 feet (30 m) down. On December 7, 1941, the leading wave — 40 B5N torpedo bombers — used the tactic to score more than 15 hits during the attack on Pearl Harbor.

In April 1942, Adolf Hitler made the production of aerial torpedoes a German priority, and the *Luftwaffe* took the task over from the *Kriegsmarine* . The quantity of available aerial torpedoes outstripped usage within a year, and an excess of aerial torpedoes were on hand at the end of the war. From 1942 to late 1944, about 4,000 aerial torpedoes were used, but some 10,000 were manufactured during the whole war. Torpedo bombers were modified Heinkel He 111 and Junkers Ju 88 aircraft, but the Focke - Wulf Fw 190 fighter aircraft was successfully tested as a delivery system.

The Mark 13 torpedo was the main American aerial torpedo, yet it was not perfected until after 1943 when tests showed that it performed satisfactorily in only 33 of 105 drops made from aircraft traveling faster than 280 km / h . Like the Japanese Type 91, the Mark 13 was subsequently fitted with a wooden nose covering and a wooden tail ring, both of which sheared off when it struck the water.

The wooden shrouds slowed it and helped it retain its targeting direction through the duration of the air drop. The nose covering absorbed enough of the kinetic energy from the torpedo hitting the water that recommended aircraft height and speed were greatly increased to 732 m high at 760 km / h .

In 1941, development began in the United States on the FIDO, an electric - powered air-dropped acoustic homing torpedo intended for anti - submarine use. In the United Kingdom, the standard airborne torpedo was strengthened for higher aircraft speeds to become the Mark XV, followed by the Mark XVII. For carrier aircraft, the explosive charge remained 176 kg of TNT until later in the war when it was increased to 196.2 kg of the more powerful Torpex.

During World War II, U.S. carrier - based torpedo bombers made 1,287 attacks against ships, 65 % against warships, and scored hits 40 % of the time. However, the low, slow approach required for torpedo bombing made the bombers easy targets for defended ships; during the Battle of Midway, for example, virtually all of the American torpedo bombers were shot down.[ ]

3 – 4 - Korean War

After World War II , anti - aircraft defenses were sufficiently improved to render aerial torpedo attacks suicidal . Lightweight aerial torpedoes were disposed or adapted to small attack boat usage. The only significant employment of aerial torpedoes was in anti-submarine warfare.

During the Korean War the United States Navy successfully disabled the Hwacheon Dam with aerial torpedoes launched from A-1 Skyraiders.

3 – 5 - Modern weapons

Since the advent of practical anti - ship missiles technology, aerial torpedoes have largely been reduced to use in anti-submarine warfare. Missiles are generally much faster, with longer range and do not have the same launch altitude limitation of aerial torpedoes. Some modern aerial anti - submarine torpedoes do have the necessary guidance capability to engage surface vessels, though given the widespread availability of missiles on aircraft and the small, specialized warhead on anti - submarine aerial torpedoes, this is not an option normally considered.

At the peak of the Falklands war, however, the Argentine Air Force, in collaboration with the Navy, outfitted an FMA IA 58 Pucará prototype, AX - 04, with pylons to mount Mark 13 torpedoes. The aim was the possible production of Pucaras as torpedo-carrying aircraft to enhance the anti - ship capabilities of the Argentine air forces. Several trials were performed off Puerto Madryn, but the war was over before the technicians could evaluate the feasibility of the project.

As a result of the loss of the role of anti-shipping aerial torpedo in modern naval doctrine, true torpedo bomber units no longer exist in modern armed forces. The most common platform for aerial torpedoes today is the ship - borne anti - submarine helicopter, followed by fixed-wing anti-submarine aircraft such as the American P-3 Orion.

A French Lynx helicopter carrying a MK46 torpedo.

The caveat to the above are torpedoes delivered by missiles/rocket systems, designed for anti - submarine warfare. Some designs are a straightforward mating of a rocket - propulsion system to the torpedo with a purely ballistic attack profile, such as the American ASROC. More complex, aerial drone - based system with autopilot have also been deployed, such as the Australian Ikara. Most such systems are designed to be deployed from surface ships, though exceptions exist such as the Soviet navy RPK-2 Viyuga which can be launched from both surface ships and submarines.

Given the relatively soft nature of submarines, modern anti-submarine aerial torpedoes are much smaller than anti-ship aerial torpedoes of the past, and often classified as light weight torpedoes. They are also often of cross - platform design, able to be deployed from both aircraft and surface ships. Examples include the American Mark 46, Mark 50 and Mark 54 torpedoes. There are few if any aerial torpedo designs that are also used by submarines, owing to the significantly reduced size and thus capability of aerial torpedoes compared with their full - sized submarine counterparts such as the American Mark 48 torpedo.

Aerial War Fare

Contents

1 - Introduction

Aerial warfare is the use of military aircraft and other flying machines in warfare, including military airlift of cargo to further the national interests. Strategic air power is the bombing of enemy resources (by bombers); tactical air power is the battle for control of the air space (by fighters); close air support is the direct support of ground units; naval aviation refers especially to the use of aircraft carriers.

2 - Kite warfare

The earliest documented aerial warfare took place in ancient China, when a manned kite was set off to spy for military intelligence and communication.

3 - Balloon warfare

3 – 1 - Balloon warfare in Ancient China

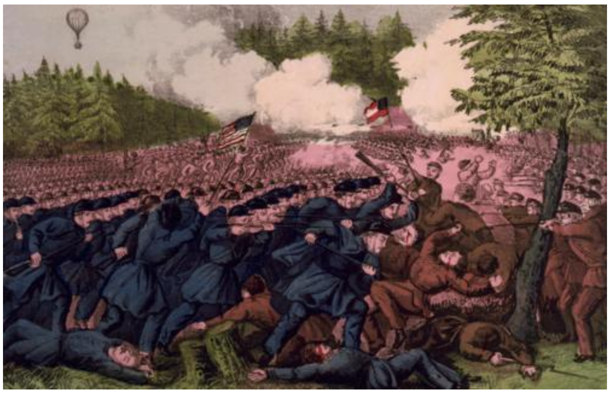
In or around the 2nd or 3rd century, a proto type hot air balloon, the Kongming lantern was invented in China serving as military communication.

3 – 2 - Balloon warfare in Europe

Some minor warfare use was made of balloons in the infancy of aeronautics. The first instance was by the French Aerostatic Corps at the Battle of Fleurus in 1794, who used a tethered balloon, *L'entreprenant*, to gain a vantage point.

Balloons had disadvantages. They could not fly in bad weather, fog, or high winds. They were at the mercy of the winds and were also very large targets.

3 – 3 - American Civil War



Battle of Fair Oaks with one of Lowe's balloons in the background

3 – 3 - 1 - Union Army Balloon Corps

The American Civil War was the first war to witness significant use of aeronautics in support of battle . Thaddeus Lowe made noteworthy contributions to the Union war effort using a fleet of balloons he created In June 1861 Professor Thaddeus S. C. Lowe left his work in the private sector and offered his services as an aeronaut to President Lincoln, who took some interest in the idea of an air war. Lowe's demonstration of flying a balloon over Washington, DC, and transmitting a telegraph message to the ground was enough to have him introduced to the commanders of the Topographical Engineers; initially it was thought balloons could be used for preparing better maps.

Lowe's first action was a free flight observation of the Confederate positions at the First Battle of Bull Run in July 1861.

Lowe was called to Fort Corcoran and ascended in order to spot rebel encampments . With flag signals he directed artillery fire on the rebels.

Lowe and other balloonists formed the Union Army Balloon Corps. Lowe insisted on the strict use of tethered (as opposed to free) flight because of concern about being shot down over enemy lines and punished as spies. By attaining altitudes from 1,000 feet (300 m) to as much as 3½ miles, an expansive view of the battle field and beyond could be had.

As the Confederates retreated, the War turned into the Peninsular Campaign. Due to the heavy forests on the peninsula, the balloons were unable to follow on land and a coal barge converted to operate balloons. The balloons and their gas generators were loaded aboard and taken down the Potomac, where reconnaissance of the peninsula could continue.

At the Battle of Fair Oaks, Lowe was able to view the enemy army advancing and sent a dispatch to have reserves sent.

The Balloon Corps was later assigned to the Engineers Corps. By August 1863, the Union Army Balloon Corps was disbanded.

3 – 3 - 3 - Confederate Army

The Confederate Army also made use of balloons, but they were gravely hampered by lack of supplies due to embargoes. They were forced to fashion their balloons from colored silk dress-making material, and their use was limited by the infrequent supply of gas in Richmond, Virginia. By the summer of 1863, all balloon reconnaissance of the American Civil War had ceased.

4 - Before World War I

Armies originally evaluated the use of aircraft for observation purposes. Naval aviation was pursued as well, with several tests done by launching floatplanes from ships at sea and recovering them later with cranes.

The United States Navy had been interested in naval aviation since the turn of the 20th century.[14][15] In August 1910 Jacob Earl Fickel did the first experimenting with Glenn Curtiss shooting a gun from an airplane. In 1910 – 1911, the Navy conducted experiments which proved the practicality of carrier-based aviation. On November 14, 1910, near Hampton Roads, Virginia, civilian pilot Eugene Ely took off from a wooden platform installed on the scout cruiser *USS Birmingham* (CL-2). He landed safely on shore a few minutes later. Ely proved several months later that it was also possible to land on a ship. On January 18, 1911, he landed on a platform attached to the American cruiser *USS Pennsylvania* (ACR - 4) in San Francisco harbor.

The first use of airplanes in an actual war occurred in the 1911 Italo-Turkish War with the Italian Army Air Corps bombing a Turkish camp at Ain Zara, Libya.[18] In the First Balkan War (1912) the Bulgarian Air Force bombed Turkish positions at Adrianople, while the Greek Aviation performed, over the Dardanelles, the first naval air co - operation mission in history . Airplanes were also used by the United States Army against Pancho Villa . Air reconnaissance was carried out in both wars too. The air-dropped bomb was extensively used during the First Balkan War (including in the first ever night bombing on 7 November 1912), and subsequently shared with the Imperial German Air Service during World War I.

5 - World War I

Sop with Camel

Initially during that war both sides made use of tethered balloons and airplanes for observation purposes, both for information gathering and directing of artillery fire.[23] A desire to prevent enemy observation led to airplane pilots attacking other airplanes and balloons, initially with small arms carried in the cockpit, but initially pilots couldn't have forward - facing machine guns.

The addition of deflector plates to the back of propellers by French pilot Roland Garros and designer Raymond Saulnier in the Morane-Saulnier monoplane was the first example of an aircraft able to fire through its propeller, permitted Garros to score three victories on April 1915. Dutch aircraft designer Anthony Fokker developed the gun synchronizer in 1915 , resulting in German *Leutnant* Kurt Wintgens scoring the first known victory for a synchronized gun-equipped fighter aircraft, on July 1, 1915.

The Allies were able to capture a Fokker *Eindecker* with a Fokker-designed *Stangensteuerung* synchronizer mechanism intact and reverse engineer it, leading to the birth of *aerial combat*, more commonly known as the dogfight. Tactics for dogfighting evolved by trial and error. The German ace Oswald Boelcke created eight essential rules of dogfighting, the *Dicta Boelcke*.

Both sides also made use of aircraft for bombing, strafing, sea reconnaissance, antisubmarine warfare, and dropping of propaganda. The German military made use of Zeppelins and, later on, bombers such as the Gotha, to drop bombs on Britain . By the end of the war airplanes had become specialized into bombers, fighters, and observation (reconnaissance) aircraft.

By the end of World War I, aerial combat had progressed to the point where dogfighting tactics based on such doctrine as the Dicta Boelcke had progressed to the point that air supremacy could be achieved; the earliest example is the Italian air offensive against the Austro - Hungarians just before the end of World War I.

6 - Between the wars

Between 1918 and 1939 aircraft technology developed very rapidly. In 1918 most aircraft were biplanes with wooden frames, canvas skins, wire rigging and air-cooled engines. Biplanes continued to be the mainstay of air forces around the world and were used extensively in conflicts such as the Spanish Civil War . Most industrial countries also created air forces separate from the army and navy. However, by 1939 military biplanes were in the process of being replaced with metal framed monoplanes, often with stressed skins and liquid cooled engines. Top speeds had tripled; altitudes doubled; ranges and payloads of bombers increased enormously.

Some theorists, especially in Britain, considered that aircraft would become the dominant military arm in the future.[37] They imagined that a future war would be won entirely by the destruction of the enemy's military and industrial capability from the air.[38] The Italian general Giulio Douhet, author of *The Command of the Air*, was a seminal theorist of this school, which has been associated with Stanley Baldwin's statement that "the bomber will always get through"; that is, regardless of air defences, sufficient raiders will survive to rain destruction on the enemy's cities . This led to what would later be called a strategy of deterrence and a "bomber gap", as nations measured air force power by number of bombers.

Others, such as General Billy Mitchell in the United States, saw the potential of air power to augment the striking power of naval surface fleets . German and British pilots had experimented with aerial bombing of ships and air - dropped torpedoes during World War I with mixed results. The vulnerability of capital ships to aircraft was demonstrated on 21 July 1921 when a squadron of bombers commanded by General Mitchell sank the ex- German battleship SMS *Ostfriesland* with aerial bombs; although the *Ostfriesland* was stationary and defenseless during the exercise, its destruction demonstrated the potency of air planes against ships.

It was during the Banana Wars, while fighting bandits, freedom fighters and insurgents in places like Haiti, the Dominican Republic and Nicaragua, that United States Marine Corps aviators would begin to experiment with air - ground tactics making the support of their fellow Marines on the ground their primary mission. It was in Haiti that Marines began to develop the tactic of dive bombing and in Nicaragua where they began to perfect it. While other nations and services had tried variations of this technique, Marine aviators were the first to embrace it and make it part of their tactical doctrine .

Germany was banned from possessing an air force by the terms of the World War I armistice.[45] The German military continued to train its soldiers as pilots clandestinely until Hitler was ready to openly defy the ban. This was done by forming the *Deutscher Luftsportverband*, a flying enthusiast's club, [46][47] and training pilots as civilians, and some German pilots were even sent to the Soviet Union for secret training; a trained air force was thus ready as soon as the word was given. This was the beginning of the *Luftwaffe*.

7 - World War II

Military aviation came into its own during the Second World War. The increased performance, range, and payload of contemporary aircraft meant that air power could move beyond the novelty applications of World War I, becoming a central striking force for all the combatant nations.

Over the course of the war, several distinct roles emerged for the application of air power.

7 – 1 - Strategic bombing

Strategic bombing of civilian targets from the air was first proposed by the Italian theorist General Giulio Douhet. In his book *The Command of the Air* (1921), Douhet argued future military leaders could avoid falling into bloody World War I–style trench stalemates by using aviation to strike past the enemy's forces directly at their vulnerable civilian populations. Douhet believed such strikes would cause these populations to force their governments to surrender.

Douhet's ideas were paralleled by other military theorists who emerged from World War I, including Sir Hugh Trenchard in Britain.[55][56] In the interwar period, Britain and the United States became the most enthusiastic supporters of the strategic bombing theory, with each nation building specialized heavy bombers specifically for this task.

Japanese strategic bombing

Strategic bombing, mostly targeting large Chinese cities, was independently conducted during the Second Sino-Japanese war and World War II by the Imperial Japanese Navy Air Service and the Imperial Japanese Army Air Service. There were also air raids on Philippines and Australia. The Navy and Army air services used tactical bombing against ships and military positions, as at Pearl Harbor.

Luftwaffe

In the early days of World War II, the Luftwaffe launched devastating air attacks against besieged cities. During the Battle of Britain, the *Luftwaffe*, frustrated in its attempts to gain air superiority, turned to bombing large British cities. However, the *Luftwaffe* found these raids did not have the effect predicted by prewar theorists.[58][59]

Soviet Red Air Force

Although the rapid industrialization the Soviet Union experienced in the 1930s had the potential to enable the Soviet Air Forces to be effective against the Luftwaffe, Stalin's purges left the organization weakened. However, when Germany invaded in June 1941, the size of the Soviet Air Forces allowed it to absorb horrendous casualties and still maintain capability.[60][61] Despite the near collapse of Soviet forces in 1941, they survived, as German forces outran their supply lines and the Americans and British provided Lend Lease assistance.

Although strategic bombing requires that the enemy's industrial war capacity be neutralized, some Soviet factories were moved far out of reach of the Luftwaffe's bombers.[63] Because the Luftwaffe's resources were needed to support the German army, the Luftwaffe became overstretched, and even victorious battles degraded Germany's air force due to attrition.[63][64] By 1943, the Soviets were able to produce considerably more airplanes than their German rivals; for example, at Kursk, the Soviets had twice the number of airplanes that the Luftwaffe had.[65] Utilizing overwhelming numerical superiority, Soviet forces were able to drive the Germans out of Soviet territory and take the war to Germany.

Allied air forces in Europe

The British started a strategic bombing campaign in 1940 that was to last for the rest of the war. Early British bombers were all twin - engine d designs and were lacking in defensive armament, and the 1939 Battle of the Heligoland Bight had shown the vulnerability of bombers to fighter attack. Therefore, RAF Bomber Command turned to a policy of area bombing at night . Later in the war pathfinder tactics, radio location, ground mapping radar, and very low-level bombing enabled specific targets to be attacked.

When the USAAF arrived in England in 1942, the Americans were convinced they could carry out successful daylight raids. The U.S. Eighth Air Force was equipped with high-altitude four-engined designs.[67][68] The new bombers also featured a strong defensive armament. Flying in daylight in large formations, U.S. doctrine held tactical formations of heavy bombers would be sufficient to gain air superiority without escort fighters. The intended raids would hit hard on chokepoints in the German war economy such as oil refineries or ball bearing factories.

The USAAF was compelled to change its doctrine since bombers alone, no matter how heavily armed, could not achieve air superiority against single - engined fighters. In a series of missions in 1943 that penetrated beyond the range of fighter cover, there were loss rates up to twenty percent. Almost 68,000 U.S. air men died helping to win the war . Overall, the Allies lost 160,000 airmen and 33,700 planes during the air war over Europe.

Air superiority

During the Battle of Britain, many of the best *Luftwaffe* pilots had been forced to bail out over British soil, where they were captured.[76] As the quality of the *Luftwaffe* fighter arm decreased, the Americans introduced the long-range escort fighters, carrying drop tanks, e.g. the Mustang. Newer, inexperienced German pilots—flying potentially superior aircraft, gradually became less and less effective at thinning the late-war bomber streams . Adding fighters to the daylight raids gave the bombers much - needed protection and greatly improved the impact of the strategic bombing effort.

Over time, from 1942 to 1944, the Allies' air forces became stronger while the Luftwaffe became weaker. During 1944, Germany's air force lost control of Germany's skies. As a result *nothing* in Germany could be securely protected—not army units, nor factories, nor civilians in cities, nor the nation's capital. German soldiers and civilians began to be slaughtered in the thousands by aerial bombardment.

Effectiveness

Strategic bombing by non - atomic means did not win the war for the Allies, nor did it succeed in breaking the will to resist of the German (and Japanese) people . But in the words of the German armaments minister Albert Speer, it created "a second front in the air." Speer succeeded in increasing the output of armaments right up to mid-1944 in spite of the bombing . Still, the war against the British and American bombers demanded enormous amounts of resources: antiaircraft guns, day and night fighters, radars, searchlights, manpower, ammunition, and fuel.

On the Allied side, strategic bombing diverted material resources, equipment (such as radar) aircraft, and manpower away from the Battle of the Atlantic and Allied armies. As a result, German army groups in Russia, Italy, and France rarely saw friendly aircraft and constantly ran short of tanks, trucks, and anti-tank weapons.

U.S. Bombing of Japan

In June 1944, B - 29s launched from China, bombed Japanese factories. From November 1944 increasingly intense raids were launched from bases closer to Japan. Tactics evolved from high-altitude to lower altitude attacks, largely removing most defensive guns and switching to incendiary bombs. These attacks devastated many Japanese cities.

In August 1945, B - 29s dropped atomic bombs on Hiroshima and Nagasaki. This, along with the Soviet invasion of Manchuria, brought about the Japanese surrender, and the official end of World War II.

7 – 2 - Tactical air support

By contrast with the British strategists, the primary purpose of the *Luftwaffe* was to support the Army. This accounted for the presence of large numbers of dive bombers on strength and the scarcity of long - range heavy bombers. This 'flying artillery' greatly assisted in the successes of the German Army in the Battle of France (1940) . Hitler determined air superiority was essential for the invasion of Britain. When this was not achieved in the Battle of Britain, the invasion was canceled, making this the first major battle whose outcome was determined primarily in the air.

The war in Russia forced the Luftwaffe to devote the majority of its resources to providing tactical air support for the beleaguered German army. In that role, the Luftwaffe used the Junkers Ju 87, Henschel Hs 123 and modified fighters — Bf 109 and FW 190.

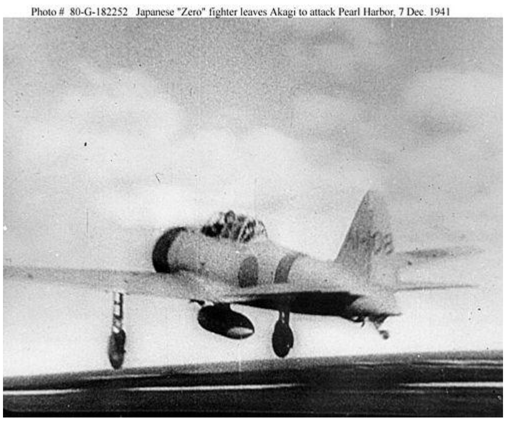
The Red Air Force was also primarily used in the tactical support role, and towards the end of the war was very effective in the support of the Red Army in its advance across Eastern Europe.[92] An aircraft of importance to the Soviets was the *Ilyushin Il-2 Sturmovik*— appropriately called "flying artillery"; the Il-2 was able to make life very difficult for panzer crews, and the Il-2 was an important part of the Soviet victory at Kursk — one of the biggest tank battles in history.

7 – 43 - Military transport aviation and use of airborne troops

Military transport aviation was invaluable to all sides in maintaining supply and communications of ground troops, and was used on many notable occasions such as resupply of German troops in and around Stalingrad after Operation Uranus, and employment of airborne troops . After the first trials in use of airborne troops by the Red Army displayed in the early 1930s many European nations and Japan also formed the airborne troops, and these saw extensive service on in all Theatres of the Second World War.

However their effectiveness as shock troops employed to surprise enemy static troops proved to be of limited success. Most airborne troops served as light infantry by the end of the war despite attempts at massed use in the Western Theatre by US and Britain during Operation Market Garden.

7 – 4 - Naval aviation



A Japanese Mitsubishi A6M2 "Zero" fighter
Main article: Naval aviation#World War II

Aircraft and the aircraft carrier first became important in naval battles in World War II. Carrier - based aircraft were specialized as dive bombers, torpedo bombers, and fighters.

Surface - based aircraft such as the PBY Catalina helped finding submarines and surface fleets. The aircraft carrier replaced the battleship as the most powerful naval offensive weapons system as battles between fleets were increasingly fought out of gun range by aircraft. The Yamato, the most powerful battleship ever built was first turned back by light escort carrier aircraft, and later sunk lacking its own air cover.

The US launched normally land-based bombers from carriers in a raid against Tokyo. Smaller carriers were built in large numbers to escort slow cargo convoys or supplement fast carriers. Aircraft for observation or light raids were also carried by battleships and cruisers, while blimps were used to search for attack submarines.

In the Battle of the Atlantic, aircraft carried by low-cost escort carriers were used for antisubmarine patrol, defense, and attack..At the start of the Pacific War in 1941, Japanese carrier-based aircraft sank many US warships at Pearl Harbor and land-based aircraft sank two large British warships. Engagements between Japanese and American naval fleets were then conducted largely or entirely by aircraft - examples include the battles of Coral Sea, Midway, Bismarck Sea and Philippine Sea.

8 - Cold War

Military aviation in the post - war years was dominated by the needs of the Cold War. The post-war years saw the almost total conversion of combat aircraft to jet power, which resulted in enormous increases in speeds and altitudes of aircraft . Until the advent of the Intercontinental Ballistic Missile major powers relied on high-altitude bombers to deliver their newly developed nuclear deterrent; each country strove to develop the technology of bombers and the high-altitude fighters that could intercept them. The concept of air superiority began to play a heavy role in aircraft designs for both the United States and the Soviet Union.

The Americans developed and made extensive use of the high-altitude observation aircraft for intelligence - gathering. The U - 2 , and later the SR - 71 Blackbird were developed in great secrecy . The

U - 2 at its time was supposed to be invulnerable to defensive measures, due to its extreme altitude. It therefore came as a great shock when the Soviets downed one piloted by Gary Powers with a surface - to - air missile.

Air combat was also transformed through increased use of air-to-air guided missiles with increased sophistication in guidance and increased range. In the 1970s and 1980s it became clear that speed and altitude was not enough to protect a bomber against air defences. The emphasis shifted therefore to maneuverable attack aircraft that could fly 'under the radar', at altitudes of a few hundred feet.

8 – 1 - Korean War

Over the course of the war, at least 16 B-29 bombers were shot down by communist aircraft.

The Korean War was best remembered for jet combat, but was one of the last major wars where propeller-powered fighters such as the P-51 Mustang, F4U Corsair and aircraft carrier - based Hawker Sea Fury and Super marine Sea fire were used. Turbojet fighter aircraft such as F-80s, F- 84 Thunder jets and F9F Panthers came to dominate the skies, overwhelming North Korea's propeller-driven Yakovlev Yak - 9s and Lavochkin La - 9s.

From 1950, North Koreans flew the Soviet-made MiG-15 jet fighters which introduced the near - sonic speeds of swept wings to air combat. Though an open secret during the war, the most formidable pilots today now admit that they were experienced Soviet Air Force pilots, a *casus belli* deliberately overlooked by the UN allied forces who suspected the use of Russians but were reluctant to engage in open war with the Soviet Union and the People's Republic of China.

At first, UN jet fighters, which also included Royal Australian Air Force Gloster Meteors, had some success, but straight winged jets were soon outclassed in daylight by the superior speed of the MiGs. At night, however, radar-equipped Marine Corps F3D Skynight night fighters claimed five MiG kills with no losses of their own, and no B-29s under their escort were lost to enemy fighters.

In December 1950, the U.S. Air Force rushed in their own swept-wing fighter, the F-86 Sabre . The MiG could fly higher, 12,800 m , offering a distinct advantage at the start of combat. In level flight, their maximum speeds were comparable about 1,060 km / h The MiG could climb better, while the Sabre could turn and dive better with an all-flying tailplane. For weapons, the MiG carried two 23 mm and one 37 mm cannon, compared to the Sabre's six .50 (12.7 mm) caliber machine guns. The American .50 caliber machine guns, while not packing the same punch, carried many more rounds and were aimed with a more accurate radar-ranging gunsight. The U.S. pilots also had the advantage of G-suits, which were used for the first time in this war.

Even after the Air Force introduced the advanced F-86, its pilots often struggled against the jets piloted by Soviet pilots, dubbed "honchos". The UN gradually gained air superiority over most of Korea that lasted until the end of the war — a decisive factor in helping the UN first advance into the north, and then resist the Chinese invasion of South Korea .

After the war, the USAF claimed 792 MiG-15s and 108 additional aircraft shot down by Sabres for the loss of 78 Sabres. Later research reduced the total to 379 victories which is still higher than the 345 losses shown in USSR records.

The Soviets claimed about 1,100 air – to - air victories and 335 combat MiG losses at that time. China's official losses were 231 planes shot down in air - to - air combat (mostly MiG-15) and 168 other losses. The number of losses of the North Korean Air Force was not revealed. It is estimated that it lost about 200 aircraft in the first stage of the war, and another 70 aircraft after Chinese intervention.

Soviet claims of 650 victories over the Sabres, and China's claims of another 211 F- 86s, are considered to be exaggerated by the USAF.

The Korean war was the first time the helicopter was used extensively in a conflict . While helicopters such as the YR-4 were used in World War II , their use was rare, and Jeeps like the Willys MB were the main method of removing an injured soldier. In the Korean war helicopters like the H-19 partially took over in the non combat Medevac area.

8 – 2 – Indo - Pakistani Wars

The wars saw the Indian Air Force and the Pakistani Air Force being involved in full scale combat for the first time since independence. Though the two forces had previously faced off in the First Kashmir War during the late 1940s, it was limited in scale compared to the conflicts of 1965 and 1971.

During the Indo - Pakistani War of 1965, both air forces engaged each other for the first time in a full blown combat. Both countries hold highly contradictory claims on combat losses during the war and hardly any neutral sources have thoroughly verified the claims of both countries' claim. PAF claimed it had shot down 104 IAF planes losing only 19 in the process. India meanwhile claimed that 35 IAF planes were lost while shooting down 73 PAF aircraft. By the end of the war, neither the numerically larger IAF, nor the PAF which possessed a qualitative advantage, achieved air superiority.

During the Indo - Pakistani War of 1971, the Indian Air force had both the qualitative as well as numerical edge over PAF after the induction of Mikoyan - Gurevich MiG-21 in large numbers. The war began with Operation Chengiz Khan, Pakistan's December 3, 1971 pre-emptive strike on 11 Indian airbases. After the initial preemptive strike, PAF adopted a defensive stance in response to the Indian retaliation. As the war progressed, the Indian Air Force continued to battle the PAF over conflict zones, but the number of sorties flown by the PAF gradually decreased day-by-day. The Indian Air Force flew 4,000 sorties while its counterpart, the PAF offered little in retaliation, partly because of the paucity of non-Bengali technical personnel. This lack of retaliation has also been attributed to the deliberate decision of the PAF High Command to cut its losses as it had already incurred huge losses in the conflict. The PAF also did not intervene during the Indian Navy's two raids on Pakistani naval port city of Karachi codenamed Operation Trident and Operation Python. PAF also was not able to support its troops during Battle of Longewala. In the east, the small air contingent of Pakistan Air Force No. 14 Sqn was destroyed, putting the Dhaka airfield out of commission and resulting in Indian air superiority in the east.

8 – 3 - Vietnam War

The South Vietnamese Air Force (VNAF) was originally equipped with helicopters such as the CH-21 and propeller powered aircraft such as the T-28 Trojan when jet aircraft were disallowed by treaty. As US involvement increased, most airpower was directly flown by US forces.

Large scale use of helicopters by the US Army in Vietnam led to a new class of airmobile troops, and the introduction of "Air Cavalry" in the U.S, culminating in extensive use of the UH-1 Huey helicopter which would become a symbol of that war , while the CH-54 Tarhe "Skycrane" and CH- 47 Chinook lifted heavier loads such as vehicles or artillery. Troops were able to land unexpectedly, strike, and leave again, and evacuate wounded . The specialized AH-1 Cobra was developed from the Huey for escort and ground support duties, The later Soviet campaign in Afghanistan would also see widespread use of helicopters as part of the Air Assault brigades and regiments.

US forces provided close support of ground force over South Vietnam, and strategic bombing of targets over North Vietnam.[115] Many types flying close support or COIN (Counter Insurgency Warfare) missions were propeller powered types such as the O-1 and OV-10 Bronco FAC spotters, A-1 Skyraider, B-26 Invader, and AC-47 "Spooky" gunship. C-123 Provider and C -130 Hercules transports flew supplies into battlefields such as Khe Sanh .

"Fast movers" included the supersonic F-100 Super Sabre, while the giant B-52 Stratofortress would be modified to unload a massive high explosive payload on enemy troop concentrations. The AC-130 would become the ultimate gunship , while the AX specification to replace the Skyraider would evolve into the A-10 Thunderbolt II.

A F-105D shoots down a MiG-17, 1967.

The USAF F-105 Thunder chiefs flew the bulk of strike missions against North Vietnam in Operation Rolling Thunder, while carrier-based A - 4 Sky hawks (which could 'buddy-buddy' refuel) were flown by the Navy. That first campaign was marred by carefully measured regulations that prohibited attacks against SAM missile sites and fighter bases, and frequent bombing halts, and produced little in political results . Rolling Thunder saw the first combat use of electronic computers aboard PIRAZ ships to display comprehensive real - time aircraft position information for force commanders.

Lessons learned were applied to the later Operation Linebacker which employed Phantoms, B-52s, swing - wing F-111s, A-7 Corsairs and all-weather A-6 Intruders was more successful in bringing North Vietnam to the negotiating table after a massive ground invasion. North Vietnam effectively combined Soviet and Chinese anti-aircraft artillery, SA-2 guided missiles, and MiG fighters to create the most heavily defended airspace up to that time .

US air strikes would combine the use of airbone radar platforms such as the EC-121 Warning Star, KC-135 Stratotankers for air refueling, radar jamming aircraft and specialized "Wild Weasel" units to attack SAM missile sites . Jolly Green Giant helicopter crews escorted by A-1 "Sandy"s would retrieve downed pilots over hostile territory .With the use of "smart" guided bombs late in the war, this would set the model for future US air operations.

Experts were surprised when advanced F-105s were shot down in its first encounter against the elderly but nimble MiG-17. Dogfights were thought to be obsolete in the age of missiles, but pilots now needed maneuverability. The F- 4 Phantom was quickly tasked with protecting against MiGs, but sorely lacked a built-in gun when missiles were often unreliable. Air combat training schools such as TOPGUN would improve kill ratios, but combat experience started programs that would produce agile air superiority fighters with guns such as the F-15 Eagle by the 1970s.

South Vietnam fell without US air support when faced with a massive assault in 1975. The VNAF South Vietnamese Air Force was never supplied with powerful fighters and bombers such as the Phantom and B-52 which could strike at North Vietnam.

8 – 4 - Middle East

In the Six - Day War of 1967, the Israeli Air Force launched pre-emptive strikes which destroyed opposing Arab air forces on the ground . The Yom Kippur War of 1973 saw the Arab deployment of mobile SA - 6 missiles which proved effective against low-flying Israeli aircraft until they were neutralized by ground forces.

8 – 5 - Iran Iraq War

In Iran-Iraq war (1980 – 1988) , the use of aerial war fare in all manner was a norm. At the war commons with the start of bombing of mostly Iranian Air Force bases by Iraq's Air Force with the aim of destroying Iranian air force in the ground. In most cases this technique was failed due to lack of training by Iraqi pilots and protection of Iranian air bases. Later on aerial warfare in all forms used by both sides.

8 – 6 - Falklands War (1982)

During the six - week Falklands War British carrier-based Harriers flew over 1500 sorties and Vulcans flew long - range bombing missions. 21 Argentine fixed - aircraft were destroyed in the air by British Harriers alone. A further 18 Argentine fixed-wing aircraft were destroyed by British Surface to Air Missiles. 15 Argentine fixed - wing Aircraft were destroyed on the ground. 14 Argentine fixed - wing aircraft were captured. Therefore a total of 68 Argentine fixed - wing aircraft were captured or destroyed by British Forces, representing 28 % of the total 240 fixed-wing aircraft the Argentinians had at the start of the war. If accidents and friendly fire is included, 31 % of the total 240 fixed - wing aircraft were lost.

9 - Post Cold War

The collapse of the Soviet Union in 1991 forced Western air forces to undergo a shift from the massive numbers felt to be necessary during the Cold War to smaller numbers of multi-role aircraft. The closure of several military bases overseas and the U.S. Base Realignment and Closure program have served to highlight the effectiveness of aircraft carriers in the absence of dedicated military or air force's bases, as the Falklands war and U.S. operations in the Persian Gulf have highlighted.

USS Abraham Lincoln rides out a storm in the Arabian Sea while on station in support of Operation Southern Watch and Operation Enduring Freedom.

The advent of precision-guided munitions have allowed for strikes at arbitrary surface targets once proper reconnaissance is performed (network- centric warfare). However, wars cannot be won through air power alone.

The Stockholm International Peace Research Institute (SIPRI) has noted that sales of combat aircraft can have a destabilizing effect because of their ability to quickly strike neighboring countries, such as during Operation Orchard in 2007.

9 – 1 - Gulf War (1991)

The role of air power in modern warfare was dramatically demonstrated during the Gulf War in 1991. Air attacks were made on Iraqi command and control centers, communications facilities, supply depots, and reinforcement forces. Air superiority over Iraq was gained before major ground combat began.

The initial strikes were composed of Tomahawk cruise missiles launched from ships, F-117 stealth bombers with an armament of laser-guided bombs, and aircraft armed with anti-radar missiles. These first attacks allowed fighter-bombers to gain air superiority over the country and then continue to drop guided bombs.

A-10 Thunderbolts attacked Iraqi armored forces with gatling guns and Maverick missiles, supporting the advance of US ground troops. Attack helicopters, fired laser guided Hellfire missiles and TOW missiles . The allied air fleet also made use of AWACS aircraft and B - 52 bombers.

The aerial strike force was made up of over 2,250 combat aircraft, which included 1,800 US aircraft, which fought against an Iraqi force of about 500 MiG - 29 and Mirage F1 fighters. More than 88,000 combat missions had been flown by allied forces with over 88,000 tons of bombs dropped by the end of the fifth week.

9 – 2 - Kargil War (1999)

During the Kargil conflict IAF Mirage 2000Hs carried out strike missions.

On 11 May 1999, the Indian Air Force was called in to provide helicopters for close air support to the Indian Army at the height of the ongoing Kargil conflict with Pakistan . The first strikes were launched on the 26 May, when the Indian Air Force struck infiltrator positions with fighter aircraft and helicopter gunships . The initial strikes saw MiG - 27s carrying out offensive sorties, with MiG - 21s and MiG - 29s providing fighter cover . The IAF also deployed radars and MiG - 29 fighters to keep check on Pakistani military movements across the border.

On 27 May, the IAF lost a MiG - 21 to enemy action and a MiG-27 to mechanical failure . The following day, a Mi - 17 was lost to SAMs while on an offensive sortie . These losses forced the IAF to withdraw helicopters from offensive roles. On 30 May, the IAF called into operation the Mirage 2000 which was deemed the best aircraft in the high-altitude conditions. Mirage 2000s not only had better defence equipment compared to the MiGs , but also gave IAF the ability to carry out aerial raids at night. The MiG - 29s were used extensively to provide fighter escort to the Mirage 2000. The Mirages successfully targeted enemy camps and logistic bases in Kargil. At the height of the conflict, the IAF was conducting over forty sorties daily over the Kargil region . By 26 July, the Indian forces had liberated 6 of the 10 strategic points captured by Pakistani forces in Kargil. The remaining 4 remain under Pakistani control.

9 – 3 - Iraq War (2003-2011)

An F-15E Strike Eagle launches heat decoys during a close-air-support mission over Afghanistan, 2008.

During the 2003 invasion of Iraq led by US and British forces putatively to defeat the regime of Saddam Hussein, aerial warfare continued to be decisive. The US - British alliance began its air campaign on March 19 with limited nighttime bombing on the Iraqi capital of Baghdad. Several days later, intensive bombardment began. About 14,000 sorties were flown, and at a cost of $ 1 million each, 800 Tomahawk cruise missiles were fired at numerous targets in Iraq from March 19 until mid - April 2003. By this time Iraqi resistance had largely ended.

Iraqi anti - aircraft weapons were unable to open fire on high - altitude US bombers such as the B - 52 or stealth aircraft such as the

B - 2 bomber and the F-117A. US and British aircraft used radar-detecting devices and aerial reconnaissance to locate Iraqi anti-aircraft weapons. Bunker buster bombs, designed to penetrate and destroy underground bunkers, were dropped on Iraqi command and control centers. Iraqi ground forces could not seriously challenge the American ground forces because of their air supremacy. By mid-April 2003, US-British forces controlled all of Iraq's major cities and oil fields.

9 – 4 - 2006 Lebanon War

In the beginning of the 2006 Lebanon War Israel utilized an intensive aerial campaign aimed to eliminate Hezbollah and destroy its military, as stated by Israeli prime minister Ehud Olmert. It also aimed to return kidnapped Israeli soldiers. The campaign started by destroying Lebanese infrastructure and Hezbollah targets. This continued during the 33 days of the war.

Taking into consideration the results of the 1991 and 2003 wars on Iraq and the 1999 war on the former Yugoslavia, the Israeli air force was unable to accomplish its objectives as completely. This partly results from the military doctrine that Hezbollah used in the war which proved effective. There have also been reports during the conflict that a Hezbollah-operated flying drone penetrated Israeli airspace, and returned to Lebanese territory.

9 – 5 – UAVs

The advent of the unmanned aerial vehicle has dramatically revolutionized aerial warfare with multiple nations developing and/or purchasing UAV fleets. Several benchmarks have already occurred, including a UAV- fighter jet dogfight, probes of adversary air defense with UAVs, replacement of an operational flight wing's aircraft with UAVs, control of UAVs qualifying the operator for 'combat' status, UAV-control from the other side of the world, jamming and/or data-hijacking of UAVs in flight, as well as proposals to transfer fire authority to AI aboard a UAV. UAVs have quickly evolved from surveillance to combat roles.

The growing capability of UAVs has thrown into question the survivability and capability of manned fighter jets.[147]

Agency for Toxic Substances and Disease Registry

Contents

1 - Introduction

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency within the United States

Department of Health and Human Services. The agency focuses on minimizing human health risks associated with exposure to hazardous substances. It works closely with other federal, state, and local agencies; tribal governments; local communities; and healthcare providers.[3] Its mission is to "Serve the public through responsive public health actions to promote healthy and safe environments and prevent harmful exposures " . ATSDR was created as an advisory, non regulatory agency by the Superfund legislation and was formally organized in 1985.

Although ATSDR is an independent operating division within the Department of Health and Human Services, the Centers for Disease Control and Prevention (CDC) performs many of its administrative functions . The CDC director also serves as the ATSDR administrator, and ATSDR has a joint Office of the Director with the National Center for Environmental Health (NCEH) . The ATSDR headquarters are located in Atlanta, Georgia, at the CDC Chamblee campus . In fiscal year 2010, ATSDR had an operating budget of $ 76.8 million and had roughly 300 full-time employees (not including contractors).

2 – Overview

ATSDR is the lead agency within the United States Public Health Service concerned with the effects of hazardous substances on human health. ATSDR is charged with assessing the presence and nature of health hazards at specific Superfund sites, as well as helping prevent or reduce further exposure and the illnesses that can result from such exposures.

ATSDR functions include public health assessments of hazardous waste sites, health consultations concerning specific hazardous substances, health surveillance and registries, response to emergency releases of hazardous substances, applied research in support of public health assessments, information development and dissemination, and education and training concerning hazardous substances . ATSDR also prepares toxicological profiles for hazardous substances found at National Priorities List sites, as well as at federal sites administered by the Department of Defense and Department of Energy.

2 – 1 – Goals

ATSDR has seven goals :

Protect the public from environmental hazards and toxic exposures.

Promote healthy environments.

Advance the science of environmental public health.

Support environmental public health practice.

Educate communities, partners, and policy makers about environmental health risks and protective measures.

Promote environmental justice and reduce health disparities associated with environmental exposures.

Provide unique scientific and technical expertise to advance public health science and practice .

2 – 2 – Authority

Unlike the Environmental Protection Agency (EPA), ATSDR is an advisory, non regulatory agency. ATSDR conducts research on the health impacts of hazardous waste sites and provides information and recommendations to federal and state agencies, community members, and other interested parties. However, ATSDR is not involved in cleanup of those sites, nor can ATSDR provide or fund medical treatment for people who have been exposed to hazardous substances.

3 – History

In response to the environmental disasters at Love Canal and Times Beach, Missouri, Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), commonly known as the Superfund legislation.[3] CERCLA gave EPA primary responsibility for identifying, investigating, and cleaning up hazardous waste sites. CERCLA also authorized the establishment of ATSDR to assess the presence and nature of health hazards to communities living near Superfund sites, to help prevent or reduce harmful exposures, and to expand the knowledge base about the health effects that result from exposure to hazardous substances . ATSDR was created as an agency under the

Department of Health and Human Services on April 19, 1983, and James O. Mason served as the agency's first administrator.[12] The Hazardous and Solid Waste Amendments of 1984 to the Resource Conservation and Recovery Act (RCRA) gave ATSDR additional authority related to hazardous waste storage facilities. ATSDR was charged with conducting public health assessments at these sites when requested by EPA, states, or individuals, as well as assisting EPA to determine which substances should be regulated and the levels at which chemicals may pose a threat to human health. ATSDR was formally organized as an agency on June 11, 1985. The Superfund Amendments and Reauthorization Act of 1986 (SARA) broadened ATSDR's responsibilities in the areas of public health assessments, establishment and maintenance of toxicological databases, information dissemination, and medical education.[5] In 2003, the position of assistant administrator was replaced with a director who is shared with NCEH.

4 – Organization

4 – 1 – Administration

Thomas R. Frieden has served as ATSDR administrator and CDC director since June 8, 2009 . Christopher J. Portier has been director of NCEH/ATSDR since August 2, 2010. The ATSDR administrator, who provides overall leadership of the agency, is appointed by the president of the United States, and the appointment does not require Senate approval. The ATSDR administrator appoints the NCEH/ATSDR director, who is responsible for managing the agency's programs and activities.

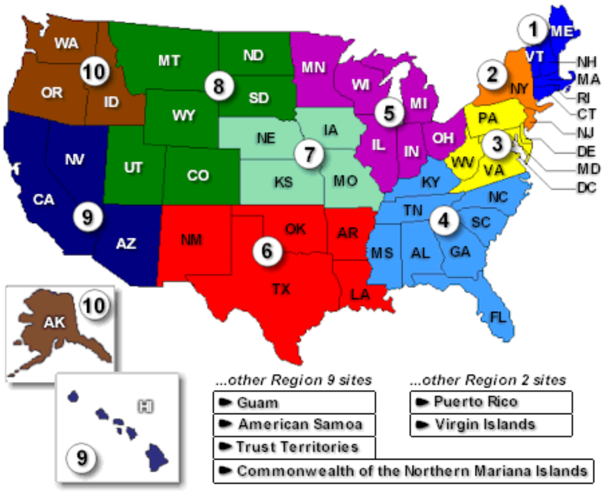
4 – 2 - Organizational structure

Office of the Director*
Office of Tribal Affairs*
Office of Policy, Planning, and Evaluation*
Office of Financial and Administrative Services*
Health Communication Science Office*
Division of Health Assessment and Consultation
Cooperative Agreement and Program Evaluation Branch
Exposure Investigation and Site Assessment Branch

Health Promotion and Community Involvement Branch
Site and Radiological Assessment Branch
Division of Health Studies
Geospatial, Research, Analysis, and Services Program
Health Investigations Branch
Surveillance and Registries Branch
Division of Regional Operations
Division of Toxicology and Environmental Medicine
Applied Toxicology Branch
Computational Toxicology and Methods Development Laboratory
Environmental Medicine and Educational Services Branch
Prevention, Response, and Medical Support Branch
**Joint with NCEH*

4 – 3 - Regional offices

The Division of Regional Operations manages an office in Washington, D.C., as well as offices in each of the 10 EPA regions:]



Map of the 10 ATSDR regions.

Boston (Region **1** : Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont)

New York and Edison, New Jersey (Region **2** : New Jersey, New York, Puerto Rico, U.S. Virgin Islands)

Philadelphia (Region **3** : Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, West Virginia)

Atlanta (Region **4** : Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee)

Chicago (Region **5** : Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin)

Dallas (Region 6 : Arkansas, Louisiana, New Mexico, Oklahoma, Texas)

Kansas City, Kansas (Region **7** : Iowa, Kansas, Missouri, Nebraska)

Denver and Helena, Montana (Region **8** : Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming)

San Francisco (Region **9** : American Samoa, Arizona, California, Guam, Hawaii, Nevada, Northern Mariana Islands, Trust Territories)

Seattle and Anchorage, Alaska (Region **10** : Alaska, Idaho, Oregon, Washington)

The regional offices work cooperatively with EPA, state and local health departments, health professionals, community groups, and other partners to implement programs and initiatives.

5 – Programs

5 – 1 - Public health assessments and health consultations

One of ATSDR's primary responsibilities is conducting public health assessments and health consultations. The agency conducts public health assessments for all current or proposed sites on the National Priorities List (commonly known as Superfund sites). The purpose of public health assessments is to examine whether hazardous substances at a site pose a human health hazard and to issue recommendations about limiting or stopping exposure to those substances . ATSDR also conducts health consultations, often in response to requests from EPA and state and local agencies. Health consultations examine specific health questions, such as the health effects of exposure to a specific chemical at a site. Health consultations are more limited in scope than public health assessments ATSDR also conducts public health assessments and health consultations in response to petitions from members of the public. To conduct public health assessments and health consultations, ATSDR relies on its own scientists or establishes cooperative agreements with states, providing technical assistance to state health departments.

ATSDR issued more than 200 public health assessments in 2009 and provides about 1,000 health consultations each year.

When investigating sites, ATSDR examines environmental data, health data, and information from community members about how the site affects their quality of life. ATSDR normally does not collect its own environmental data ; rather, it usually relies on partner organizations, such as EPA, to conduct testing and gather data. This environmental data provides information on the amount of contamination and possible ways humans could be exposed to the hazardous substances at the site. The health data provides information on rates of illness, disease, and death in the local community.[20] Since ATSDR is an advisory agency, the conclusions in its public health assessments and health consultations are often in the form of recommendations to state and national environmental and health agencies, such as EPA, that have regulatory authority. Other agencies and the general public rely on ATSDR to provide trusted information on the health effects of hazardous substances at contaminated sites.

5 – 2 - Toxicology research

Another major responsibility of ATSDR is producing toxicological profiles for the most common substances that are found at Superfund sites. The toxicological profiles summarize important studies on the substances' health effects. ATSDR also publishes Tox FAQs, Tox Guides, and public health statements, which summarize the health information in toxicological profiles for use by the general public and health professionals. The agency maintains a Toxic Substances Portal that compiles all of the agency's toxicology information and allows users to search by chemical. ATSDR has published toxicological profiles for more than 250 hazardous substances.

ATSDR has a computational toxicology laboratory that conducts research and modeling on the effects of toxic substances on human health. The agency's toxicology work involves pharmacokinetic / pharmacodynamics modeling, quantitative structure – activity relationship methods, and benchmark dose modeling, as well as establishing minimal risk levels for human exposure to hazardous substances . One model developed by the toxicology laboratory showed that children were much more susceptible than adults to chemical exposure from inhalation and oral exposure. In the aftermath of chemical spills and emergencies, the laboratory also conducts research for state and local health departments on the health effects of the chemicals involved.

5 – 3 - Health registries

ATSDR maintains registries of people who were exposed to certain toxic substances or have certain diseases. Participation in these registries is voluntary, and individual data and personal information is kept private. The information collected is used by epidemiologists and other researchers to examine long-term health outcomes or risk factors for illness. It can also help doctors diagnose those health conditions in other individuals and treat them earlier. The agency also uses registries to contact registered individuals with important health information.

5 – 3 - 1 - Tremolite Asbestos Registry

The Tremolite Asbestos Registry contains people who lived in or worked in Libby, Montana, while vermiculite was mined there; these people were at risk for exposure to the tremolite asbestos that was naturally occurring in the vermiculite. ATSDR began addressing public health concerns in Libby in 1999 and created the registry in 2004. The purpose of the registry was to monitor the long-term health effects of people in Libby exposed to tremolite asbestos and to assist with communicating important health information to registrants. Researchers have used the registry to study how asbestos exposure affects human health . This research has yielded several important findings. Registry data was used to conduct the first study of the relationship between asbestos exposure and respiratory problems in children . Another study using registry data found a significant relationship between asbestos exposure and death from cardiovascular disease.

5 – 3 - 2 - World Trade Center Health Registry

The World Trade Center Health Registry was established in 2002 by ATSDR and the New York City Department of Health and

Mental Hygiene to track the long-term physical and mental health effects of the September 11 attacks. The registry contains more than 71,000 people who lived, worked, or went to school near the World Trade Center site, as well as emergency response personnel who were involved in rescue and recovery efforts. It is the largest post - disaster health registry in the United States. Researchers use the registry to study the health effects of the disaster and to develop public health recommendations for future disasters . A 2009 study based on registry data found that posttraumatic stress disorder and asthma were the two most commonly reported conditions among registry participants 5 to 6 years after the disaster. The study found that 19% of adult participants reported new posttraumatic stress symptoms, and 10 % of adult participants reported developing new asthma.[33]

4 – 3 - 3 - ALS Registry

ATSDR is starting a new registry for people with amyotrophic lateral sclerosis (also known as ALS or Lou Gehrig's Disease). President George W. Bush signed the ALS Registry Act, which provided for establishment of the registry, on October 8, 2008.[34] It is hoped that the registry will provide information on the prevalence of ALS and lead to a better understanding of factors that may be associated with the disease. The agency began registering people for the registry on October 20, 2010.

5 – 4 - Surveillance

ATSDR conducts surveillance by maintaining projects to collect and analyze information on diseases and chemical exposures. Research using that information and data can then be used to prevent future and control injury, disease, and death.

5 – 4 - 1 - Hazardous Substances Emergency Events Surveillance Program

One of the most notable surveillance projects was the Hazardous Substances Emergency Events Surveillance (HSEES) program, which lasted from 1990 to 2009. ATSDR partnered with 15 states to collect information for HSEES in order to track, report, and study chemical spills . The information in the HSEES system was used to plan for emergency events involving hazardous substances (including terrorist attacks). States also used the information to develop policies and programs to strengthen public health and reduce illnesses and deaths that can result from exposure to hazardous substances.[27] For example, states used HSEES data to support legislation addressing the problem of hazardous chemicals at illegal methamphetamine labs. Other states used HSEES data to implement programs designed to minimize exposure to hazardous chemicals and mercury at schools. More than 50 published studies were conducted using HSEES data.

5 – 4 - 2 - National Toxic Substance Incidents Program

As a successor to the HSEES program, ATSDR launched the National Toxic Substance Incidents Program (NTSIP) in 2009. One aspect of NTSIP is a national database of information related to chemical spills. NTSIP also has Assessment of Chemical Exposure teams to assist state and local health departments in the aftermath of toxic spills. These teams interview people who were exposed to the hazardous substances and collect samples to test the level of contamination in the environment and in people.

5 – 5 - Emergency response

ATSDR represents the Department of Health and Human Services on the National Response Team and works with other agencies to provide technical assistance during emergencies involving hazardous substances, such as chemical spills. In July 2007, for example, ATSDR responded to the Verdigris River flood in Coffeyville, Kansas, after an oil refinery spilled crude oil into the floodwaters, contaminating many homes in the city. ATSDR worked with EPA and state and local authorities to provide health information to local residents and advised those agencies during the clean-up process . ATSDR also assists with responding to terrorism incidents, which have included the September 11 attacks and the 2001 anthrax attacks . ATSDR responded to 132 chemical emergency events in 2008.

In addition to working with communities and other agencies in the aftermath of chemical emergencies, ATSDR has developed the Managing Hazardous Materials Incidents series, which includes several tools to assist emergency medical services personnel and hospital emergency departments during chemical emergencies. This includes important information on emergency planning, emergency response, and rescuer protection. Another tool is the Medical Management Guidelines, which summarize important information on exposure to common chemicals and provide suggestions for safely treating and decontaminating patients.

5 – 6 - Brownfield / land reuse initiative

ATSDR works closely with communities to evaluate the public health effects related to redevelopment of brownfields properties. These are sites that were formerly used for industrial purposes and may still be contaminated with hazardous substances. ATSDR has worked at more than 400 brownfield or land reuse sites to assess health effects of potential exposure to hazardous substances . The agency has created resources to provide guidance to communities when planning redevelopment projects, including tools to evaluate the potential threat of chemicals at development sites.[47] In addition to evaluating the health effects of contamination at specific brownfield sites, ATSDR encourages communities to monitor community health. One of the agency's brownfields projects was the Menomonee Valley in Milwaukee, Wisconsin, where the agency evaluated potential health effects of contamination at the site and worked closely with developers and the city.

5 – 7 - Community partnerships

A major focus of the work ATSDR does involves interacting with communities. ATSDR often establishes partnerships with state and local health departments to assist them with their public health duties. In 2008, ATSDR had cooperative agreements with 29 states and one tribal government, providing technical assistance to help those partners address local environmental health concerns.[49] ATSDR also creates community assistance panels to solicit feedback and community health concerns from local residents when the agency works at sites to evaluate health effects resulting from exposure to toxic substances.

5 – 8 - National Conversation on Public Health and Chemical Exposures

In June 2009, ATSDR and NCEH launched a joint project, the National Conversation on Public Health and Chemical Exposures.[51] The goal of the National Conversation is to develop recommendations for ways ATSDR and other government agencies can improve their efforts to protect the public from harmful chemical exposures. To foster a productive dialogue, ATSDR encouraged broad public participation in the National Conversation and welcomed involvement from all interested stakeholders, including government agencies, public health professionals, environmental organizations, community leaders, business and industry representatives, tribal groups, and other interested citizens.[52] The National Conversation is led by a 40-person Leadership Council that includes experts in various areas related to environmental public health.[53] In addition, there are six work groups, which also have a diverse membership, to research and propose recommendations on certain key areas . To encourage involvement from community groups, interested citizens, and the general public, ATSDR developed a community toolkit to assist community leaders in holding discussions to solicit feedback and ideas for the National Conversation . ATSDR plans to release its final action agenda in early 2011.

6 - Quality of work

ATSDR prides itself on using "the best science."[57] And in 2003, BBC News described ATSDR as "widely regarded as the world's leading agency on public health and the environment."

However, ATSDR has also been the focus of scrutiny from Congress and other groups. Much of the criticism is due to the fact that the agency has been overtasked yet understaffed and underfunded for much of its history.

In August 1991, the General Accounting Office (now the Government Accountability Office) published a report that faulted the quality of ATSDR's original public health assessments and questioned their usefulness. It also placed part of the blame on the deadlines and requirements that Congress imposed with SARA: "SARA’s requirement that ATSDR quickly assess 951 Superfund sites came at a time when the agency was still relatively new and ... not staffed or organized for the job." The report also noted that after meeting the SARA deadline, ATSDR was able to increase the rigor of its public health assessments.

In May 1992, the Environmental Health Network and the National Toxics Campaign Fund published "Inconclusive by Design," a report which noted structural limitations to the work of CDC and ATSDR.

In April 2008, the United States House of Representatives Committee on Science and Technology Subcommittee on Investigations and Oversight held a hearing on formaldehyde exposures in trailers that the Federal Emergency Management Agency (FEMA) provided as temporary housing to people displaced by Hurricane Katrina.

A report based on the hearing, issued by the subcommittee's Democratic majority staff in September 2008, noted shortcomings in the agency’s original health consultation that examined the health risks of formaldehyde in the FEMA trailers.

In March 2009, the Democratic majority staff of the Subcommittee on Investigations and Oversight issued another report on ATSDR, which called for leadership changes within the agency. The report stated: "Time and time again ATSDR appears to avoid clearly and directly confronting the most obvious toxic culprits that harm the health of local communities throughout the nation. Instead, they deny, delay, minimize, trivialize or ignore legitimate concerns and health considerations of local communities and well respected scientists and medical professionals " .

In the March 12, 2009, congressional hearing, the subcommittee chairman, Congressman Brad Miller, characterized ATSDR as keen to "please industries and government agencies" and referred to ATSDR's reports as "jackleg assessments saying 'not to worry.'" . In defense of ATSDR's work, director Howard Frumkin noted that ATSDR's staff has declined from 500 to about 300, and that often communities expect "definitive answers about the links between exposures and illnesses," but expectations can be unmet due to scientific uncertainty. However, Dr. Frumkin also acknowledged the possibility that some assessments did not use the best data or monitoring techniques.

6 – 1 - Vieques , Puerto Rico

In 2003, ATSDR released public health assessments that evaluated the potential health effects of pollution left behind by the United States Navy in Vieques, Puerto Rico. The public health assessments noted that residents of the island were exposed to environmental contamination at such low levels that no harmful health effects were expected, and the agency concluded that there was "no apparent public health hazard " . In 2009, however, ATSDR announced that it had identified gaps in environmental data and planned to take a "fresh look" at Vieques by reviewing studies on the island.

Agent Orange

U.S. Army Huey helicopter spraying Agent Orange over Vietnamese agricultural land

Contents

1 - Introduction

Agent Orange or Herbicide Orange (HO) is one of the herbicides and defoliants used by the U.S. military as part of its chemical warfare program, Operation Ranch Hand, during the Vietnam War from 1961 to 1971. Vietnam estimates 400,000 people were killed or maimed, and 500,000 children born with birth defects as a result of its use . The Red Cross of Vietnam estimates that up to 1 million people are disabled or have health problems due to Agent Orange . The United States government has dismissed these figures as unreliable and unrealistically high .

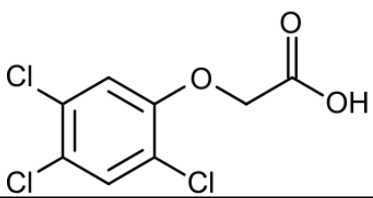
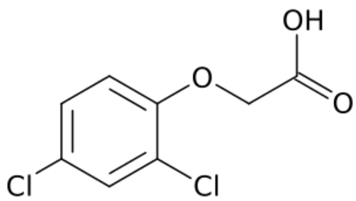
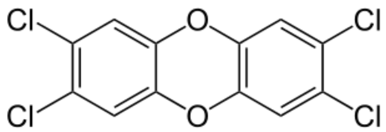
A 50 : 50 mixture of 2,4,5 - T and 2,4 - D , it was manufactured for the U.S. Department of Defense primarily by Monsanto Corporation and Dow Chemical. The 2,4,5 - T used to produce Agent Orange was contaminated with 2,3,7,8 - tetra chloro dibenzo dioxin (TCDD), an extremely toxic dioxin compound. It was given its name from the color of the orange - striped 208 l barrels in which it was shipped, and was by far the most widely used of the so-called "Rainbow Herbicides".

During the Vietnam War, between 1962 and 1971, the United States military sprayed nearly 76,000,000 l of material containing chemical herbicides and defoliants mixed with jet fuel in Vietnam, eastern Laos and parts of Cambodia, as part of Operation Ranch Hand The program's goal was to defoliate forested and rural land, depriving guerrillas of cover; another goal was to induce forced draft urbanization, destroying the ability of peasants to support themselves in the countryside, and forcing them to flee to the U.S. dominated cities, thus depriving the guerrillas of their rural support and food supply.

The US began to target food crops in October 1962, primarily using Agent Blue. In 1965, 42 percent of all herbicide spraying was dedicated to food crops. Rural-to-urban migration rates dramatically increased in South Vietnam, as peasants escaped the war and famine in the countryside by fleeing to the U.S.- dominated cities. The urban population in South Vietnam nearly tripled: from 2.8 million people in 1958, to 8 million by 1971. The rapid flow of people led to a fast-paced and uncontrolled urbanization; an estimated 1.5 million people were living in Saigon slums.

United States Air Force records show that at least 6,542 spraying missions took place over the course of Operation Ranch Hand . By 1971, 12 percent of the total area of South Vietnam had been sprayed with defoliating chemicals, at an average concentration of 13 times the recommended USDA application rate for domestic use In South Vietnam alone, an estimated 10 million hectares of agricultural land was ultimately destroyed . In some areas, TCDD concentrations in soil and water were hundreds of times greater than the levels considered safe by the U.S. Environmental Protection Agency . Overall, more than 20 % of South Vietnam's forests were sprayed at least once over a nine - year period .

2 - Chemical description and toxicology

		
2,4,5 - T	*2,4 - D*	*2,3,7,8 - TCDD*

Chemically , Agent Orange is an approximately 1:1 mixture of two phenoxyl herbicides – 2,4 - dichloro phenoxy acetic acid (2,4-D) and 2,4,5- trichloro phenoxy acetic acid (2,4,5-T) – in iso - octyl ester form .

Numerous studies have examined health effects linked to Agent Orange, its component compounds, and its manufacturing byproducts.

Prior to the controversy surrounding Agent Orange, there was already a large body of scientific evidence linking 2,4,5-T to serious negative health effects and ecological damage.[18] But in 1969, it was revealed to the public that the 2,4,5-T was contaminated with a dioxin, 2,3,7,8 - tetra chloro dibenzo dioxin (TCDD), and that the TCDD was causing many of the previously unexplained adverse health effects which were correlated with Agent Orange exposure. TCDD has been described as "perhaps the most toxic molecule ever synthesized by man". Internal memoranda revealed that Monsanto (a major manufacturer of 2,4,5-T) had informed the U.S. government in 1952 that its 2,4,5-T was contaminated . In the manufacture of 2,4,5-T, accidental overheating of the reaction mixture easily causes the product to condense into the toxic self-condensation product TCDD. At the time, precautions were not taken against this unintended side reaction, which caused also the Seveso disaster in Italy in 1976.

In 1979, the Yale biologist Arthur Galston, who specialized in herbicide research, published a review of what was known at the time about the toxicity of TCDD. Even "vanishingly small" quantities of dioxin in the diet caused adverse health effects when tested on animals.[20] Since then, TCDD has been comprehensively studied. It has been associated with increased neoplasms in every animal bioassay reported in the scientific literature . The National Toxicology Program has classified TCDD as "known to be a human carcinogen", frequently associated with soft-tissue sarcoma, non-Hodgkin's lymphoma, Hodgkin's lymphoma and chronic lymphocytic leukemia (CLL).

Of the two herbicides that make up Agent Orange, 2,4-D and 2,4,5-T, the latter is considered to be less bio degradable . While degradation of 2,4,5-T with a half - life on a scale of days can be achieved by adding bacteria of a special strain, "no substantial degradation" was observed in the same soil without addition of bacteria . The half - life of dioxins in soil is more than 10 years, and that of TCDD in human fat tissue is about 7 years.

A 1969 report authored by K. Diane Courtney and others found 2,4,5-T could cause birth defects and stillbirths in mice. Several studies have shown an increased rate of cancer mortality for workers exposed to 2,4,5-T. In one such study, from Hamburg, Germany, the risk of cancer mortality increased by 170 % after working for 10 years at the 2,4,5-T-producing section of a Hamburg manufacturing plant. Three studies have suggested prior exposure to Agent Orange poses an increased risk of acute myelogenous leukemia in the children of Vietnam veterans.

It has often been claimed that the contamination with dioxin was discovered only *later*. However, prior to Operation Ranch Hand (1962-1971), health - risks had become apparent, from several accidents in 2,4,5-T- production in the U.S. and in Europe. The causes had been investigated, and results published in 1957, specifically stating "tetra chlor dibenzo dioxine proved very active." Additionally "Boehringer, which used the relative safer low-temperature-process since 1957, in the same year warned the other producers of 2,4,5-TCP, which were using the high - t - process, pointing out the risk and providing suggestions how to avoid them " . Furthermore, Dr. James R. Clary (a former government scientist with the Chemical Weapons Branch, BW / CW Division) has stated that "When we (military scientists) initiated the herbicide program in the 1960's, we were aware of the potential for damage due to dioxin contamination in the herbicide. We were even aware that the 'military' formulation had a higher dioxin concentration than the 'civilian' version due to the lower cost and speed of manufacture. However, because the material was to be used on the 'enemy', none of us were overly concerned " .

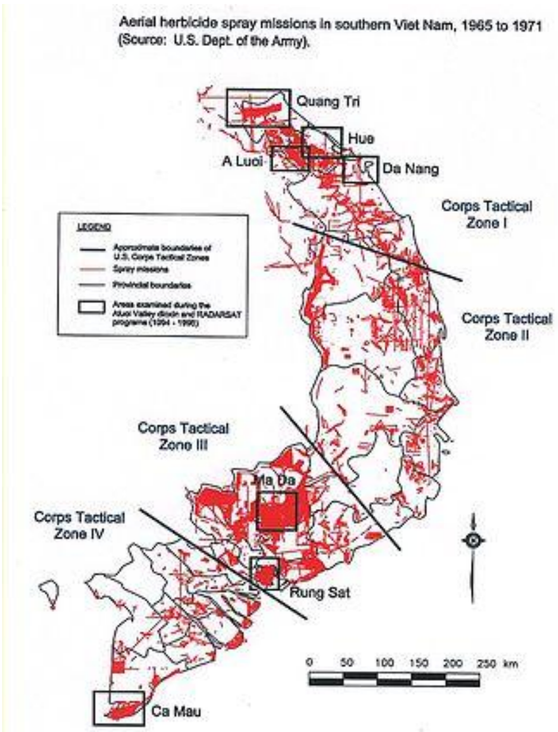
Starting in 1991, the US Congress asked the Institute of Medicine to review the scientific literature on Agent Orange and the other herbicides used in Vietnam, including their active ingredients and the dioxin contaminant. The IOM found an association between dioxin exposure and diabetes .

3 - Early development

In 1943, plant biologist Arthur Galston began studying the compound tri iodo benzoic acid as a plant growth hormone, in an attempt to adapt soybeans to a short growing season. Galston applied a low dose of the substance on a Soybean plant. The plant presented with flowering and accelerated growth when compared to a control. However, applied in excess, the plant would respond with catastrophic defoliation — a finding later used by his colleague Ian Sussex to develop the family of herbicides used in Operation Ranch Hand. Galston was especially concerned about the compound's side effects to humans and the environment.

In 1943, the U.S. Department of the Army contracted the University of Chicago to study the effects of 2,4-D and 2,4,5-T on cereal grains (including rice) and broadleaf crops. From these studies arose the concept of using aerial applications of herbicides to destroy enemy crops to disrupt their food supply. In early 1945, the U.S. army ran tests of various 2,4-D and 2,4,5-T mixtures at the Bushnell Army Airfield in Florida, which is now listed as a Formerly Used Defense Site (FUDS).

4 - Use in the Vietnam War



Map showing locations of U.S. army aerial herbicide spray missions in South Vietnam taking place from 1965 to 1971

During the Vietnam War, between 1962 and 1971, the United States military sprayed nearly 75,700,000 l) of chemical herbicides and defoliants in Vietnam, eastern Laos and parts of Cambodia, as part of the aerial defoliation program known as Operation Ranch Hand . The goal was to defoliate rural / forested land, depriving guerrillas of food and cover and clearing sensitive areas such as around base perimeters. The program was also a part of a general policy of forced draft urbanization, which aimed to destroy the ability of peasants to support themselves in the countryside, forcing them to flee to the U.S. dominated cities, depriving the guerrillas of their rural support base.

Spraying was usually done either from helicopters or from low-flying C-123 Provider aircraft, fitted with sprayers and "MC-1 Hourglass" pump systems and 3,800 L chemical tanks. Spray runs were also conducted from trucks, boats, and backpack sprayers.

The first batch of herbicides was unloaded at Tan Son Nhut Air Base in South Vietnam, on January 9, 1962 . Air Force records show at least 6,542 spraying missions took place over the course of Operation Ranch Hand . By 1971, 12 percent of the total area of South Vietnam had been sprayed with defoliating chemicals, at an average concentration of 13 times the recommended USDA application rate for domestic use . In South Vietnam alone, an estimated 10 million hectares of agricultural land were ultimately destroyed . In some areas, TCDD concentrations in soil and water were hundreds of times greater than the levels considered safe by the U.S. Environmental Protection Agency.

The campaign destroyed 20,000 km^2 of upland and mangrove forests and millions of acres of crops. Overall, more than 20 % of South Vietnam's forests were sprayed at least once over a nine-year period.

In 1965, members of the U.S. Congress were told "crop destruction is understood to be the more important purpose ... but the emphasis is usually given to the jungle defoliation in public mention of the program " . Soldiers were told they were destroying crops because they were going to be used to feed guerrillas. They later discovered nearly all of the food they had been destroying was not being produced for guerrillas; it was, in reality, only being grown to support the local civilian population. For example, in Quang Ngai province, 85 % of the crop lands were scheduled to be destroyed in 1970 alone. This contributed to widespread famine, leaving hundreds of thousands of people malnourished or starving.

The U.S. military began targeting food crops in October 1962, primarily using Agent Blue; the American public was not made aware of the crop destruction programs until 1965 (and it was then believed that crop spraying had begun that spring). In 1965, 42 percent of all herbicide spraying was dedicated to food crops. The first official acknowledgement of the programs came from the State Department in March 1966.

Many experts at the time, including Arthur Galston, the biologist who developed and intensively studied 2,4,5-T and TCDD, opposed herbicidal warfare, due to concerns about the side effects to humans and the environment by indiscriminately spraying the chemical over a wide area. As early as 1966, resolutions were introduced to the United Nations charging that the U.S. was violating the 1925 Geneva Protocol, which regulated the use of chemical and biological weapons.

	
Defoliant spray run, part of Operation Ranch Hand, during the Vietnam War by UC-123B Provider aircraft.	*Stacks of 200 L drums containing Agent Orange*

	
A UH-1D helicopter from the 336th Aviation Company sprays a defoliation agent over farmland in the Mekong Delta	*U.S. Army armored personnel carrier (APC) spraying Agent Orange over Vietnamese rice fields during the Vietnam War*

4 – 1 - Effects on the Vietnamese people
4 – 1 – 1 - Health effects

	
Vietnamese babies, deformed and stillborn after prenatal dioxin exposure from Agent Orange	*Major Tự Đức Phang was exposed to dioxin-contaminated Agent Orange*

The Vietnam Red Cross reported as many as 3 million Vietnamese people have been affected by Agent Orange, including at least 150,000 children born with birth defects . According to Vietnamese Ministry of Foreign Affairs, 4.8 million Vietnamese people were exposed to Agent Orange, resulting in 400,000 people being killed or maimed, and 500,000 children born with birth defects.[1] Women had higher rates of miscarriage and stillbirths, as did livestock such as cattle, water buffalo, and pigs.

Children in the areas where Agent Orange was used have been affected and have multiple health problems, including cleft palate, mental disabilities, hernias, and extra fingers and toes . In the 1970s, high levels of dioxin were found in the breast milk of South Vietnamese women, and in the blood of U.S. soldiers who had served in Vietnam . The most affected zones are the mountainous area along Truong Son (Long Mountains) and the border between Vietnam and Cambodia. The affected residents are living in substandard conditions with many genetic diseases.
]

About 28 of the former US military bases in Vietnam where the herbicides were stored and loaded onto airplanes may still have high level of dioxins in the soil, posing a health threat to the surrounding communities. Extensive testing for dioxin contamination has been conducted at the former US airbases in Da Nang, Phu Cat and Bien Hoa. Some of the soil and sediment on the bases have extremely high levels of dioxin requiring remediation. The Da Nang Airbase has dioxin contamination up to 350 times higher than international recommendations for action . The contaminated soil and sediment continue to affect the citizens of Vietnam, poisoning their food chain and causing illnesses, serious skin diseases and a variety of cancers in the lungs, larynx, and prostate.[

4 – 1 – 2 - Ecological effects

About 17.8 % (3,100,000 ha) of the total forested area of Vietnam was sprayed during the war, which dramatically disrupted ecological equilibrium. Furthermore, the persistent nature of dioxins, erosion caused by loss of protective tree cover, and loss of seeding forest stock, meant reforestation was difficult or impossible in many areas . Many defoliated forest areas were quickly invaded by aggressive pioneer species, such as bamboo and cogon grass, which make it unlikely the forests will be able to regenerate. Animal species diversity was also significantly impacted: in one study, a Harvard biologist found 24 species of birds and 5 species of mammals in a sprayed forest, while in two adjacent sections of unsprayed forest there were 145 and 170 species of birds and 30 and 55 species of mammals.

Dioxins from Agent Orange have persisted in the Vietnamese environment since the war, settling in the soil and sediment and entering into food chain through the animals and fish that feed in the contaminated areas. Movement of dioxins through the food web has resulted in bio concentration and bio magnification . The areas most heavily contaminated with dioxins are the sites of former U.S. air bases.

4 – 1 – 3 - Sociopolitical effects

The RAND Corporation's *Memorandum 5446 - ISA/ARPA* states : "the fact that the VC obtain most of their food from the neutral rural population dictates the destruction of civilian crops ... if they (the VC) are to be hampered by the crop destruction program, it will be necessary to destroy large portions of the rural economy – probably 50 % or more".

Rural - to - urban migration rates dramatically increased in South Vietnam, as peasants escaped the war in the countryside by fleeing to the U.S.- dominated cities. The urban population in South Vietnam nearly tripled, growing from 2.8 million people in 1958 to 8 million by 1971. The rapid flow of people led to a fast - paced and uncontrolled urbanization; an estimated 1.5 million people were living in Saigon slums.

4 –2 - Effects on U.S. veterans

Some studies showed that veterans who served in the South during the war have increased rates of cancer, and nerve, digestive, skin and respiratory disorders. Veterans from the south had higher rates of throat cancer, acute/chronic leukemia, Hodgkin's lymphoma and non - Hodgkin's lymphoma, prostate cancer, lung cancer, colon cancer, soft tissue sarcoma and liver cancer. With the exception of liver cancer, these are the same conditions the US Veterans Administration has determined may be associated with exposure to Agent Orange / dioxin, and are on the list of conditions eligible for compensation and treatment .

Military personnel who loaded airplanes and helicopters used in Ranch Hand probably sustained some of the heaviest exposures.

Members of the Army Chemical Corps, who stored and mixed herbicides and defoliated the perimeters of military bases, and mechanics who worked on the helicopters and planes, are also thought to have had some of the heaviest exposures. However, this same group of individuals has not shown remarkably higher incidences of the associated diseases. Others with potentially heavy exposures included members of U.S. Army Special Forces units who defoliated remote campsites, and members of U.S. Navy river units who cleared base perimeters. Military members who served on Okinawa also claim to have been exposed to the chemical but there is no verifiable evidence to corroborate these claims.

While in Vietnam, the veterans were told not to worry, and were persuaded the chemical was harmless.[70] After returning home, Vietnam veterans began to suspect their ill health or the instances of their wives having miscarriages or children born with birth defects might be related to Agent Orange and the other toxic herbicides to which they were exposed in Vietnam. Veterans began to file claims in 1977 to the Department of Veterans Affairs for disability payments for health care for conditions they believed were associated with exposure to Agent Orange, or more specifically, dioxin, but their claims were denied unless they could prove the condition began when they were in the service or within one year of their discharge.

By April 1993, the Department of Veterans Affairs had only compensated 486 victims, although it had received disability claims from 39,419 soldiers who had been exposed to Agent Orange while serving in Vietnam.

4 – 3 – Legal and diplomatic proceedings

4 – 3 – 1 - US veterans class action lawsuit against manufacturers

Since at least 1978, several lawsuits have been filed against the companies which produced Agent Orange, among them Dow Chemical, Monsanto, and Diamond Shamrock.

Hy Mayerson of The Mayerson Law Offices, P.C. was an early pioneer in Agent Orange litigation, working with environmental attorney Victor Yannacone in 1980 on the first class-action suits against wartime manufacturers of Agent Orange. In meeting Dr. Ronald A. Codario, one of the first civilian doctors to see afflicted patients, Mayerson, so impressed by the fact a physician would show so much interest in a Vietnam veteran, forwarded more than a thousand pages of information on Agent Orange and the effects of dioxin on animals and humans to Codario's office the day after he was first contacted by the doctor . The corporate defendants sought to escape culpability by blaming everything on the U.S. government.

The Mayerson law firm, with Sgt. Charles E. Hartz as their principal client, filed the first U.S. Agent Orange class-action lawsuit, in Pennsylvania in 1980, for the injuries soldiers in Vietnam suffered through exposure to toxic dioxins in the defoliant . Attorney Hy Mayerson co - wrote the brief that certified the Agent Orange Product Liability action as a class action, the largest ever filed as of its filing. Hartz's deposition was one of the first ever taken in America, and the first for an Agent Orange trial, for the purpose of preserving testimony at trial, as it was understood that Hartz would not live to see the trial because of a brain tumor that began to develop while he was a member of Tiger Force , Special Forces, and LRRPs in Vietnam . The firm also located and supplied critical research to the Veterans' lead expert, Dr. Ronald A. Codario, M.D., including about 100 articles from toxicology journals dating back more than a decade, as well as data about where herbicides had been sprayed, what the effects of dioxin had been on animals and humans, and every accident in factories where herbicides were produced or dioxin was a contaminant of some chemical reaction.

The chemical companies involved denied that there was a link between Agent Orange and the veterans' medical problems. However, on May 7, 1984, seven chemical companies settled the class-action suit out of court just hours before jury selection was to begin. The companies agreed to pay $180 million as compensation if the veterans dropped all claims against them. Slightly over 45 % of the sum was ordered to be paid by Monsanto alone. Many veterans who were victims of Agent Orange exposure were outraged the case had been settled instead of going to court, and felt they had been betrayed by the lawyers. "Fairness Hearings" were held in five major American cities, where veterans and their families discussed their reactions to the settlement, and condemned the actions of the lawyers and courts, demanding the case be heard before a jury of their peers. Federal Judge Julius Weinstein refused the appeals, claiming the settlement was "fair and just". By 1989, the veterans' fears were confirmed when it was decided how the money from the settlement would be paid out. A totally disabled Vietnam veteran would receive a maximum of $12,000 spread out over the course of 10 years. Furthermore, by accepting the settlement payments, disabled veterans would become ineligible for many state benefits that provided far more monetary support than the settlement, such as food stamps, public assistance, and government pensions. A widow of a Vietnam veteran who died of Agent Orange exposure would only receive $ 3700.

In 2004, Monsanto spokesman Jill Montgomery said Monsanto should not be liable at all for injuries or deaths caused by Agent Orange, saying: "We are sympathetic with people who believe they have been injured and understand their concern to find the cause, but reliable scientific evidence indicates that Agent Orange is not the cause of serious long-term health effects " .

4 – 3 – 2 - New Jersey Agent Orange Commission

In 1980, New Jersey created the New Jersey Agent Orange Commission, the first state commission created to study its effects. The commission's research project in association with Rutgers University was called "The Pointman Project". It was disbanded by Governor Christine Todd Whitman in 1996.

During Pointman I, commission researchers devised ways to determine small dioxin levels in blood. Prior to this, such levels could only be found in the adipose (fat) tissue. The project studied dioxin (TCDD) levels in blood as well as in adipose tissue in a small group of Vietnam veterans who had been exposed to Agent Orange and compared them to those of a matched control group; the levels were found to be higher in the former group.

The second phase of the project continued to examine and compare dioxin levels in various groups of Vietnam veterans, including Army, Marines and brown water riverboat Navy personnel.

4 – 3 – 3 - US Congress

In 1991, the US Congress enacted the Agent Orange Act, giving the Department of Veterans Affairs the authority to declare certain conditions 'presumptive' to exposure to Agent Orange/dioxin, making these veterans who served in Vietnam eligible to receive treatment and compensation for these conditions . The same law required the National Academy of Sciences to periodically review the science on dioxin and herbicides used in Vietnam to inform the Secretary of Veterans Affairs about the strength of the scientific evidence showing association between exposure to Agent Orange/dioxin and certain conditions.

Through this process, the list of 'presumptive' conditions has grown since 1991, and currently the U.S. Department of Veterans Affairs has listed prostate cancer, respiratory cancers, multiple myeloma, type II diabetes, Hodgkin's disease, non-Hodgkin's lymphoma, soft tissue sarcoma , chloracne , porphyria cutanea tarda, peripheral neuropathy, chronic lymphocytic leukemia, and spina bifida in children of veterans exposed to Agent Orange as conditions associated with exposure to the herbicide. This list now includes B cell leukemias, such as hairy cell leukemia, Parkinson's disease and ischemic heart disease, these last three having been added on August 31, 2010. Several highly placed individuals in government are voicing concerns about whether some of the diseases on the list should, in fact, actually have been included.

4 – 3 – 4 - U.S. – Vietnamese government negotiations

In 2002, Vietnam and the US held a joint conference on Human Health and Environmental Impacts of Agent Orange. Following the conference, the US National Institute of Environmental Health Sciences (NIEHS) began scientific exchanges between the US and Vietnam, and began discussions for a joint research project on the human health impacts of Agent Orange.[87]

These negotiations broke down in 2005, when neither side could agree on the research protocol and the research project was cancelled. More progress has been made on the environmental front. In 2005, the first US - Vietnam workshop on remediation of dioxin was held.

Starting in 2005, the U.S. Environmental Protection Agency (EPA) began to work with the Vietnamese government to measure the level of dioxin at the Da Nang Airbase. Also in 2005, the Joint Advisory Committee on Agent Orange, made up of representatives of Vietnamese and US government agencies, was established. The committee has been meeting yearly to explore areas of scientific cooperation, technical assistance and environmental remediation of dioxin.

A breakthrough in the diplomatic stalemate on this issue occurred as a result of United States President George W. Bush's state visit to Vietnam in November 2006. In the joint statement, President Bush and President Triet agreed "further joint efforts to address the environmental contamination near former dioxin storage sites would make a valuable contribution to the continued development of their bilateral relationship ".

In late May 2007, President Bush signed into law a supplemental spending bill for the war in Iraq and Afghanistan that included an earmark of $3 million specifically for funding for programs for the remediation of dioxin 'hotspots' on former US military bases, and for public health programs for the surrounding communities ; some authors consider this to be completely inadequate, pointing out that the U.S. airbase in Da Nang, alone, will cost $14 million to clean up, and that three others are estimated to require $60 million for cleanup. The appropriation was renewed in the fiscal year 2009 and again in FY 2010. An additional $ 12 million was appropriated in the fiscal year 2010 in the Supplemental Appropriations Act and a total of $18.5 million appropriated for fiscal year 2011 .

Secretary of State Hillary Clinton stated during a visit to Hanoi in October 2010 that the US government would begin work on the clean - up of dioxin contamination at the Da Nang airbase.

In June 2011 a ceremony was held at Da Nang airport to mark the start of US-funded decontamination of dioxin hotspots in Vietnam. $ 32 m has so far been allocated by the US congress to fund the program.

A $ 43 million project began in the summer of 2012, as Vietnam and the U.S. forge closer ties to boost trade and counter China's rising influence in the disputed South China Sea.

4 – 3 – 5 - Vietnamese victims class action lawsuit in U.S. courts

On January 31, 2004, a victim's rights group, the Vietnam Association for Victims of Agent Orange/dioxin (VAVA), filed a lawsuit in the United States District Court for the Eastern District of New York in Brooklyn, against several U.S. companies for liability in causing personal injury, by developing and producing the chemical. Dow Chemical and Monsanto were the two largest producers of Agent Orange for the U.S. military, and were named in the suit, along with the dozens of other companies (Diamond Shamrock, Uniroyal, Thompson Chemicals, Hercules, etc.). On March 10, 2005, Judge Jack B. Weinstein of the Eastern District – who had presided over the 1984 US veterans class-action lawsuit – dismissed the lawsuit, ruling there was no legal basis for the plaintiffs' claims. He concluded Agent Orange was not considered a poison under international law at the time of its use by the U.S.; the U.S. was not prohibited from using it as a herbicide; and the companies which produced the substance were not liable for the method of its use by the government. The U.S. government was not a party in the lawsuit, due to sovereign immunity, and the court ruled the chemical companies, as contractors of the US government, shared the same immunity. The case was appealed and heard by the Second Circuit Court of Appeals on June 18, 2007. The Court of Appeals upheld the dismissal of the case, stating the herbicides used during the war were not intended to be used to poison humans and therefore did not violate international law. The US Supreme Court declined to consider the case.

Three judges on the Second Circuit Court of Appeals in Manhattan heard the appeal on June 18, 2007. They upheld Weinstein's ruling to dismiss the case. They ruled that, though the herbicides contained a dioxin (a known poison), they were not intended to be used as a poison on humans. Therefore, they were not considered a chemical weapon and thus not a violation of international law. A further review of the case by the whole panel of judges of the Court of Appeals also confirmed this decision. The lawyers for the Vietnamese filed a petition to the US Supreme Court to hear the case. On March 2, 2009, the Supreme Court denied certiorari and refused to reconsider the ruling of the Court of Appeals.

In a November 2004 Zogby International poll of 987 people, 79 % of respondents thought the US chemical companies which produced Agent Orange defoliant should compensate US soldiers who were affected by the toxic chemical used during the war in Vietnam. Also, 51 % said they supported compensation for Vietnamese Agent Orange victims.

4 – 4 – Help for those affected in Vietnam

To assist those who have been affected by Agent Orange/dioxin, the Vietnamese have established "peace villages", which each host between 50 and 100 victims, giving them medical and psychological help. As of 2006, there were 11 such villages, thus granting some social protection to fewer than a thousand victims. U.S. veterans of the war in Vietnam and individuals who are aware and sympathetic to the impacts of Agent Orange have supported these programs in Vietnam. An international group of veterans from the U.S. and its allies during the Vietnam War working with their former enemy — veterans from the Vietnam Veterans Association — established the Vietnam Friendship Village outside of Hanoi.

The center provides medical care, rehabilitation and vocational training for children and veterans from Vietnam who have been affected by Agent Orange. In 1998, The Vietnam Red Cross established the Vietnam Agent Orange Victims Fund to provide direct assistance to families throughout Vietnam that have been affected. In 2003, the Vietnam Association of Victims of Agent Orange (VAVA) was formed. In addition to filing the lawsuit against the chemical companies, VAVA provides medical care, rehabilitation services and financial assistance to those injured by Agent Orange .

The Vietnamese government provides small monthly stipends to more than 200,000 Vietnamese believed affected by the herbicides; this totaled $ 40.8 million in 2008 alone. The Vietnam Red Cross has raised more than $ 22 million to assist the ill or disabled, and several U.S. foundations, United Nations agencies, European governments and nongovernmental organizations have given a total of about $23 million for site cleanup, reforestation, health care and other services to those in need.

Vuong Mo of the Vietnam News Agency described one of centers :

"May is 13, but she knows nothing, is unable to talk fluently, nor walk with ease due to for her bandy legs. Her father is dead and she has four elder brothers, all mentally retarded ... The students are all disabled, retarded and of different ages. Teaching them is a hard job. They are of the 3rd grade but many of them find it hard to do the reading. Only a few of them can. Their pronunciation is distorted due to their twisted lips and their memory is quite short. They easily forget what they've learned ... In the Village, it is quite hard to tell the kids' exact ages. Some in their twenties have a physical statures as small as the 7 - or 8 – years - old. They find it difficult to feed themselves, much less have mental ability or physical capacity for work. No one can hold back the tears when seeing the heads turning round unconsciously, the bandy arms managing to push the spoon of food into the mouths with awful difficulty ... Yet they still keep smiling, singing in their great innocence, at the presence of some visitors, craving for something beautiful."

On June 16, 2010, members of the U.S.-Vietnam Dialogue Group on Agent Orange/Dioxin unveiled a comprehensive 10-year Declaration and Plan of Action to address the toxic legacy of Agent Orange and other herbicides in Vietnam. The Plan of Action was released as an Aspen Institute publication and calls upon the U.S. and Vietnamese governments to join with other governments, foundations, businesses, and nonprofits in a partnership to clean up dioxin "hot spots" in Vietnam and to expand humanitarian services for people with disabilities there . On September 16, 2010, Senator Patrick Leahy (D-VT) acknowledged the work of the Dialogue Group by releasing a statement on the floor of the United States Senate. The statement urges the U.S. government to take the Plan of Action's recommendations into account in developing a multi-year plan of activities to address the Agent Orange/dioxin legacy.

5 - Use outside Vietnam

While 'Agent Orange' was only used between 1965 and 1970, 2,4-D, 2,4,5-T and other herbicides were used by the US military from the late 1940s through the 1970s. There is, however, no scientific evidence that these herbicides contained the same levels of dioxin as those used in Vietnam.

5 – 1 – Australia

Queensland

In 2008, Australian researcher Jean Williams claimed that cancer rates in the town of Innisfail, Queensland were 10 times higher than the state average due to secret testing of Agent Orange by the Australian military scientists during the Vietnam War. Williams, who had won the Order of Australia medal for her research on the effects of chemicals on U.S. war veterans, based her allegations on Australian government reports found in the Australian War Memorial's archives. A former soldier, Ted Bosworth, backed up the claims, saying that he had been involved in the secret testing. Neither Williams or Bosworth have produced verifiable evidence to support their claims. The Queensland health department determined that cancer rates in Innis fail were no higher than those in other parts of the state.

5 – 2 – Brazil

The Brazilian government used herbicides to defoliate a large section of the Amazon rainforest so that Alcoa could build the Tucuruí dam to power mining operations. Large areas of rainforest were destroyed, along with the homes and livelihoods of thousands of rural peasants and indigenous tribes.

5 – 3 – Canada

New Brunswick

The U.S. military, with the permission of the Canadian government,[110] tested herbicides, including Agent Orange, in the forests near the Canadian Forces Base Gagetown in New Brunswick in 1966 and 1967. On September 12, 2007, Greg Thompson, Minister of Veterans Affairs, announced that the government of Canada was offering a one - time ex gratia payment of $ 20,000 as the compensation package for Agent Orange exposure at CFB Gagetown.

On July 12, 2005, Merchant Law Group LLP on behalf of over 1,100 Canadian veterans and civilians who were living in and around the CFB Gagetown filed a lawsuit to pursue class action litigation concerning Agent Orange and Agent Purple with the Federal Court of Canada.

On August 4, 2009, the case was rejected by the court due to lack of evidence. The ruling was appealed.

In 2007 the Canadian government announced that a research and fact - finding program initiated in 2005 had found the base was safe .

Ontario

On February 17, 2011, the Toronto Star revealed that the same chemicals used to strip the jungles of Vietnam were also employed to clear extensive plots of Crown land in Northern Ontario.[116] The same day, in response to the Toronto Star article, the Ontario provincial government launched a probe into the use of Agent Orange.
]

On February 18, 2011, Ontario's Ministry of Natural Resources widened the probe of Agent Orange spraying to include all areas of the province where government managed forests on Crown land.[

The Toronto Star reported that, "records from the 1950s, 1960s and 1970s show forestry workers, often students and junior rangers, spent weeks at a time as human markers holding red, helium-filled balloons on fishing lines while low - flying planes sprayed toxic herbicides including an infamous chemical mixture known as Agent Orange on the brush and the boys below."

British Columbia

Records show tens of thousands of gallons of the toxic mixture were applied to clear brush near highways and along power lines in the late 1960s and early 1970s – and in some cases the substance was sprayed next to homes. In B.C., the mix of 2-4-D and 2-4-5-T was called "Type B Weed and Brush Killer" in government invoices. Sometimes, the engineers ordered 2-4-5-T by itself, and dubbed it "Type C Weed and Brush Killer."

In total, about 26,000 gallons of Type B Weed and Brush Killer were ordered between 1965 and 1972. About 10,000 gallons of Type C Weed and Brush Killer were ordered in the same time period. The barrels were shipped to all four of the regions of B.C. as designated by the Ministry of Highways: Kamloops, Nelson, Prince George and Vancouver.

In 1976, documents from BC Hydro show 2-4-5-T and 2-4-D was sprayed along Hydro lines Vernon-Monashee and Nicola-Brenda circuits. The documents also say "brushkiller" was sprayed in Pemberton and Daisy Lake.

5 – 4 – Korea

Agent Orange was used in Korea in the late 1960s . Republic of Korea troops were the only personnel involved in the spraying, which occurred along the Korean Demilitarized Zone (DMZ). "Citing declassified U.S. Department of Defense documents, Korean officials fear thousands of its soldiers may have come into contact with the herbicide in the late 1960s and early 1970s. According to one top government official, as many as '30,000 Korean veterans are suffering from illness related to their exposure'. The exact number of GIs who may have been exposed is unknown. But C. David Benbow, a North Carolina attorney who served as a sergeant with Co. C, 3rd Battalion, 23rd Infantry Regiment, 2nd Infantry Division, along the DMZ in 1968 – 69, estimates as many as '4,000 soldiers at any given time' could have been affected.".

In 1999, about 20,000 South Koreans filed two separated lawsuits against U.S. companies, seeking more than $5 billion in damages. After losing a decision in 2002, they filed an appeal.

In January 2006, the South Korean Appeals Court ordered Dow Chemical and Monsanto to pay $62 million in compensation to about 6,800 people. The ruling acknowledged that "the defendants failed to ensure safety as the defoliants manufactured by the defendants had higher levels of dioxins than standard", and, quoting the U.S. National Academy of Science report, declared that there was a "causal relationship" between Agent Orange and 11 diseases, including cancers of the lung, larynx and prostate. The judges failed to acknowledge "the relationship between the chemical and peripheral neuropathy, the disease most widespread among Agent Orange victims" according to the *Mercury News*.

The United States local press KPHO-TV in Phoenix, Arizona alleged that the United States Army had buried Agent Orange in Camp Carroll, the U.S. Army base located in Gyeongsangbuk-do, Korea . It is based on the claim of three U.S. Army veterans. They claimed approximately 250 drums of Agent Orange were buried at Camp Carroll in 1978. The South Korean Ministry of Environment announced that they will request cooperative investigation at Camp Carroll officially.[123] The USFK issued a statement that confirmed that barrels were buried there, but all (plus an additional 60 tons of soil) were removed in 1996.

Currently, veterans who provide evidence meeting VA requirements for service in Vietnam, and who can medically establish that anytime after this 'presumptive exposure' they developed any medical problems on the list of presumptive diseases, may receive compensation from the VA. Certain veterans who served in Korea and are able to prove they were assigned to certain specified around the DMZ during a specific time frame are afforded similar presumption. The differences in requirements between Vietnam and Korea service stem from the fact that congress has not made any laws to provide for the same sweeping presumption of exposure similar to the Agent Orange Act of 1991 for Korean veterans.

5 – 5 - New Zealand

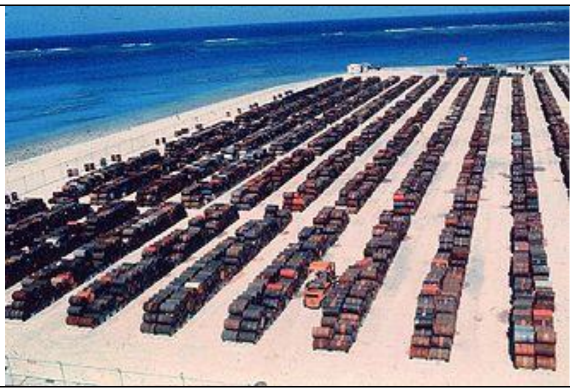
The use of Agent Orange has been controversial in New Zealand, because of the exposure of New Zealand troops in Vietnam and because of the production of Agent Orange for Vietnam and other users at an Ivon Watkins - Dow chemical plant in Paritutu, New Plymouth. There have been continuing claims, as yet unproven, that the suburb of Paritutu has also been polluted; see New Zealand in the Vietnam War.[126] There are cases of New Zealand soldiers developing cancers such as bone cancer but none have been scientifically connected to exposure to herbicides.

5 – 6 – Philippines

Herbicide persistence studies of Agents Orange and White were conducted in the Philippines . The Philippine herbicide test program was conducted in cooperation with the University of the Philippines, College of Forestry and was described in a 1969 issue of The Philippine Collegian.

5 – 7 - Johnston Atoll

Rusting Agent Orange Barrels at Johnston Atoll, circa 1976



Leaking Agent Orange Barrels at Johnston Atoll circa 1973

The Air Force operation to remove Herbicide Orange from Vietnam in 1972 was named Operation Pacer IVY while the operation to destroy the Agent Orange stored at Johnston Atoll in 1977 was named Operation Pacer HO. Operation Pacer IVY (In Ventor Y) collected Agent Orange in South Vietnam and removed it in 1972 aboard the ship MV *Transpacific* for storage on Johnston Atoll. The Environmental Protection Agency (EPA) reports that 1,800,000 gallons of Herbicide Orange was stored at Johnson Island in the Pacific and 480,000 gallons at Gulf port Mississippi.

Research and studies were initiated to find a safe method to destroy the materials and it was discovered they could be incinerated safely under special conditions of temperature and dwell time.[129] However, these herbicides were expensive and the Air Force wanted to resell its surplus instead of dumping it at sea.[130] Among many methods tested, a possibility of salvaging the herbicides by reprocessing and filtering out the 2,3,7,8 – tetra chloro dibenzo-p-dioxin (TCDD) contaminant with carbonized (charcoaled) coconut fibers. This concept was then tested in 1976 and a pilot plant constructed at Gulfport, Mississippi.

From July to September 1977 during Operation Pacer HO (Herbicide Orange), the entire stock of Herbicide Orange from both storage sites at Gulfport, Mississippi and Johnston Atoll was subsequently incinerated in four separate burns in the vicinity of Johnson Island aboard the Dutch-owned waste incineration ship MT *Vulcanus*.

As of 2004, some records of the storage and disposition of Agent Orange at Johnston Atoll have been associated with the historical records of Operation Red Hat.

5 – 8 - Allegations of usage and storage in Okinawa

There have been repeated reports in the Japanese press about use and/or storage of Agent Orange in Okinawa, based on statements by former US service members that had been stationed on the island, photographs, records, and unearthed storage barrels. The US

Department of Defense (Do D) has denied these allegations, most recently in a January 2013 report that was released in April 2013.

In particular, the 2013 report refuted articles written by journalist Jon Mitchell as well as a statement from "An Ecological Assessment of Johnston Atoll" a 2003 publication produced by the United States Army Chemical Materials Agency that states, "in 1972, the US Air Force also brought about 25,000 (208 L) drums of the chemical, Herbicide Orange (HO) to Johnston Island that originated from Vietnam and was stored on Okinawa." The 2013 report stated: "The authors of the [2003] report were not DoD employees, nor were they likely familiar with the issues surrounding Herbicide Orange or its actual history of transport to the Island." and detailed the transport phases and routes of Agent Orange from Vietnam to Johnston Atoll, none of which included Okinawa.

Further official confirmation of restricted (Dioxin containing) herbicide storage on Okinawa appeared in a 1971 Fort Detrick report titled "Historical, Logistical, Political and Technical Aspects of the Herbicide/Defoliant Program", which mentioned that the environmental statement should consider "Herbicide stockpiles elsewhere in PACOM (Pacific Command) U.S. Government restricted materials Thailand and Okinawa (Kadena AFB)."[135] The 2013 Do D report says that the environmental statement urged by the 1971 report was published in 1974 as "The Department of Air Force Final Environmental Statement", and that the latter did not find Agent Orange was held in either Thailand or Okinawa.

In July 2013, 2,3,7,8-Tetra chloro dibenzo – p - dioxin (TCDD) and 2,4,5-T from U.S. herbicides was detected in buried barrels labelled DOW Chemical that were unearthed the previous month under an Okinawan soccer field on land that was formerly part of Kadena Air Force Base and was returned to civilian control in 1987.

5 – 9 – Thailand

Agent Orange was tested by the United States in Thailand during the war in Southeast Asia. Buried drums were uncovered and confirmed to be Agent Orange in 1999 . Workers who uncovered the drums fell ill while upgrading the airport near Hua Hin, 100 km south of Bangkok.

Vietnam - era Veterans whose service involved duty on or near the perimeters of military bases in Thailand anytime between February 28, 1961 and May 7, 1975 may have been exposed to herbicides and may qualify for VA benefits. A claim for direct exposure is possible if the individual can verify that they worked or lived in close proximity to the affected areas of the bases in Thailand.

Report on defense tactics in Thailand A recently declassified Department of Defense (DoD) Report written in 1973, "*Project CHECO Southeast Asia Report: Base Defense in Thailand 1968–1972,*" (8.3 MB , PDF) contains evidence that there was a significant use of herbicides on the fenced - in perimeters of military bases in Thailand to remove foliage that provided cover for enemy forces.

In 2013 VA determined that herbicides used on the Thailand base perimeters may have been tactical and procured from Vietnam, or a strong, commercial type resembling tactical herbicides.[140]

5 – 10 - United States

The University of Hawaii has acknowledged extensive testing of Agent Orange on behalf of the United States Department of Defense in Hawaii along with mixtures of Agent Orange on Kaua'i Island in 1967- 68 and on Hawaii Island in 1966; testing and storage in other U.S. locations has been documented by the United States Department of Veterans Affairs .

In 1971, the C-123 aircraft used for spraying Agent Orange were returned to the United States and assigned various East Coast USAF Reserve squadrons, and then employed in traditional airlift missions between 1972 and 1982. In 1994, testing by the Air Force identified some former spray aircraft as "heavily contaminated" with dioxin residue. Inquiries by aircrew veterans in 2011 brought a decision by the US Department of Veterans Affairs opining that not enough dioxin residue remained to injure these post-Vietnam War veterans. On 26 January 2012, the US Center For Disease Control's

Agency for Toxic Substances and Disease Registry challenged this with their finding that former spray aircraft were indeed contaminated and the aircrews exposed to harmful levels of dioxin.

In 1978, the U.S. Environmental Protection Agency suspended spraying of Agent Orange in National Forests, due to a threefold increase in miscarriages in women living near forests that had been sprayed.

On December 23, 1982, the EPA announced it had identified dangerous levels of dioxin in the soil of Times Beach, Missouri. Panic spread through the town, with many illnesses, miscarriages and animal deaths attributed to the dioxin. By 1985, the town was evacuated except for one elderly couple who refused to leave, and the site was quarantined. Residents were shunned in their new communities by people who feared the effects of exposure to dioxin were contagious.

A December 2006 Department of Defense report listed Agent Orange testing, storage, and disposal sites at 32 locations throughout the United States, as well as in Canada, Thailand, Puerto Rico, Korea, and in the Pacific Ocean . The Veteran Administration has also acknowledged that Agent Orange was used domestically by U.S. forces in test sites throughout the US. Eglin Air Force Base in Florida was one of the primary testing sites throughout the 1960s.

AGM-114 Hellfire

A model of a Hellfire's components

Contents

1 - Introduction

The AGM-114 Hellfire is an air-to-surface missile (ASM) developed primarily for anti-armor use. It was originally developed under the name *Helicopter Launched, Fire and Forget Missile*, which led to the acronym 'Hellfire' that became the missile's formal name.[2] It has multi-mission, multi-target precision-strike capability, and can be launched from multiple air, sea, and ground platforms. The Hellfire missile is the primary 100 lb-class air-to-ground precision weapon for the armed forces of the United States and many other nations, and is considered a proven tactical missile system, as it has been used in combat since the mid-1980s.

AGM-114 Hellfire	
Type	Air - to - surface and surface-to-surface missile
Place of origin	United States
Service history	
In service	1984 – present
Production history	
Manufacturer	Lockheed Martin
Unit cost	US $ 68,000
Produced	1974 – present
Specifications	
Weight	45.4 – 49 kg
Length	163 cm
Diameter	17.8 cm
Warhead	High Explosive Anti-Tank (HEAT); 9 kg tandem anti - armor Metal augmented charge 8 kg shaped - charge Blast Fragmentation
Engine	Solid - fuel rocket
Wingspan	33 cm
Operational range	500 m – 8 km
Speed	1530 Km / h
Guidance system	Semi - active laser homing millimeter wave radar seeker
Launch platform	Rotary- and fixed - wing platforms, Unmanned combat air vehicles, tripods, ships, and ground vehicles

2 – Description

The Hellfire is a comprehensive weapon system that can be deployed from rotary- and fixed-wing aircraft, waterborne vessels and land-based systems against a variety of targets.

The development of the Hellfire Missile System began in 1974 with the U.S. Army requirement for a "tank-buster", launched from helicopters to defeat armored fighting vehicles.[3][4] Production of the AGM-114A started in 1982. The Development Test and Evaluation (DT&E) launch phase of the AGM-114B took place in 1984. The DT&E on the AGM-114K was completed in Fiscal Year (FY)93 and FY94. AGM-114M did not require a DT&E because it is the same as the AGM-114K except for the warhead. Most variants are laser guided with one, AGM-114L "Longbow Hellfire", being radar guided.[5][6] Laser guidance can be provided either from the launcher, such as the nose-mounted opto-electronics of the AH-64 Apache attack helicopter, other airborne target designators or from ground based observers, the latter two options allowing the launcher to break line of sight with the target and seek cover.

Cockpit video showing the missile being used in Afghanistan against two human targets on a road.

The Hellfire II, developed in the early 1990s is a modular missile system with several variants for maximum battlefield flexibility. Hellfire II's semi - active laser variants — AGM-114K high-explosive anti-tank (HEAT), AGM-114KII with external blast fragmentation sleeve, AGM-114M (blast fragmentation), and AGM-114N metal augmented charge (MAC)—achieve pinpoint accuracy by homing in on a reflected laser beam aimed at the target. Predator and Reaper UCAVs carry the Hellfire II, but the most common platform is the AH-64 Apache helicopter gunship, which can carry up to 16 of the missiles at once. The AGM-114L, or Longbow Hellfire, is a fire-and-forget weapon: equipped with a millimeter wave (MMW) radar seeker, it requires no further guidance after launch—even being able to lock-on to its target after launch[8]—and can hit its target without the launcher or other friendly unit being in line of sight of the target. It also provides capability in adverse weather and battlefield obscurants (obscurants such as smoke and fog being able to mask the position of the target or to prevent the designating laser from producing a detectable reflection). Each Hellfire weighs 47 kg / 106 pounds, including the 9 kg / 20 pound warhead, and has a range of 8,000 meters. The AGM-114R "Romeo" Hellfire II entered service in late 2012. It uses a semi-active laser homing guidance system and an integrated blast fragmentation sleeve warhead to engage targets that previously needed multiple Hellfire variants. It will replace AGM-114K, M, N, and P variants in U.S. service.[9] In October 2012, the U.S. ordered 24,000 Hellfire II missiles, for both the U.S. armed forces and foreign customers.

The Joint Common Missile (JCM) was to replace Hellfire II (along with the AGM-65 Maverick) by around 2011. The JCM was developed with a tri-mode seeker and a multi-purpose warhead that would combine the capabilities of the several Hellfire variants. In the budget for FY2006, the U.S. Department of Defense canceled a number of projects that they felt no longer warranted continuation based on their cost effectiveness, including the JCM. A possible new JCM successor called the Joint Air to Ground Missile (JAGM) is under consideration.

3 - Combat history

Since being fielded, Hellfire missiles have been used in combat in Operation Just Cause in Panama, Operation Desert Storm in

Persian Gulf, Operation Allied Force in Yugoslavia, Operation Enduring Freedom in Afghanistan, in Operation Iraqi Freedom, where they have been fired from Apache and Super Cobra attack helicopters, Kiowa scout helicopters, and Predator unmanned combat air vehicles (UCAVs).

The only known operational air-to-air kill with a Hellfire took place on 24 May 2001. A civilian Cessna 152 aircraft entered Israeli airspace from Lebanon, with unknown intentions and refusing to answer or comply with ATC repeated warnings to turn back. Fearing a terrorist attack, an Israeli Air Force AH-64A helicopter fired upon the Cessna, resulting in its complete disintegration,[11] and the death of Estephan Nicolian, a student pilot.

In 2008, the usage of the AGM-114N variant caused controversy in the United Kingdom when it was reported that these thermo baric munitions were added to the British Army arsenal. Thermo baric weapons have been condemned by human rights groups. The UK Ministry of Defence refers to the AGM-114N as an "enhanced blast weapon".

The AGM-114 has been the munition of choice for airborne targeted killings that have included high-profile figures such as Ahmed Yassin (Hamas leader) in 2004 by the Israeli Air Force and; Anwar al-Awlaki (American-born Islamic cleric and Al Qaeda in the Arabian Peninsula leader) in Yemen in 2011, and Abu Yahya al-Libi in Pakistan in 2012 by the United States.

4 - Launch vehicles and systems

4 – 1 - Manned helicopters

AH-1W Super Cobra
AH-1Z Viper
AH-64 Apache
Agusta A129 Mangusta
Eurocopter Tiger
SH-60 / MH-60R / MH-60S Seahawk
OH-58D Kiowa Warrior

RAH - 66 Comanche
AH - 6 Little Bird
UH - 60 Blackhawk
Westland WAH - 64 Apache

4 – 1 - Fixed-wing aircraft
AC- 208 Combat Caravan
Lockheed Martin KC- 130 Harvest HAWK
A - 29 Super Tucano
Air Tractor AT- 802U

Hellfire loaded onto the rails of a United States Marine Corps AH-1W Super Cobra at Balad Air Base in Iraq in 2005.

4 – 2 – 1 - Unmanned aircraft

Predator launching a Hellfire missile

MQ -1B Predator
MQ - 9 Reaper
Predator C
MQ -1C Grey Eagle

4 – 3 – Manned boat

Combat Boat 90

4 – 4 - Experimental platforms

The system has been tested for use on the Humvee and the Improved TOW Vehicle (ITV). Test shots have also been fired from a C-130 Hercules. Sweden and Norway use the Hellfire for coastal defense, and Norway has conducted tests with Hellfire launchers on Protector (RWS) remotely - controlled weapon systems mounted on the Stridsbåt 90 coastal assault boat.

5 – Operators

Australia
Egypt
France
Greece
Iraq
Israel
India
Italy
Japan
Jordan
Kuwait
Lebanon
Netherlands
Norway
Pakistan
Qatar
Saudi Arabia
Singapore
Sweden
Republic of China (Taiwan)
Thailand
Turkey
United Arab Emirates
United Kingdom
United States

6 – Variants

AGM-114A Basic Hellfire

Target : Tanks, armored vehicles.
Range : 8,000 m
Guidance : Semi - active laser homing (SALH).
Warhead : 8 kg shaped charge HEAT.
Length : 163 cm
Weight: 45 kg

AGM-114B / C Basic Hellfire

AGM-114B has electronic SAD (Safe / Arming Device) for safe shipboard use.

Unit cost : $ 25,000

AGM-114D / E Basic Hellfire

Proposed upgrade of AGM-114B/C with digital autopilot—not built.

AGM-114F Interim Hellfire

Target: Tanks, armored vehicles.
Range: 7,000 m
Guidance : Semi - active laser homing.
Warhead : 9 kg tandem shaped charge HEAT.
Length : 180 cm
Weight : 48.5 kg

AGM-114G Interim Hellfire

Proposed version of AGM-114F with SAD—not built.

AGM-114H Interim Hellfire

Proposed upgrade of AGM-114F with digital autopilot—not built.

AGM-114J Hellfire II

Proposed version of AGM - 114F with lighter components, shorter airframe, and increased range — not built.

A Hellfire II exposed through transparent casing.

AGM - 114K Hellfire II

Target : All armored threats

Range : 8,000 m

Guidance : Semi - active laser homing with Electro-optical countermeasures hardening

Digital autopilot improvements allow target reacquisition after lost laser lock

New electronic SAD

Warhead : 9 kg tandem shaped charge HEAT

Length : 163 cm

Weight: 45.4 kg

Unit cost : $ 65,000

Essentially the proposed AGM-114J w/ SAD

AGM - 114L Longbow Hellfire

Target : All armored threats

Range : 8,000 m

Guidance :

Fire and forget Millimeter wave radar seeker coupled with Inertial guidance

Homing capability in adverse weather and the presence of battlefield obscurants

Warhead : 9 kg tandem shaped charge high explosive anti-tank (HEAT)

Length: 176 cm

Weight: 49 kg

AGM - 114M Hellfire II

Target: Bunkers, light vehicles, urban (soft) targets and caves

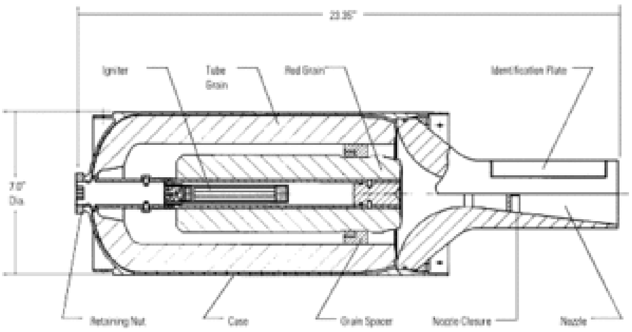
Range: 8,000 m
Guidance:
Semi-active laser homing
Warhead: Blast fragmentation/incendiary
Weight: 48.2 kg (106 lb)
Length: 163 cm (64 in)

AGM-114N Hellfire II
Target: Enclosures, ships, urban targets, air defense units
Range: 8,000 m
Guidance: Semi-active laser homing
Warhead: Metal augmented charge (MAC) (Thermobaric)
Weight: 48 kg
Length: 163 cm
AGM-114P Hellfire II
Version of AGM-114K optimized for use from UCAVs flying at high altitude.

ATM-114Q Hellfire II
Practice version of AGM-114N with inert warhead.
AGM-114R Hellfire II
Target: Bunkers, light vehicles, urban (soft) targets and caves
Range: 8,000 m
Guidance: Semi-active laser homing
Warhead: Integrated Blast Frag Sleeve (IBFS) (combine blast fragmentation and fragment dispersion).
Weight: 50 kg
Speed : Mach 1.3
AGM-114S Hellfire II
Practice version of AGM-114K with a spotting charge instead of a warhead.

AGM-114T Hellfire II
AGM-114R with insensitive munition rocket motor and electromagnetic control actuators.

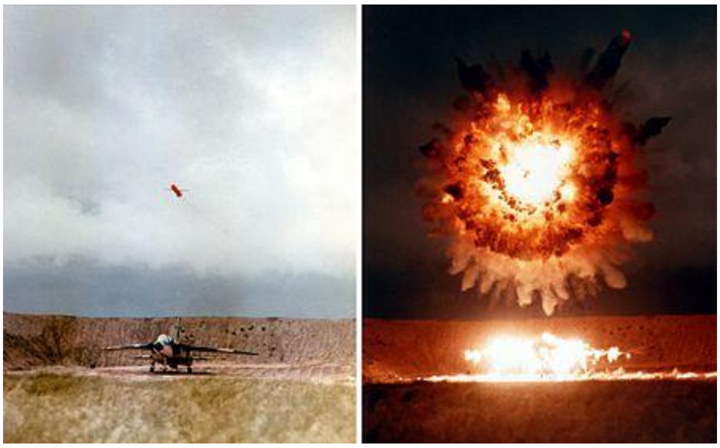
7 - Rocket motor



Cross section diagram of Hellfire rocket motor, showing the rod and tube grain design.

Contractor : Alliant Techsystems
Designation:
M120E3 (Army)
M120E4 (Navy)
Main features:
Qualified minimum smoke propellant
Rod and tube grain design
Neoprene bond line system
Performance:
Operating temperature: − 43 °C to 63 °C
Storage temperature: − 43 °C to 71 °C
Service life: 20 + years (estimated)
Technical data:
Weight: 14.2 kg
Length: 59.3 cm
Diameter: 18 cm
Case : 7075 - T73 aluminum
Insulator : R-181 aramid fiber-filled EPDM
Nozzle : Cellulose phenolic
Propellant : Minimum smoke cross linked double based (XLDB)

Air Burst



UGM-109 Tomahawk missile detonates above a test target, 1986

Contents

1 - Introduction

An air burst is the detonation of an explosive device such as an anti - personnel artillery shell or a nuclear weapon in the air instead of on contact with the ground or target or a delayed armor piercing explosion. The principal military advantage of an air burst over a ground burst is that the energy from the explosion (as well as any shell fragments) is distributed more evenly over a wider area; however, the peak energy is lower at ground zero.

The term may also refer to naturally occurring air bursts arising from the explosions of incoming meteors as happened in the Tunguska event, the Curuçá River event, and the 2013 Russian meteor event.

2 – History

Air burst artillery has a long history. The shrapnel shell was invented by Henry Shrapnel of the British army in about 1780 to increase the effectiveness of canister shot. It was widely used by the time of the War of 1812 and stayed in use until it was superseded during the First World War. Modern shells, though sometimes called "Shrapnel shells", actually produce fragments and splinters, not shrapnel.

Air bursts were used in the First World War to shower enemy positions and men with shrapnel balls to kill the largest possible number of them with a single burst, assuming that the burst was directly in front of the trench in which the men were positioned.

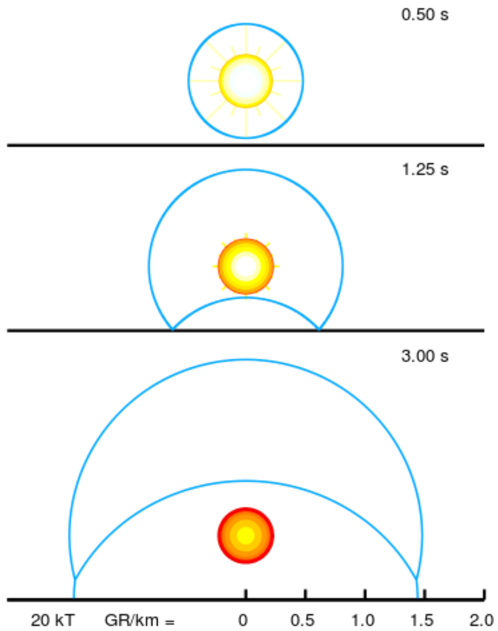
When infantry moved into deep trenches , shrapnel shells were rendered useless and high - explosive shells were used to attack field fortifications and troops in the open. The time fuses for the shells could be set to function on contact or in the air. During the Second World War, a "Variable Time Fuse" was developed. This fuse could not be set by the gun detachment but was controlled by a doppler radar device which caused the shell to explode when near the target.

During the Vietnam War, air bursting shells were used to great effect to defend US Army bases. This tactic was known as 'Killer Junior' when referring to 105 mm or 155 mm shells, and 'Killer Senior' when employed with larger howitzers.

Some anti - personnel land mines such as the "Bouncing Betty" fire a grenade into the air which detonates at approximately two foot eleven inches, causing the fragments to fly out at waist level, severely maiming limbs and genitalia of anyone within a fifteen foot radius.

A relatively recent example of airburst munitions is the VOG - 25P "jumping" 40 mm case less grenade, which contains a secondary charge to launch it up to 1.5 meters above its point of impact before the main charge detonates. Another recent development is computer programmable rounds. Weapons using this new technology include the XM29, XM25, XM307, K11, and PAPOP, all of which are in various stages of prototyping or testing.

2 - 1 - Nuclear weapons



A blast wave reflecting from a surface and forming a mach stem.

The air burst is usually several hundred to a few thousand feet (100 to 1000m) above the hypocenter to allow the shockwave of the fission or fusion driven explosion to bounce off of the ground and back into itself, creating a shockwave that is more forceful than one from a detonation at ground level. This "mach stem" only occurs near ground level, and is similar in shape to the letter Y when viewed from the side. Air bursting also minimizes fallout by keeping the fireball from touching the ground, limiting the amount of debris that is vaporized and drawn up in the radioactive debris cloud. For the Hiroshima bomb, an air burst 550 – 610 m above the ground was chosen "to achieve maximum blast effects, and to minimize residual radiation on the ground as it was hoped U.S. troops would soon occupy the city".

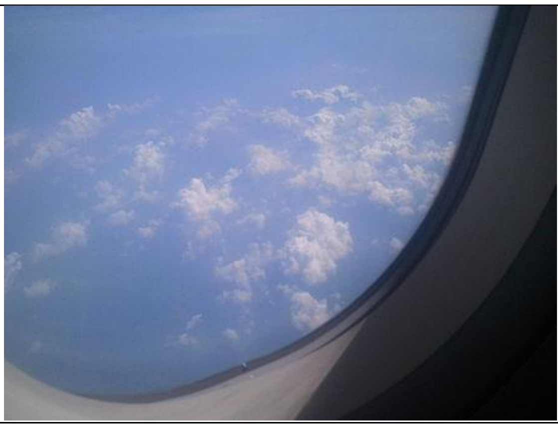
3 – Tactics

Air bursts are used primarily against infantry in the open or unarmored targets, as the resulting fragments cover a large area but will not penetrate armor, entrenchments, or fortifications.

Air Burst Round

An airburst round, air burst grenade, or smart grenade is a type of explosive ammunition, typically a shell or grenade, that detonates in midair, causing air burst effect shrapnel damage to an enemy. This makes it easier to hit enemy soldiers behind a wall, in a Defensive fighting position, or in a confined space or room. It is used on many guns, from artillery to the hand-held XM 25 Individual Airburst Weapon System (derived from the XM29 OICW). Unlike traditional grenades, such as the 40 mm grenade, smart grenades can be electronically programmed to explode after traveling a certain distance. A fire control computer or some other electronic sighting system is used to quickly program the electronic fuse with any distance, as conditions dictate.

Air Craft

	
Sky pictured in an aircraft	*A Qantas Airbus A380, the world's largest passenger airliner*

Contents

1 - Introduction

An aircraft is a machine that is able to fly by gaining support from the air, or, in general, the atmosphere of a planet. It counters the force of gravity by using either static lift or by using the dynamic lift of an airfoil, or in a few cases the downward thrust from jet engines.

The human activity that surrounds aircraft is called *aviation*. Crewed aircraft are flown by an onboard pilot, but unmanned aerial vehicles may be remotely controlled or self-controlled by onboard computers. Aircraft may be classified by different criteria, such as lift type, propulsion, usage and others.

2 - History[edit source

Flying model craft and stories of manned flight go back many centuries, however the first manned ascent – and safe descent – in modern times took place by hot-air balloon in the 18th century. Each of the two World Wars led to great technical advances. Consequently the history of aircraft can be divided into five eras :

Pioneers of flight, from the earliest experiments to 1913.

First World War, 1914 to 1918.
Inter - war, some times called the Golden Age, 1919 to 1938.

Second World War, 1939 to 1945.
Postwar era, also called the jet age, 1946 to the present day.

3 - Methods of lift

3 – 1 - Lighter than air – aerostats[edit source

A hot air balloon in flight

Aerostats use buoyancy to float in the air in much the same way that ships float on the water. They are characterized by one or more large gasbags or canopies, filled with a relatively low-density gas such as helium, hydrogen, or hot air, which is less dense than the surrounding air. When the weight of this is added to the weight of the aircraft structure, it adds up to the same weight as the air that the craft displaces.

Small hot - air balloons called sky lanterns date back to the 3rd century BC, and were only the second type of aircraft to fly, the first being kites.

A balloon was originally any aerostat, while the term airship was used for large, powered aircraft designs – usually fixed-wing – though none had yet been built. The advent of powered balloons, called dirigible balloons, and later of rigid hulls allowing a great increase in size, began to change the way these words were used. Huge powered aerostats, characterized by a rigid outer framework and separate aerodynamic skin surrounding the gas bags, were produced, the Zeppelins being the largest and most famous. There were still no fixed-wing aircraft or non-rigid balloons large enough to be called airships, so "airship" came to be synonymous with these aircraft. Then several accidents, such as the Hindenburg disaster in 1937, led to the demise of these airships. Nowadays a "balloon" is an unpowered aerostat, whilst an "airship" is a powered one.

A powered, steerable aerostat is called a *dirigible*. Sometimes this term is applied only to non-rigid balloons, and sometimes *dirigible balloon* is regarded as the definition of an airship (which may then be rigid or non-rigid). Non-rigid dirigibles are characterized by a moderately aerodynamic gasbag with stabilizing fins at the back. These soon became known as *blimps*. During the Second World War, this shape was widely adopted for tethered balloons; in windy weather, this both reduces the strain on the tether and stabilizes the balloon. The nickname *blimp* was adopted along with the shape. In modern times, any small dirigible or airship is called a blimp, though a blimp may be unpowered as well as powered.

3 – 2 - Heavier than air – aerodynes

Heavier – than - air aircraft, such as airplanes, must find some way to push air or gas downwards, so that a reaction occurs (by Newton's laws of motion) to push the aircraft upwards. This dynamic movement through the air is the origin of the term *aerodyne*. There are two ways to produce dynamic up thrust : aerodynamic lift, and powered lift in the form of engine thrust.

Aerodynamic lift involving wings is the most common, with fixed-wing aircraft being kept in the air by the forward movement of wings, and rotorcraft by spinning wing-shaped rotors sometimes called rotary wings. A wing is a flat, horizontal surface, usually shaped in cross-section as an aero foil. To fly, air must flow over the wing and generate lift. A *flexible wing* is a wing made of fabric or thin sheet material, often stretched over a rigid frame. A *kite* is tethered to the ground and relies on the speed of the wind over its wings, which may be flexible or rigid, fixed, or rotary.

With powered lift, the aircraft directs its engine thrust vertically downward. V/STOL aircraft, such as the Harrier Jump Jet and F-35B take off and land vertically using powered lift and transfer to aerodynamic lift in steady flight.

A pure rocket is not usually regarded as an aerodyne, because it does not depend on the air for its lift (and can even fly into space); however, many aerodynamic lift vehicles have been powered or assisted by rocket motors. Rocket-powered missiles that obtain aerodynamic lift at very high speed due to airflow over their bodies are a marginal case.

3 – 2 – 1 - Fixed-wing

NASA test aircraft

The forerunner of the fixed-wing aircraft is the kite. Whereas a fixed-wing aircraft relies on its forward speed to create airflow over the wings, a kite is tethered to the ground and relies on the wind blowing over its wings to provide lift. Kites were the first kind of aircraft to fly, and were invented in China around 500 BC. Much aerodynamic research was done with kites before test aircraft, wind tunnels, and computer modeling programs became available.

The first heavier – than - air craft capable of controlled free-flight were gliders. A glider designed by Cayley carried out the first true manned, controlled flight in 1853.

Practical, powered, fixed-wing aircraft (the aeroplane or airplane) were invented by Wilbur and Orville Wright. Besides the method of propulsion, fixed - wing aircraft are in general characterized by their wing configuration. The most important wing characteristics are :

Number of wings – Mono plane, bi plane, etc.

Wing support – Braced or cantilever, rigid, or flexible.

Wing plan form – including aspect ratio, angle of sweep, and any variations along the span (including the important class of delta wings) .

Location of the horizontal stabilizer, if any.

Dihedral angle – positive, zero, or negative (anhedral).

A variable geometry aircraft can change its wing configuration during flight.

A *flying wing* has no fuselage, though it may have small blisters or pods. The opposite of this is a *lifting body*, which has no wings, though it may have small stabilizing and control surfaces.

Wing-in-ground-effect vehicles may be considered as fixed-wing aircraft. They "fly" efficiently close to the surface of the ground or water, like conventional aircraft during takeoff. An example is the Russian ekranoplan (nicknamed the "Caspian Sea Monster"). Man-powered aircraft also rely on ground effect to remain airborne with a minimal pilot power, but this is only because they are so underpowered — in fact, the airframe is capable of flying higher.

3 – 2 – 2 – Rotor craft

An auto gyro

Rotorcraft, or rotary-wing aircraft, use a spinning rotor with aero foil section blades (a *rotary wing*) to provide lift. Types include helicopters, auto gyros, and various hybrids such as gyro dynes and compound rotorcraft.

Helicopters have a rotor turned by an engine-driven shaft. The rotor pushes air downward to create lift. By tilting the rotor forward, the downward flow is tilted backward, producing thrust for forward flight. Some helicopters have more than one rotor and a few have rotors turned by gas jets at the tips.

Auto gyros have unpowered rotors, with a separate power plant to provide thrust. The rotor is tilted backward. As the autogyro moves forward, air blows upward across the rotor, making it spin. This spinning increases the speed of airflow over the rotor, to provide lift. Rotor kites are unpowered autogyros, which are towed to give them forward speed or tethered to a static anchor in high-wind for kited flight.

Compound rotorcraft have wings that provide some or all of the lift in forward flight. They are nowadays classified as *powered lift* types and not as rotorcraft. *Tiltrotor* aircraft (such as the V-22 Osprey), tilt wing, tail sitter, and coleopter aircraft have their rotors/propellers horizontal for vertical flight and vertical for forward flight.

3 – 2 – 43- Other methods of lift

X-24B lifting body, specialized glider

A *lifting body* is an aircraft body shaped to produce lift. If there are any wings, they are too small to provide significant lift and are used only for stability and control. Lifting bodies are not efficient: they suffer from high drag, and must also travel at high speed to generate enough lift to fly. Many of the research prototypes, such as the Martin - Marietta X-24, which led up to the Space Shuttle, were lifting bodies (though the shuttle itself is not), and some supersonic missiles obtain lift from the airflow over a tubular body.

Powered lift types rely on engine-derived lift for vertical takeoff and landing (VTOL). Most types transition to fixed-wing lift for horizontal flight. Classes of powered lift types include VTOL jet aircraft (such as the Harrier jump-jet) and tilt rotors (such as the V-22 Osprey), among others.

4 – Propulsion

4 – 1 - Unpowered aircraft

Gliders are heavier-than-air aircraft that do not employ propulsion once airborne. Take-off may be by launching forward and downward from a high location, or by pulling into the air on a tow-line, either by a ground-based winch or vehicle, or by a powered "tug" aircraft. For a glider to maintain its forward air speed and lift, it must descend in relation to the air (but not necessarily in relation to the ground). Many gliders can 'soar' – gain height from updrafts such as thermal currents. The first practical, controllable example was designed and built by the British scientist and pioneer George Cayley, whom many recognize as the first aeronautical engineer. Common examples of gliders are sailplanes, hang gliders and paragliders.

Balloons drift with the wind, though normally the pilot can control the altitude, either by heating the air or by releasing ballast, giving some directional control (since the wind direction changes with altitude). A wing-shaped hybrid balloon can glide directionally when rising or falling; but a spherically shaped balloon does not have such directional control.

Kites are aircraft that are tethered to the ground or other object (fixed or mobile) that maintains tension in the tether or kite line; they rely on virtual or real wind blowing over and under them to generate lift and drag. Kytoons are balloon-kite hybrids that are shaped and tethered to obtain kiting deflections, and can be lighter-than-air, neutrally buoyant, or heavier - than - air.

4 – 2 - Powered aircraft

Powered aircraft have one or more onboard sources of mechanical power, typically aircraft engines although rubber and manpower have also been used. Most aircraft engines are either lightweight piston engines or gas turbines. Engine fuel is stored in tanks, usually in the wings but larger aircraft also have additional fuel tanks in the fuselage.

4 – 2 - 1 - Propeller aircraft

A turboprop- engined DeHavilland Twin Otter adapted as a floatplane

Propeller aircraft use one or more propellers (airscrews) to create thrust in a forward direction. The propeller is usually mounted in front of the power source in *tractor configuration* but can be mounted behind in *pusher configuration*. Variations of propeller layout include *contra-rotating propellers* and *ducted fans*.

Many kinds of power plant have been used to drive propellers. Early airships used man power or steam engines. The more practical internal combustion piston engine was used for virtually all fixed-wing aircraft until World War II and is still used in many smaller aircraft. Some types use turbine engines to drive a propeller in the form of a turboprop or prop fan. Human-powered flight has been achieved, but has not become a practical means of transport. Unmanned aircraft and models have also used power sources such as electric motors and rubber bands.

4 – 2 - 2 - Jet aircraft

Lockheed Martin F-22A Raptor

Jet aircraft use air breathing jet engines which take in air, burn fuel with it in a combustion chamber, and accelerate the exhaust rearwards to provide thrust.

Turbojet and turbofan engines use a spinning turbine to drive one or more fans, which provide additional thrust. An afterburner may be used to inject extra fuel into the hot exhaust, especially on military "fast jets". Use of a turbine is not absolutely necessary: other designs include the pulse jet and ramjet. These mechanically simple designs cannot work when stationary, so the aircraft must be launched to flying speed by some other method. Other variants have also been used, including the motorjet and hybrids such as the Pratt & Whitney J58, which can convert between turbojet and ramjet operation.

Compared to propellers, jet engines can provide much higher thrust, higher speeds and, above about 12,000 m , greater efficiency . They are also much more fuel-efficient than rockets. As a consequence nearly all large, high-speed or high-altitude aircraft use jet engines.

4 – 2 - 3 – Rotorcraft

Some rotor craft, such as helicopters, have a powered rotary wing or *rotor*, where the rotor disc can be angled slightly forward so that a proportion of its lift is directed forwards. The rotor may, like a propeller, be powered by a variety of methods such as a piston engine or turbine. Experiments have also used jet nozzles at the rotor blade tips.

4 – 2 - 4 - Other types of powered aircraft

Rocket-powered aircraft have occasionally been experimented with, and the Messerschmitt *Komet* fighter even saw action in the Second World War. Since then, they have been restricted to research aircraft, such as the North American X-15, which traveled up into space where air-breathing engines cannot work (rockets carry their own oxidant). Rockets have more often been used as a supplement to the main power plant, typically for the rocket-assisted take off of heavily loaded aircraft, but also to provide high-speed dash capability in some hybrid designs such as the Saunders-Roe SR.53.

The ***ornithopter*** obtains thrust by flapping its wings. It has found practical use in a model hawk used to freeze prey animals into stillness so that they can be captured, and in toy birds.

5 - Design and construction

Aircraft are designed according to many factors such as customer and manufacturer demand, safety protocols and physical and economic constraints. For many types of aircraft the design process is regulated by national airworthiness authorities.

The key parts of an aircraft are generally divided into three categories:

The ***structure*** comprises the main load-bearing elements and associated equipment.

The ***propulsion*** *system* (if it is powered) comprises the power source and associated equipment, as described above.

The ***avionics*** comprise the control, navigation and communication systems, usually electrical in nature.

5 - 1 – Structure

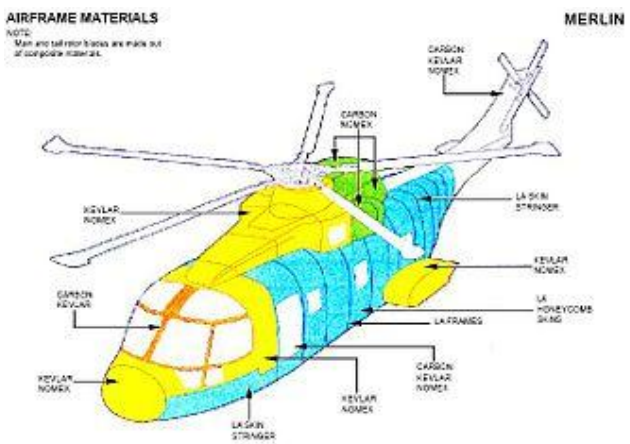
The approach to structural design varies widely between different types of aircraft. Some, such as paragliders, comprise only flexible materials which act in tension and rely on aerodynamic pressure to hold their shape. A balloon similarly relies on internal gas pressure but may have a rigid basket or gondola slung below it to carry its payload. Early aircraft, including airships, often employed flexible doped aircraft fabric covering to give a reasonably smooth aero shell stretched over a rigid frame. Later aircraft employed semi-monocoque techniques, where the skin of the aircraft is stiff enough to share much of the flight loads. In a true monocoque design there is no internal structure left.

The key structural parts of an aircraft depend on what type it is.

5 – 1 - 1 - Aerostats

Lighter – than - air types are characterized by one or more gasbags, typically with a supporting structure of flexible cables or a rigid frame work called its hull. Other elements such as engines or a gondola may also be attached to the supporting structure.

5 – 1 - 2 – Aerodynes



Airframe diagram for an Agusta Westland AW101 helicopter

Heavier - than - air types are characterized by one or more wings and a central fuselage. The fuselage typically also carries a tail or empennage for stability and control, and an undercarriage for takeoff and landing. Engines may be located on the fuselage or wings. On a fixed - wing aircraft the wings are rigidly attached to the fuselage, while on a rotorcraft the wings are attached to a rotating vertical shaft. Smaller designs sometimes use flexible materials for part or all of the structure, held in place either by a rigid frame or by air pressure. The fixed parts of the structure comprise the airframe.

5 – 1 - 3 – Avionics

he avionics comprise the flight control systems and related equipment, including the cockpit instrumentation, navigation, radar, monitoring, and communication systems.

6 - Flight characteristics

6 - 1 - Flight envelope

The flight envelope of an aircraft refers to its capabilities in terms of airspeed and load factor or altitude . The term can also refer to other measurements such as maneuverability. When a craft is pushed, for instance by diving it at high speeds, it is said to be flown "outside the envelope", something considered unsafe.

6 - 2 – Range

The Boeing 777-200LR is the longest - range airliner, capable of flights of more than halfway around the world.

The range is the distance an aircraft can fly between takeoff and landing, as limited by the time it can remain airborne.

For a powered aircraft the time limit is determined by the fuel load and rate of consumption.

For an unpowered aircraft, the maximum flight time is limited by factors such as weather conditions and pilot endurance. Many aircraft types are restricted to daylight hours, while balloons are limited by their supply of lifting gas. The range can be seen as the average ground speed multiplied by the maximum time in the air.

6 - 2 - Flight dynamics

Flight dynamics is the science of air vehicle orientation and control in three dimensions. The three critical flight dynamics parameters are the angles of rotation around three axes about the vehicle's center of mass, known as pitch, roll, and yaw (quite different from their use as Tait-Bryan angles).

Roll is a rotation about the longitudinal axis (equivalent to the rolling or heeling of a ship) giving an up - down movement of the wing tips measured by the roll or bank angle.

Pitch is a rotation about the sideways horizontal axis giving an up - down movement of the aircraft nose measured by the angle of attack.

Yaw is a rotation about the vertical axis giving a side-to-side movement of the nose known as sideslip.

Flight dynamics is concerned with the stability and control of an aircraft's rotation about each of these axes.

6 – 3 - 1 – Stability

The empennage of a Boeing 747–200

An aircraft which is unstable tends to diverge from its current flight path and so is difficult to fly. An aircraft which is very stable tends to stay on its current flight path and is difficult to manoeuvre. So it is important for any design to achieve the desired degree of stability. Since the widespread use of digital computers, it is becoming increasingly common for designs to be inherently unstable and to rely on computerized control systems to provide artificial stability.

A fixed wing is typically unstable in pitch, roll and yaw. Pitch and yaw stabilities of conventional fixed wing designs need horizontal and vertical stabilizers which act in a similar way to the feathers on an arrow. These stabilizing surfaces allow equilibrium of aero dynamic forces and to stabilize the flight dynamics of pitch and yaw. They are usually mounted on the tail section (empennage), although in the canard layout, the main aft wing replaces the canard fore plane as pitch stabilizer. tandem and Tailless aircraft rely on the same general rule to achieve stability, the aft surface being the stabilizing one.

A rotary wing is typically unstable in yaw, requiring a vertical stabilizer.

A balloon is typically very stable in pitch and roll due to the way the payload is hung under Neath.

6 - 3 – 2 – Control

Flight control surfaces enable the pilot to control an aircraft's flight attitude and are usually part of the wing or mounted on, or integral with, the associated stabilizing surface. Their development was a critical advance in the history of aircraft, which had until that point been uncontrollable in flight.

Aerospace engineers develop control systems for a vehicle's orientation (attitude) about its center of mass. The control systems include actuators, which exert forces in various directions, and generate rotational forces or moments about the aerodynamic center of the aircraft, and thus rotate the aircraft in pitch, roll, or yaw. For example, a pitching moment is a vertical force applied at a distance forward or aft from the aerodynamic center of the aircraft, causing the aircraft to pitch up or down. Control systems are also sometimes used to increase or decrease drag, for example to slow the aircraft to a safe speed for landing.

The two main aerodynamic forces acting on any aircraft are lift supporting it in the air and drag opposing its motion. Control surfaces or other techniques may also be used to affect these forces directly, without inducing any rotation.

7 - Impact and use

In general, aircraft have positive properties as they permit long distance, high speed travel and are often reasonably efficient. In addition to their usefulness, they have some environmental impacts. They generate some atmospheric pollution, are relatively noisy compared to other forms of travel and high altitude aircraft generate contrails which experimental evidence suggests may alter weather patterns.

Aircraft are produced in several different types optimized for various uses; military aircraft, which includes not just combat types but many types of supporting aircraft, and civil aircraft, which include all non-military types, experimental and model.

7 - 1 – Military

Boeing B-17E in flight. The Allies of World War II lost 160,000 airmen and 33,700 planes during the air war over Europe.

A military aircraft is any aircraft that is operated by a legal or insurrectionary armed service of any type.[11] Military aircraft can be either combat or non – combat :

Combat aircraft are aircraft designed to destroy enemy equipment using its own armament. Combat aircraft divide broadly into fighters and bombers, with several in-between types such as fighter-bombers and ground-attack aircraft (including attack helicopters).

Non - combat aircraft are not designed for combat as their primary function, but may carry weapons for self-defense. Non-combat roles include search and rescue, reconnaissance, observation, transport, training, and aerial refueling. These aircraft are often variants of civil aircraft.

Most military aircraft are powered heavier-than-air types. Other types such as gliders and balloons have also been used as military aircraft; for example, balloons were used for observation during the American Civil War and World War I, and military gliders were used during World War II to land troops.

7 - 2 – Civil

Agusta A109 helicopter of the Swiss air rescue service

Civil aircraft divide into *commercial* and *general* types, however there are some overlaps.

Commercial aircraft include types designed for scheduled and charter airline flights, carrying passengers, mail and other cargo. The larger passenger-carrying types are the airliners, the largest of which are wide-body aircraft. Some of the smaller types are also used in general aviation, and some of the larger types are used as VIP aircraft.

General aviation is a catch-all covering other kinds of private (where the pilot is not paid for time or expenses) and commercial use, and involving a wide range of aircraft types such as business jets (bizjets), trainers, homebuilt, gliders, war birds and hot air balloons to name a few. The vast majority of aircraft today are general aviation types.

7 - 3 – Experimental

An experimental aircraft is one that has not been fully proven in flight, or one that carries an FAA airworthiness certificate in the "Experimental" category. Often, this implies that new aerospace technologies are being tested on the aircraft, although the term also refers to amateur- and kit - built aircraft; many of which are based on proven designs.

Air Soft Gun

Classic Army M15A4 AEG with Aim point Comp2 Replica Red dot sight

Contents

1 - Introduction

Airsoft guns are replica firearms used in airsoft that fire plastic pellets by way of compressed gas or electric and / or spring - driven pistons. These guns are designed to be non - lethal and to provide realistic replicas.

Depending on the mechanism driving the pellet, an airsoft gun can be operated manually or cycled by either compressed gas such as Green Gas (propane and silicone mix) or CO_2, or by compressed air via a spring or an electric motor pulling a piston.

2 – Manufacturers

Currently, a large number of airsoft weaponry manufacturers are on the market , these include AGM, ARES, A&K, APS, Army Armament, Both Elephant, Celcius Technology,[2] Airsoft Atlanta,[3] Classic Army, CYMA , D - Boys, Deep Fire, Double Eagle, Echo 1,T.I.E.R.,G&G, G&P, HFC, ICS, Jing Gong, Jing Peng, Galaxy, King Arms, KJ Works, KWA, which is OEM for KSC, KWC, Mad Bull Airsoft, LCT, Marushin, Maruzen, Silesia Factory, SRC, Systema Engineering, Team SD, Tokyo Marui, VFC, Wei-E Tech, Well, Western Arms, Crossman, and Win Gun . Companies, such as Aftermath, Crossman, Cyber gun, Echo 1, and UTG, re - brand and distribute guns, sometimes with other accessories in countries where some manufacturers may not have an established distribution network. Many of the best-selling airsoft weapons are high detailed replicas of real lethal weapons, which are manufactured and designed by companies headquartered in Asian countries like Japan, Taiwan, South Korea, Hong Kong and China, however, European and North American brands exist also. Beyond airsoft guns proper, those companies may produce other items like BBs, airsoft grenades and airsoft landmines (like Airsoft Innovations and S-Thunder), as well as spare parts and a varied range of accessories for the replicas, like scopes, mounts and suppressors. Mid-High end companies such as Ares, ICS, Classic Army, King Arms, Marushin, Tokyo Marui and Star (to name a few) will often find that their products have been illegally copied and sold at a fraction of the cost by Chinese companies such as AGM , CYMA and JG (are the most common) the Chinese Government clamped down on this practice in 2007, manufacture has now been resumed. However the cheaper price and similar quality has made them ideal platforms to upgrade without the risk of destroying an expensive airsoft gun.[*citation needed*]

3 – Usage

	
Soldiers with the US Army 187th Ordnance Battalion prepared to clear a room during urban combat training at the battalion's Field Training Exercise site. The Soldiers were armed with airsoft weapons as part of a pilot program in 2009.	*Systema Professional Training Weapon System M4A1 MAX*

Airsoft in the past was used almost solely for recreational purposes, but in 2012 GBB airsoft technology became adopted by many federal and state institutions as an extremely affordable and reliable training tool. The GBB Platforms allowed for correct weapons manipulation and training for a fraction of the cost of conventional conversion kits that used UTMs and Sim rounds. The Airsoft platforms also provide a much safer platform for training allowing for basic and advanced shooter training in a much safer environment reducing the risks of injury or death from a negligent discharge.

There are airsoft clubs, teams and even athletic associations devoted to airsoft events around the world. Europe is home to some of the largest events, with skirmishes of over 2,000 people participating. The US is catching up quickly in size. In 2012 Fulda Gap in North Carolina had over 1,100 people and O.L.C.M.S.S. Lion Claws (John Lu) had 800 people attend at Georges Air Force Base, CA. American Mil – sim , Black Sheep, and Ball ahack also host large games (to name a few). The draw of the larger games is due to the intensity and variety in equipment that is used from small arms all the way up to technicals and armored vehicles.

In many countries, every airsoft gun owner and active enthusiast must be affiliated with an accredited airsoft association or federation. Most airsoft players host games at a registered field where combat situations are simulated using airsoft weaponry like replicas of pistols, carbines (including submachine guns), rifles (including sniper rifles), grenades and landmines. Great variety and profusion of militaria is usually used. Historical reenactment of war situations is another favorite of many airsoft players and clubs. In addition, a number of companies such as Systema Engineering and Celcius Technology manufacture ultra-realistic high-velocity airsoft rifles designed specifically for the police and military for non-lethal training purposes. People today can also use it for film making props for shooting films.

4 - Types of airsoft guns

4 – 1 - Spring powered

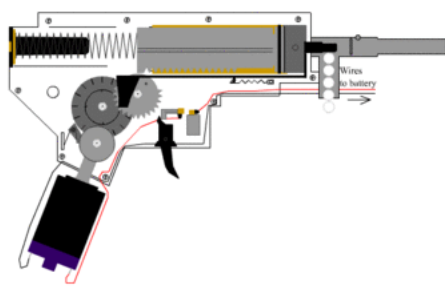
The age a person has to be to purchase a spring-powered gun depends completely on locality. Spring-powered airsoft guns are single shot devices that use elastic potential energy (EPE) stored in a spring to compress air to launch an airsoft pellet down the barrel of the gun. The user must cock a spring gun prior to each shot. This is typically achieved by pulling back the slide (pistols), bolt (rifles), or the grip on a shotgun, which in turn compresses the spring and makes the gun ready to fire . Because of this, these guns are by definition incapable of automatic or semi - automatic fire. Spring-powered airsoft guns are generally not as powerful as gas but are more powerful than electric models, although some spring shotguns and sniper rifles can be very powerful and shoot at velocities of 400 – 120 – 210 m / s . These are generally inexpensive, excluding the high power bolt action sniper rifles and shotguns, and may not last long (depending on the quality) because of the tension created by a powerful spring. However, many spring guns can be modified and upgraded to last longer and shoot better.

While most electric guns also use springs for propulsion of the BB, they are not considered to be in the same category as the single-shot spring-powered guns. Low - end spring guns tend to be much cheaper than their electric - powered equivalents due to their simplicity and lack of electrical components (spring assembly, electric motor, battery, and battery charger) and thus are widely available. These guns are less suited for competition because they are at a disadvantage against automatic guns in close combat and do not provide enough accuracy and power for long-range use. There are some exceptions, however, as higher-end spring-powered airsoft rifles can be quite expensive; these guns are typically suited for "marksman" applications in airsoft matches and provide competitive muzzle velocities. Additionally, pump shotguns are sometimes used for both short and longer range engagements. In colder weather, spring pistols are more reliable than gas - powered pistols and even the batteries on AEPs (Automatic Electric Pistols) both of which can be adversely affected by extreme cold.

This represents one of the major advantages of spring-powered airsoft gun, as it can be fired in any situation, without reliance on an external source of power, such as batteries or gas. The lack of reliance on external power sources causes some players to favor spring-powered guns. Spring guns are also less susceptible to the effects of water, where a battery-powered gun could malfunction when wet.

Spring - powered weapons are often cheaper than electric or gas powered weapons. They are also more readily available in most department stores. Because of their price and availability, spring guns tend to act as "training guns" to bring new players to airsoft games and are considered the primary weapon of "backyard skirmishes". Almost all airsoft players at some point owned a spring weapon, whether for its actual use in a competitive event or for the replica value since some airsoft weapons are only available as spring versions. However, some airsoft players still rely on sniper-rifle type spring guns as a primary arm due to the reliability, high power and accuracy, and low noise, as well as their ease of repair and modification compared to electric powered guns.

4 – 2 - Automatic electric guns

	
An ARES L85 customised with a Daniel Defense RIS system, a replica ACOG scope, a replica gripod and Magpul PTS EMAG.	*An illustration of the working of a Version 2 gearbox*

Electric - powered airsoft guns typically use a rechargeable battery or batteries to drive an electric motor, which cycles an internal piston/spring assembly in order to launch pellets. Automatic, 3 round burst, and semi-automatic operation is possible which gives these guns the popular name "automatic electric guns" or AEGs.[8] These guns often attain muzzle velocities from 150 to 650 ft/s (46 to 200 m/s) and rates of fire of between 100 and 1500 rounds per minute. They are the most commonly used and widely available type of airsoft gun.

These type of guns were developed in Japan and the Japanese company Tokyo Marui dominates the market. In a Tokyo Marui AEG, the motor drives a series of 3 gears mounted inside a gearbox.

The gears then compress a piston assembly against a spring. Once the piston is released, the spring drives it forward through the cylinder to push a pellet into the chamber, through the barrel, and forward from the muzzle. Many manufacturers have now more or less replicated this basic model, adding reinforced parts or minor improvements. These guns are powered primarily by nickel metal hydride (NiMH) with varying voltages and mille ampere hours ratings. The most common battery is an 8.4 V large battery (between 2200 and 5000 mAh.) Also available are "mini" and "stick" batteries, which generally have 900–1600 m Ah capacities. Voltages for NiMH batteries range from 7.2 V, all the way up to 12 V. The rule of thumb usually is the higher the m Ah, the longer the battery lasts while the higher voltage, the higher Rate of Fire (Ro F). Recently, however, Lithium-Polymer, or Li-po, batteries are becoming more popular in the airsoft world. These batteries can last longer and have higher m Ah and Volts while at the same time, being small and light. Li-po batteries are usually at 11.1 V or 7.4 V varying in mAh from 500 m Ah to 6500 m Ah.

External modifications, such as metal bodies and reinforced plastics that make AEGs look and feel even more realistic, have become very popular. AEG manufacturers such as Classic Army and Tokyo Marui produce replicas that are visually nearly identical to their real counterparts. Tokyo Marui uses an ABS plastic, whereas Classic Army features full metal bodied guns and stronger furnishings. Most AEGs produced as of late are designed to be as visually realistic as possible.

The three most common AEGs on the field are the AR-15 series (M16 rifle, M4 carbine, etc.; sometimes referred to as the Arma Lite or Colt series), the Heckler & Koch MP5 series, and the AK or Kalashnikov series. Also increasing popular is the Heckler & Koch G36 and more recently, FN P90. Subsequently numerous parts for repairs and modifications are commonly available for these rifles. AEG models range from a simple pistol to an RPG (Rocket Propelled Grenade) all the way to a Mini gun.

4 – 3 - Hybrid guns

Hybrid Airsoft guns are the newest type of airsoft guns on the market. Hybrid airsoft guns are basically standard AEGs or Gas Blowback Airsoft Guns with a "little extra reality" built in. These guns are usually more powerful.

AEG Hybrid Operation

The magazine is loaded with shell cases, each containing a single plastic pellet. These shell casings can have a small red cap, the same as those found in any child's toy cap gun placed on the top of them. These guns feature an electrically powered, full blowback system and operate on a "round-per-shell" basis such that for every pellet fired, a shell casing is ejected and the cap is fired providing a realistic sound and smoke effect. Since its debut, the only Hybrid guns seen on the market are TOP M4A1, as well as M1 Garand, Kar98, and other rifle models. These guns are the least common type of gun on the market today and are generally used by collectors and re-enactors rather than skirmishers.

Gas Blow Back Hybrid Operation

Hybrid Gas Blow Back Airsoft guns are quite similar with hybrid AEGs and their operations are similar with Gas Blow Back Airsoft Guns. A single 6mm pellet is still loaded to a shell casing. Then it is placed into a magazine. The Airsoft Replica itself also has a tank for compressed gas as propellant (Such as Green Gas). So as the slide/bolt is pulled back, it loads a shell into the chamber. As the trigger is pulled, it releases a small burst of propellant and the pellet is forced out the barrel.

4 – 4 - Low price electric guns

Called *low price electric guns* (LPEGs) to distinguish them from the original, more expensive and more powerful AEGs even though their mechanical/electrical design and operation is similar. They are not to be confused with *Mini Electrics* (described below). Originally they were only of novelty value, often regarded below spring operated guns due to their construction and low velocities. Since there are spring action guns that can notably outperform the true low-end

LPEGs and can be found at comparable prices, they are generally considered to be better choices.

4 – 5 - Medium price electric guns

Some companies - like UTG with their popular MP5 and AK-47 models - have improved their quality to such an extent that some models are now considered simply as mid-ranged AEGs that are more affordable but still reasonably effective. Among air softers, these are commonly called middle priced electric guns (MPEGs). Sometimes, MPEGs are copies or 'clones' of designs by full - price manufacturers like Tokyo Marui . As of late 2008 a small number of MPEG brands such as Echo-1 / Jing Gong, and CYMA are considered by many to approach the quality and match the performance of the originals, at less than half the price. "Fully compatible" MPEGs imitate the Marui or Classic Army originals so precisely that standard upgrade parts will work with them, making it possible to hotn - rod an MPEG to well beyond stock out-of-the-box AEG performance.

4 – 6 - Electric blow backs

Electric blowbacks, also known as EBBs, are high - end AEGs which generally run from a rechargeable 9.6 volt battery. Most models utilizing this system are rifles. EBBs simulate the blowback action of a real pistol or rifle but generally have less of a kick. Essentially an AEG in design, EBBs are just as powerful. However, a drawback to having the blow back feature is that the battery is quickly depleted, additionally blowbacks can cause extra stress on the gear box which may result in the gearbox's shorter life span. The blowback system can be disabled with some tinkering.

Electric blowback can also refer to a feature in some higher-end guns which offers more realistic operation. Companies such as G&G now offer guns such as the combat machine M4 and the combat machine "RK47" which has moving parts linked directly to the main mechanism of the gun, such as the bolt. Echo 1 has recently released a Blowback MP5SD. Also, APS (Accuracy Pneumatics Shooting) makes EBB M4A1, M4 Commando, and the AK47. The M4s also have 3 others with an RIS unit. These weapons perform identically to similar non - blowback offerings, with the added realism of reciprocating bolts and some recoil. Most models incorporate pneumatic blowback systems but some feature mechanical systems.

4 – 7 - Mini electrics

Recently, the company Well, well known for its spring guns, began manufacturing a range of battery powered guns in miniature size that fire only full automatic. They differ from GPMGs in that they are not replicas of real firearms, being miniaturized version of real firearms, mostly made of black or clear plastic.

They have a small bb capacity, usually between 50 and 100 rounds, but they have fair range and a functional hop-up. They have become very popular in recent years, and are now being manufactured by Tokyo Marui. These “minis,” as they are referred to, are not a viable option in games against AEGs since their small ammo capacity, short range and poor far range accuracy leave their wielder at a large disadvantage. Mini electric guns are able to compete with spring pistols at close ranges however, primarily due to their higher rate of fire.

4 – 8 - Automatic Electric Pistols

Automatic Electric Pistols, abbreviated AEPs, were first introduced by Tokyo Marui in 2005 with their Glock 18C (followed later by a Beretta 93R model). They were the first handguns to incorporate an electric powered system that is capable of fully automatic operation.

In cold weather, AEPs are often considered better sidearms than gas powered pistols, because batteries are not as badly affected by frigid weather. Gases like CO_2 and green gas are stored in liquid form and require heat in order to vaporize. A gas pistol at 10 °F (−12 °C) will usually only get one to two usable shots from a full magazine, and even will be at reduced power because of the lowered pressure of the gas.

Because the AEP gearbox and battery are smaller, the velocity of AEP BBs (usually between 200 to 280 ft/s (85.3 m/s)) is relatively slow by the standards of airsoft simulations, rendering them useful only for close-range simulation. However, the advanced hop up units on these new guns tend to compensate for the low power and can produce an effective range comparable to those of an AEG. CYMA has made a clone Glock 18C, which is a lower priced alternative.

An AEP differs from electric blow-backs because the AEP has a fixed slide (in which there is no external movement of the slide during operation), while an EBB simulates the "blow back" action in the slide experienced in a real pistol or Gas Blow Back (GBB). An AEP, however, has much more power and accuracy.

One of the newer AEP - styled guns is the Marui replica of the Heckler & Koch MP7. It is considerably larger than either of the other guns, and can be upgraded to a much higher power through the use of an external battery, but uses the same system as the AEP, so the classification is ambiguous. It is slightly more powerful than the others and is a suitable choice for CQB (Close Quarter Battle) games due to its small size and decent barrel - to gun-length ratio.

Some semi - automatic pistols can be modified to be automatic pistols. To make them more effective, they use rechargeable batteries supplied with the gun, and can be replaced with a larger battery to make their ROF higher.

Due to restrictions on size, either the electric motor or batteries have to occupy space in the hand grip, reducing the available space for a magazine. Because of this no AEP uses a full size magazine found in most gas powered pistols.

In addition, most AEPs are constructed almost entirely of plastic and have a light, toy-like feeling to them.

4 – 9 - Training Weapons

Airsoft gun manufacturer, Systema Engineering (PTW) developed a line of airsoft guns and accessories intended for military and law enforcement training. These airsoft guns are made of aircraft grade aluminum combined with stainless steel parts that gives strength, stability, weather protection, and easy maintenance. These training weapons offer a more realistic display of military weapons. Unfortunately they have been plagued by reliability problems and parts availability. They have also had models banned from the US due to them been able to be converted into real fire arms. Two manufactures, King Arms and KWA came out with ATF approved GBBR AR15 platforms that allowed for correct weapons tear down, manipulation, and function that were designed for military use, but were also legal for US citizens to own. The King Arms model required upgrade parts out of the parts to give it reliability, though the KWA was plagued by a weak hop up system, but otherwise reliable.

4 – 10 - Gas powered airsoft guns

These guns are capable of automatic and semi-automatic operation. The most common gases used are "green gas" and Propane which requires an adaptor, HFC-134a is also commonly used, particularly with pistols which have plastic sliders due to the lower pressure giving a smaller chance of damage to the weaker slide.[7] Less commonly used gases include "red gas" (which is actually HCFC-22), CO_2 and nitrogen/high pressure air. It is unlawful to use HCFC-22 as a propellant in the US. HCFC-22 is a Class II ozone depleting substance and its use as an aerosol propellant has been banned since January 1994 under section 610(d) of Clean Air Act.

Red gas is usually avoided unless the airsoft gun has undergone modification, as its relatively high critical pressure can cause damage to the airsoft gun, such as breakage of the slide or bolt. CO_2, nitrogen, and high pressure air are less common because they need to be stored at higher pressures than "green gas" or HFC-134a.

The first ever gas powered airsoft guns were commonly referred to as 'classic' guns, owing to their age. These guns were most commonly powered by liquid propellants such as R-12 (Which was marketed by the Japanese as FLON-12 or DuPont trade name Freon 12)CFC-12 feed system with a majority of the configurations containing two tanks, one containing the CFC-12 and one used as an expansion tank, and the gun itself. CFC-12 was a commonly used refrigerant for car air conditioning and refrigerators. It is considered a highly potent ozone depleting substance and listed as a Class I Ozone Depleting Substance by the US EPA. Its use as a general purpose aerosol propellant has been banned by the US EPA since March 1978 under 43 FR 11301 for use in aerosol use with a very few exceptions.[12] Its use is also banned in many countries under United Nations treaties. On Dec 31, 2008, the use of CFCs for medical inhalers were banned.

Later users modified these old guns to be powered by regulated CO_2 canisters or nitrogen/high pressure air bottles to increase power and consistency. However, these guns have largely been superseded by the newer and more versatile AEGs, or automatic electric guns. One of the reasons for this is because the most commonly available propellant, R-12, is costly. Additionally, at high flow rates, liquid propellants tend to cool down, eventually freezing. As cool down progresses, the rate of fire gradually decreases until the gun ceases operation. The user would then be forced to wait for the propellant to warm up again. CO_2 is not affected as badly by this tendency, and nitrogen/high pressure air is immune to it. Furthermore, if liquid propellant is introduced into the gun's mechanism, rubber parts can freeze and eventually damage the gun. However, it is unlikely for this to occur since once the gas is released from the containing cylinder it instantly turns back into its gaseous state, and expands rapidly. It is doubtful whether the retained pressure behind the BB before it begins to accelerate down the barrel is enough to keep the gas in a liquid form. Also, any gun that is expected to be exposed to the intense cold of de - pressurizing gas should have materials that can handle it.

Gas power tends to be used in airsoft pistols where size constraints make electric - powered mechanisms impractical. Other instances where gas is favored are where adjustable velocities are required or where a blowback feature is desired. A blow back feature is a mechanism which cycles a slide or bolt to better simulate a real firearm's operation. Because of the mechanical complexities involved with distributing and regulating gas, these guns have largely given way to electric guns for less specialized applications, however, they still remain favorable amongst most air softers. They are not just limited to pistols; submachine guns, sniper rifles and assault rifles commonly use gas mechanisms. Whilst the submachine gun replicas typically feature a blowback mechanism similar to the pistol replicas, sniper rifle replicas usually omit the blowback mechanism in favor of reduced recoil and increased muzzle velocity.

Along with using gas to power guns, it is also applied for use in replica grenades. These grenades are either projectiles, fired from a grenade launcher such as the M203 or GP-25, or throwable. The shells work on the system of an internal piston, filled with gas. Either a series of BB's or in some cases a rubber or soft foam head is seated in or on top of the shell . When the pressure is released the projectile(s) are shot from the launcher sent downrange.

In the case of the throw able grenades, inside the grenade there is a similar piston to the one used in the shells, but is on a literal "timer" that allows the user to clear the area of effect. BB's or powder act as the projectile in the case of these grenades. Currently both types of grenades are not very common, mostly because grenade launchers are quite expensive and the throw able grenades are not very reliable.

4 – 11 - Classic guns

Classic airsoft guns are usually the older variety of airsoft guns which are gas powered though in the recent past other manufacturers have found interest in them. Unlike the gas rifles of today, they can run on either an internal tank using conventional airsoft gas or use an external CO_2 or HPA tank much like a paintball gun. These type of guns generally cost considerably more than the standard AEGs. Some models, such as those made by the Sun Project, feature a type of "recoil" provided by these guns. The rate of fire on these can be regulated by the amount of air being fed through the system, versus using different battery voltages in an AEG. Other manufacturers for example are Polar Star Airsoft and Daytona gun.

5 – Sights

Optical sights are fairly common for use on rifles; mostly red dot sights for short - range use, and telescopic sights for longer-range use. These range from inexpensive sights designed for use on pellet guns and .22 rifles, to mid - range sights, usually inexpensive replicas of actual rifle sights (such as replicas of the M68 Aim point, Advanced Combat Optical Gun sight (ACOG), and imitation holographic weapon sights that are actually red dot sights), to actual sights designed for use on rifles, including the EO Tech holographic sight, and the Tri jicon ACOG TA01NSN. Replica (or 'clone') sights are much cheaper than their real counterparts, but are usually unlicensed, much less durable and reliable and should not be used with real firearms where violent recoil may damage them or throw the sight off zero. Most optical sights are mounted on a MIL-STD-1913 rail. Other guns, including replicas of Kalashnikovs, MP5s, and G36s may have specific mounts for particular sights.

6 – Magazines

Magazines are usually realistic looking replicas of real firearms' magazines and as such are made of the same materials like stamped metal or high impact plastic. They occasionally feature markings and/or engravings that match or mimic their real counterparts.

Airsoft magazines are divided into the following classes according to the number of pellets they hold:

6 – 1 - Low capacity (Low-cap)

Low capacity magazines are the type of magazine provided by Tokyo Marui and some other manufacturers with their guns. They are known as "Low capacity" or "low - cap" as they hold drastically fewer BBs than most medium capacity or high capacity magazines. Many contain around 68 BBs (the standard amount for a Tokyo Marui magazine) and are normally loaded by inserting pellets down a shaft, compressing a spring held inside that will later feed the pellets into the gun.

Low capacity magazines offer quiet operation (no rattle or manual winding of *high-capacity* magazines) and are sometimes the only option available for certain airsoft gun models. They are also useful to help players limit their ammunition consumption and simulate more realism by simulating the 10-30 rounds in a real rifle.

Low-cap magazines almost only come with Tokyo Marui guns whereas some companies like Classic Army or ICS supply *high-capacity* magazines with their guns. However, most magazines will not feed every single pellet, leaving 2–3 pellets at the end of the magazine or in the feed tube of the hop-up chamber (some players may circumvent this problem by inverting the gun to allow gravity to feed the pellets instead)

6 – 2 - Medium capacity (Mid - cap)

These kinds of magazines are either bought or modded to accommodate from 90 – 190 BB's Traditionally, they still function like a low-cap / real - cap magazine and as such keep the advantage of quiet operation over *high - capacity* magazines (that require a winding mechanism) , but minimize the disadvantage of a *low capacity* magazine's lower number of rounds. They are also somewhat more reliable because of the lower level of dry firing due to the higher number of rounds that can be shot off without having to even touch the magazine, whereas high-cap magazines need winding after a few dozen shots. Increasingly, however, winding magazines are being released to the market and can be placed into this category due to their 190 rounds or fewer capacity, though usually when magazines are referred to as mid - cap, it is assumed that they are non-wound magazines.

Mid - cap magazines are somewhat the preferred medium among many players, as they offer a fair amount of rounds without winding, bring some variability to game play in terms of magazine change, simulate reality the best and prevent endless spraying from guns that are not really designed to do so. It's not unusual for many games to only allow the use of mid-cap or low-cap magazines in game (with exceptions for weapons intended to deliver a high volume of fire, e.g. light machine guns). Also used by players that play MilSim games , where Mid - Cap magazines are required.

6 – 3 - High capacity (High – cap)

High-cap mags hold more shots than a mid-cap (about 200–800), there are three main ways in which they work. The most common type of high cap is one which a wheel has to be wound (often one full wind will load 50 -100 rounds). Another type which is most commonly used in support type weapons is the electric magazine, these ones work in a similar way to the wheel magazines however the wheel is wound by a small motor within the magazine. The final type of high cap magazine is one which has a string that is pulled in order to turn a wheel, although these magazines can be wound quickly, the string has been known to snap occasionally and the system not to be as reliable as the other two magazines.

6 – 4 - Drum/Box Magazine

Drum and Box Magazines usually have the greatest ammunition capacity of all airsoft magazines; ranging from 2000 to 5000 rounds. These magazines replicate the ammunition boxes used by belt-fed support weapons such as M249s and M60s. Drum Magazines tend to replicate magazines like the Beta C-Mag and the equivalent for weapons such as G36s , AK - 47s and MP5s. Internally these magazines work very similarly to High - Cap magazines and most have a push button operated electric motor to wind the spring that drives the feeding system.

6 – 5 - Real capacity (Real - cap)

Real-caps are identical in operation compared to low capacity magazines, but they carry the same amount of ammunition that the real version of the magazine can carry, which is often much less than the low-cap magazine, e.g. an M-16 real-cap will hold 30 rounds instead of the 68 of a low-cap magazine. Few magazines are designed as real-caps; for flexibility it is common to purchase higher-capacity magazines and only load rounds to the equivalent capacity of the real magazine. Some ultra-realistic groups require the magazines to be weighted equivalent to the replicated fire arm.

These tend to be used solely by those wanting the most realistic MilSim ("MILitary SIMulation") games. They also offer the stealth of no rattling rounds, but their main use is for the realistic qualities.

6 – 6 - Pistol Magazines

There are 2 general types of pistol magazines: single stack and double stack magazines. Single stack magazines hold anything from 7 to upwards of 20 rounds depending on the weapon type. The BBs are stacked directly on top of each other, hence the term "single stack".

Unlike the single stack magazines, "double stack" magazines have rounds loaded in a staggered column, similar to many real firearm magazines. This allows for more BBs to be loaded (usually around 30) without extending the length of the magazine. Double stack magazines tend to be wider, requiring a wider grip on some models, like the M1911 pistol. The term "double stack" or "double column" is a common misnomer.

6 – 7 - Alternate Style Magazines

Some other magazine styles are seen with a few models of airsoft guns, typically airsoft sniper rifles. Most airsoft sniper rifles employ a magazine that is similar to a mid cap magazine as with the twisting spring design seen in most mid cap magazines, while maintaining a relatively low magazine capacity.

7 - Performance

Airsoft guns shoot plastic pellets at velocities from 30 m / s for a low - end spring pistol, to 200 m / s for heavily upgraded customized sniper rifles. Most non - upgraded AEGs are in the middle, producing velocities from 90 m / s to 120 m / s . The internal components of most guns can be upgraded which can increase the pellet velocity significantly. Using heavier pellets (.25 g, .3 g, etc.) will significantly reduce the gun's muzzle velocity, but can increase accuracy at range and reduce susceptibility to wind drift. Lighter pellets have less kinetic energy than their heavier pellets, despite their higher exit velocity. Decreasing the pellet's weight does not generally increase its range. High - velocity AEGs often employ heavier pellets.

Most high-end AEGs, such as Classic Army and Tokyo Marui, should not be loaded with anything lighter than 0.2 g pellets, as the lighter pellets (0.12 g, 0.15 g) are typically made for low - end guns, and are not built to the same quality (such as surface smoothness). The stresses the pellets go under upon firing could shatter lighter or poorly made pellets as they leave the barrel, potentially damaging the weapon.

Air soft guns can be modified to increase pellet velocity, rate of fire, reliability, or accuracy/range. For an electric airsoft gun, the pellet velocity can be increased by two different methods. The first is upgrading the inner barrel of the gun. The inner barrel is what the BB travels within while in the gun. Stock AEG inner barrels are usually between 6.05-6.10mm. An airsoft inner barrel is considered "tight-bore" when the inner diameter is less than 6.05mm. Typically, tight-bore barrels that are 6.03mm in diameter are installed into stock AEGs, so that accuracy as well as an up to 30fps increase is enjoyed by the player. Tighter bores risk a higher chance of pellet jams and a need for higher quality pellets and require more lubrication as well as a larger cylinder inside the gear - box in some cases(to contain more air to be forced through, most commonly called a "bore - up" upgrade). Tight-bore barrel upgrades as small as 6.01 mm are usually reserved for high - powered sniper rifles. The second is simply upgrading the mainspring. Doing this will increase the air pressure subjected to the pellet produced during operation. But due to the higher forces at play, it is advised that other parts should be upgraded together with the mainspring in order to maintain a high level of reliability. The rate of fire is increased by using a battery with a higher voltage, high-speed ratio gears and/or a high-speed motor. Rates of fire can be increased to over 20 rounds per second with very few upgrades, but with careful selection and extreme modification of gearbox components, rates of fire in excess of 50 rounds per second are not unheard of. In the case of gas guns, a higher pellet velocity can be achieved through the use of different types of gases and/or changing the valve. Some gases have detrimental effects to some plastic components inside the airsoft gun.

The ballistics of spring or electric powered airsoft guns differ from real firearms in that a longer barrel will not always result in better accuracy. In spring/electric airsoft weapons, barrel length does not have a significant effect on accuracy. The "sweet spot" for barrel length in a spring/electric powered airsoft gun is around 400-500mm. Past that length, added barrel length will not improve accuracy. In any case, barrel quality, fps consistency, and hop up quality/design are more important factors in regard to accuracy. However, added barrel length will result in slightly increased velocity if the cylinder size and compression are appropriate for the barrel length. For example, a gun with a large cylinder and a long barrel will shoot slightly harder than a gun with a small cylinder and a short barrel(with everything else being equal). This rule will apply even for barrels longer than 500mm, if there is enough cylinder volume and air compression to propel the BB through the barrel. However, the resulting FPS increase will be hardly noticeable. The only considerable advantage of using a longer inner barrel in an aeg or spring powered gun is that it generally will make the gun quieter. Gas powered replicas function more like real firearms. In gas powered guns, added barrel length (to an appropriate degree) will result in significantly increased velocity, and increased accuracy to a degree.

Another common upgrade done by most players is in the "Hop-Up" system. Most mid to high end AEG's, as well as gas guns and spring sniper rifles, feature this "hop-up" system, in which the wall of a rubber tube, called a bucking, is forced into the path of the pellet right before it begins flying down the inner barrel, causing it to begin spinning backwards, giving it a straight shot upward as soon as it leaves the barrel. This is adjusted by screws or gears that cause the bucking to only show a small or large presence in the barrel. Different degrees of firmness of the rubber are considered when a hop-up is being upgraded. The hop-up can either make or break an airsoft gun's range and accuracy: Too much hop-up makes the pellet fly very straight, but also makes it take a sharp curve upward as soon as it leaves the barrel. Too little hop-up and the pellet won't necessarily fly upwards, but in whatever direction the air resistance lets it. The hop-up is adjusted around the weight of the pellet and the speed in which it is leaving the barrel. A well-tuned hop-up puts just enough spin on the pellet as to it flies straight, but not too much so that it can fly for a distance of 140 – 300 ft before curving up wards.

Airsoft guns commonly come with mounts or rails on which the air softer can add external accessories. Some common customizations added are flashlights, scopes and lasers. Since some airsoft guns have the exact external frame as real guns, one can use these external parts meant for real guns, but the opposite does not apply. Airsoft replicas of real scopes are commonly made available for sale at a much lower price (sometimes thousands of dollars less). The replicas differ from their real-steel counterparts in that the replicas are not made to function in a high-recoil environment such as that in a real gun. In no way can an airsoft rifle be modified to shoot real ammunition. In most cases, add-ons are more for aesthetics rather than performance. However, scopes can commonly increase accuracy at longer ranges and can also allow for quicker aiming on large airsoft guns, with proper firing technique by the user/operator (the installation of a scope does not physically make the gun fire pellets more accurately). Other attachments, such as replica grenade launchers can act as under-barrel shotguns (in lower-end models), and a mock silencer can be added to provide concealment for a longer inner barrel therefore improving accuracy and range.

8 - Maintenance and lubrication

One should wipe their airsoft gun with a clean cloth after use, remove any dirt, oil and other contaminants. On the inside of the chamber and the barrel a cotton swab should be used to remove any dirt or possible shrapnel from shattered pellets / BBs. After every 3,000 to 4,000 shots fired (Modern Manufactures such as KWA have been recorded firing over 100,000 rounds without malfunction or service) to, the airsoft gun should be lubricated, by placing a few drops or sprays of silicone-based oil or silicone grease into all moving parts of the gun, including the piston and cylinder, hop up chamber, and inner barrel. The inner barrel should be lubricated more often to decrease barrel wear and corrosion depending on the inner barrel material, brass barrels are the most robust due to their self honing nature and require a break in period of 1500-2000 rounds to reach peak accuracy. They also can re - hone if scratched on the inside of the barrel. Aircraft aluminum are lighter weight, and Stainless steel are stronger, but do not hone nearly as quickly. Gears should also be regularly lubricated by using a specially made silicone grease that will not fail in high temperatures created by the friction the gears generate during operation. It is important to not use too much oil, and wipe excess oil off the gun since excess oiling can lead to jams and will accumulate dirt and grime inside a gun. Stored airsoft guns should be placed in a cool, clean room. Storing a gun that is cocked is not recommended because it will wear out the spring, on AEGs this can be achieved by firing a few shots on semi-automatic or using the spring release when available.

It is also highly recommended to not store pellets in your magazines. Due to smaller sizes and lighter materials of the spring, it will relax considerably fast causing it to be weaker, thus not being able to feed as many pellets and subjecting your gun to more misfeeds. This should especially taken into consideration with high cap, manually wound magazines.

One of the most important parts of proper airsoft gun maintenance, is to use quality BBs. Some BBs, like the BBs most airsoft guns come with, are too light or carry surface imperfections that can damage the gearbox of an airsoft gun. Using BBs that are at least . 2 g or heavier is the most beneficial for the airsoft gun parts. One should never re-use BBs, as once fired they become chipped, scarred or covered with contaminants that can jam the airsoft gun. The use of metallic BBs, or any foreign objects, may damage the airsoft gun.

Airsoft guns, like any mechanical device are prone to heat and friction which cause wear. The airsoft gun owner can take steps to reduce wear and get the most life out of his/her airsoft gun as possible. A proper maintenance program that includes regular airsoft lubrication is very important to getting the most out of an airsoft gun. Silicone greases are widely used in airsoft gun parts, internals and mounts in order to avoid corrosion, abrasion and general aging of the materials. A dry-set lubricant is delivered with a solvent carrier to penetrate the mechanism. The solvent evaporates, leaving a clear film that lubricates but does not attract dirt and grit as much as a traditional "wet" lubricant. Airsoft safe lubricants use non-petroleum based, inert propellants that will not harm the rubber and plastic parts on the airsoft gun such as the Hop rubber and "O" rings.

9 – Trade mark problems

Some airsoft guns can be such accurate replicas that they violate intellectual property laws (specifically those regarding trademarks), most notably some models from Tokyo Marui bearing Colt or Heckler & Koch trademarks that may not be imported into the United States. Certain companies such as Classic Army or ICS avoid this problem by licensing their replicas from the original manufacturers like Arma Lite by license from Action Sport Games or Olympic Arms. The airsoft company Action Sport Games has licensed trademark rights from many well-known firearm manufacturers, such as Armalite, Dan Wesson, CZ, Steyr , STI, B &T, Franchi etc.. In addition, there have been reports of companies making direct action in defense of their intellectual property rights. Some end users have made attempts to sell their guns, some in the style of Glock pistols, only to find Glock blocking the sale and threatening legal action. In addition to these actions, Glock, as well as HK, have made themselves known to be blocking the sale, trade, and distribution of replicas bearing resemblance to their real world counterparts.

10 - Safety concerns

Airsoft is relatively safe when played with proper protection. Most airsoft guns on the market are usually below110 m / s , but projectiles expelled from any type of airsoft guns can travel as low as 20 m / s to more than 210 m / s and are capable of breaking skin at 91 m / s . Though, if over 91 m /s , the hit would have to be within a short range and breaking the skin is not the same as penetrating it. Blood can be drawn, but flesh is usually left intact or bruised at worst. Protective eyewear (goggles or glasses) is widely considered the minimum protection for airsoft players, as the eyes may be injured by any type of impact. A little known fact is that the teeth can also be injured (fractured) by the impact of a pellet. Dentists have reported broken teeth that require root canal and crowns to repair damage. A face mask (like that used for paintball) is recommended to protect eyes and teeth.

There are legal issues in airsoft as well as several rules imposed in a game by game basis. Most airsoft fields only allow up to 350 ft/s (110 m/s). In order for an airsoft gun to be lethal or a threat to an airsoft player physical integrity, it would have to be well over that limit. To even reach such speeds the gun would have to be highly modified. So it is therefore unlikely to kill anyone with any standard airsoft gun sold. The use of metallic BBs, or any foreign objects, is very dangerous for the user and other people and property in close vicinity, and may damage the airsoft gun as well. However, specially designed and built metallic 6mm BBs for airsoft guns can be found on the market. These metallic BBs should not be used for airsoft play because they can break airsoft player protections like goggles.

Although Airsoft guns in the United States are generally sold with a 6mm . or longer orange tip on the barrel in order to distinguish them from real firearms, this is not in fact required by federal law. There is some controversy on this topic as Title 15 of the Code of Federal Regulations, on foreign commerce and trade, stipulates that "no person shall manufacture, enter into commerce, ship, transport, or receive any toy, look-alike, or imitation firearm" without approved markings; these may include an orange tip, orange barrel plug, brightly colored exterior of the whole toy, or transparent construction (part 272.2, formerly part 1150.2). However, section 272.1 (formerly 1150.1) clearly indicates that these restrictions shall not apply to "traditional b-b, paint - ball, or pellet-firing air guns that expel a projectile through the force of compressed air, compressed gas or mechanical spring action, or any combination thereof." [18] Local laws may differ by jurisdiction. Full or partial preventive painting of airsoft guns as a legal obligation to avoid confusion of the airsoft replicas with real lethal weapons is in practice in several jurisdictions around the World.

Air Tractor AT – 802

Air Tractor AT-802 SEAT (Single Engine Air Tanker)

Role	Agricultural / Fire - fighting aircraft
Manufacturer	Air Tractor
First flight	1990

Contents

1 - Introduction

The Air Tractor AT- 802 is an agricultural aircraft that may also be adapted into fire - fighting or armed versions. It first flew in the United States in October 1990 and is manufactured by Air Tractor Inc. The AT- 802 carries a chemical hopper between the engine firewall and the cockpit and another one under the belly. In the U.S., it is considered a Type III SEAT, or Single Engine Air Tanker.

2 – Development

In its standard configuration, the aircraft utilizes conventional landing gear (two main wheels and a tail wheel). However, a number of aircraft have been converted to the Fire Boss aerial firefighting configuration, which utilizes Wipaire 10000 amphibious floats, so that it can land on a traditional runway or on water. The Fire Boss can scoop water from a lake or river for use on a fire. In addition to the 3,100 L standard fuselage - mounted retardant tank, the Fire Boss can have optional 260 L tanks in the floats . Operations with floats installed have been shown to produce a shorter and narrower retardant drop pattern than wheeled AT- 802s.

2 – 1 - Armed version

AT- 802U prototype at Paris Air Show

In response to the United States Air Force's LAAR program and the growing requirement for light counter-insurgency aircraft, Air Tractor developed an armed model, the AT- 802 U, in 2008, with engine and cockpit armor, a bulletproof windscreen, self-sealing fuel tanks, and structural reinforcements for the carriage of 4,100 kg of payload. A reinforced wing spar was certified for 12,000 hours of flight time , and the AT- 802 U was displayed in 2008 at the Paris Air Show.

The AT- 802 U was purchased by the United Arab Emirates Air Force, with deliveries starting in January 2011.

The AT- 802 has also been used in counter-drug operations in the USSOUTHCOM AOR by the U.S. Department of State as a delivery vehicle for herbicides and defoliants over narcotics production facilities.

3 – Variants

AT- 802 - two seat (tandem) cockpit

AT- 802A – single - seat cockpit

AT- 802U - two seat (tandem) heavily armored military version, modified with sensors and reinforced for weapons carriage

AT-802F or AT-802AF - An aerial firefighting model 802 equipped with the Air Tractor Computerized Fire gate

Fire Boss - A model 802 equipped with Wipaire amphibious floats and Air Tractor Computerized Fire gate

4 – Operators

Montenegrin air force AT- 802A Fire Boss

Argentina
Córdoba Province - Fire-fighting
Australia
Aero tech First Response (South Australia) - 7 AT-802
Dunn Aviation (Western Australia) - 9 AT- 802
Kennedy Aviation (New South Wales) - 4 AT-802
Brazil
Military Fire fighters of Distrito Federal
Military Fire fighters of Mato Grosso
Burkina Faso

Military of Burkina Faso 1 AT-802[14]
Canada
Forest Protection Limited , New Brunswick Department of Natural Resources - 6 AT-802F and 1 AT-802A Fire Boss
Conair Group - 13 AT-802A Fire Boss
Chile
Com bate de Incendios Fore stales, Martinez Ridao Chile Ltda.[AT-802A Fire Boss
Croatia
Croatian Air Force - 5 AT-802A Fire Boss + 1 AT-802F
Finland
- Fire-fighting
Gambia
Military of Gambia[17]
Israel
Israeli Air Force - 7 AT-802F (of which 2 are Fire Boss)[18]
Italy
Protezione Civile - 10 AT-802A Fire Boss
Macedonia
Protection and Rescue Directorate of the Republic of Macedonia - 3 AT-802A Fire Boss
Montenegro
2 AT-802A Fire Boss[19]
Spain
Ministry of Environment (CEGISA) - 3 AT-802A[20]
Avialsa T35 - 15 AT-802 + 14 AT-802F [21]
UAE
United Arab Emirates Air Force - 10 AT-802U[8]
United States
Aero spray, Inc.

5 - Specifications

Data from Jane's All The World's Aircraft 2003 – 2004
General characteristics
Crew: Two
Capacity: 3,104 L of chemicals
Length : 10.95 m

Wingspan : 18.06 m
Height: 3.89 m
Wing area: 37.25 m^2
Aspect ratio: 8.8 : 1
Empty weight : 2,951 kg
Gross weight : 7,257 kg
Power plant: 1 × Pratt & Whitney PT6A-67F turboprop, 1,350 hp (1,007 kW) each
Performance
Cruise speed: 356 km / h
Range: 1,289 km
Service ceiling: 7,620 m
Rate of climb: 4.3 m/s

6 - Specifications (AT- 802U)
Data from
General characteristics
Crew: 2 (tandem)
Length: 35 ft 8 in (10.87 m)
Wingspan: 18 m
Height: 3.5 m
Wing area: 37.3 m^2
Empty weight: 2,903 kg
Gross weight: 7,257 kg
Max takeoff weight: 7,257 kg
Power plant: 1 × Pratt & Whitney Canada PT6A-67F turboprop, 1,600 shp (1,200 kW)
Propellers: 5 - bladed Hartzell Propeller HC-B3TN
Performance
Maximum speed: 230 mph; 370 km / h (200 kn)
Cruising speed: 184 mph; 296 km / h (160 kn)
Range: 1,841 mi; 2,963 km (1,600 nmi)
Endurance: 10 hours
Service ceiling: 7,620 m

A – IX - 2

A – IX - 2 (or hexal) is a Russian explosive used in modern Russian military shells. It consists of 73 % RDX with 23% aluminum powder , phlegmatized with 4 % wax.

Al Hubbard (VVAW)

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Alfred H. Hubbard	
Born	1936
Allegiance	United States of America
Service/branch	United States Air Force
Years of service	1952 - 1966
Rank	Staff Sergeant
Unit	7th Air Transport Squadron
Awards	Korean Service Medal, United Nations Medal, National Defense Medal, four Good Conduct Medals, Air Force Longevity Service Award, Air Force Unit Award and Air Force Expeditionary Medal
Other work	Executive Secretary of VVAW

Contents

1 - Introduction

Alfred H. Hubbard is a U.S. Air Force veteran of both the Korean and Vietnam wars, anti-war and civil rights activist, former executive secretary of Vietnam Veterans Against the War and poet.

He grew up in Brooklyn, New York, and entered the Air Force planning to make it his career. He was forced to take an early retirement in 1966 after suffering an injury during a plane crash. After leaving the service, he enrolled at the University of Washington and earned an undergraduate degree.

2 - Military service

Hubbard enlisted in the United States Air Force in October 1952, rein listed twice and was honorably discharged after 14 years of service. At the time of his discharge, he was an instructor/ flight engineer on C-124 Globe master with the 7th Air Transport Squadron, McChord Air Force Base, Tacoma, Washington. Hubbard was awarded a Korean Service Medal, United Nations Medal, National Defense Medal, four Good Conduct Medals, Air Force Longevity Service Award, Air Force Unit Award and Air Force Expeditionary Medal. He was a flight engineer with the 22 nd Troop Carrier Squadron at Tachikawa Air Force Base, Japan.

Hubbard was injured in a military plane crash and is registered with the VA with a service-connected disability rating of 60 per cent.

3 - Anti - war and civil rights activism

In the fall of 1969, Hubbard joined the Vietnam Veterans Against the War, and became an active organizer for the group.

During the publicity generated by the April, 1971 anti-war protest march on Washington DC, Hubbard made claims about his rank during interviews that he later admitted were false. He was introduced on *Meet the Press* as a decorated Air Force captain who had spent two years in Vietnam. After receiving a tip that Hubbard was a sergeant and not a captain, NBC contacted Hubbard about the discrepancy. Hubbard admitted to lying about being an officer, and publicly acknowledged it when he appeared on the *Today Show* the following morning. Frank Jordan, then Washington Bureau Chief of NBC News, recalls Hubbard's explanation for why he claimed to be an officer, "He was convinced no one would listen to a black man who was also an enlisted man."

William Over end in the *National Review* reported that a Defense Department news release stated: "Alfred H. Hubbard entered the Air Force in October 1952, re-enlisted twice and was honorably discharged in October 1966, when his enlistment expired. At the time of his discharge he was an instructor flight engineer on C-123 aircraft with the 7th Air Transport Squadron, McCord (*sic*) Air Force Base, Tacoma, Washington. There is no record of any service in Vietnam, but since he was an air crew member he could have been in Vietnam for brief periods during cargo loading, unloading operations or for crew rest purposes. His highest grade held was staff sergeant." Defense Department officials stressed it was still possible Hubbard could have served in Vietnam, flying in and out from Tacoma.

Historian and author of *Home to War: A History of the Vietnam Veteran's Movement*, Gerald Nicosia commented on the Hubbard military record controversy:

"... service people doing covert missions, such as rangers going across the border in Laos, into North Vietnam, etc., never had those actions put into their records. Al Hubbard was on similar covert missions, flying in a supply plane to the French when they were fighting the Viet Minh in the fifties. It doesn't surprise me that those flights were not in his record. He did lie about being an officer, when he was a career sergeant, because the press kept paying more attention to his co-leader John Kerry, a decorated officer. Also, Hubbard never claimed to have been wounded in combat; his back was hurt when his plane crashed on a runway. When I interviewed him in 1992, he was on medical disability from the Air Force."

2008 Gërdec Explosions

2008 Gërdec explosions	
Date	15 March 2008
Time	noon (12:05 GMT)
Location	Gërdec, Albania
Casualties	
26 dead	
300+ injured	


Scene of the accident in April 2008

Contents

1 - Introduction

At approximately noon local time on Saturday 15 March 2008, at an ex-military ammunition depot in the village of Gërdec in the Vorë Municipality, Albania (14 kilometers from Tirana, the nation's capital), U.S and Albanian munitions experts were preparing to destroy stockpiles of obsolete ammunition. The methodical destruction of the old ammo was supposed to occur with a series of small, controlled explosions, but a chain of events led to the entire stockpile going up at once. The main explosion, involving more than 400 tons of propellant in containers, destroyed hundreds of houses within a few kilometers from the depot and broke windows in cars on the Tirana - Durrës highway. A large fire caused a series of smaller but powerful explosions that continued until 2 a.m. on Sunday. The explosions could be heard as far away as the Macedonian capital of Skopje, 170 km away.

Thousands of artillery shells, most of them un-exploded, littered the area. The blast shattered all the windows of the terminal building at the country's only international airport, and all flights were suspended for some 40 minutes. Some 4,000 inhabitants of the zone were evacuated and offered shelter in state - owned resorts. The Government declared the zone a disaster area. According to subsequent investigations, a privately managed ammo dismantling process was ongoing in the area .

2 - Possible causes

A human error during the work, such as lighting a cigarette or damaging a fuse

Improper storage of the ammunition

The employment of untrained workers without the proper technical knowledge

Violation of the technical security rules in the area where the destruction of ammunition took place

Sabotage

Although existing technologies were employed and adapted for the operations at G**ë**rdec the techniques of ammunition disposal being used at the time were, and still are (in 2010), new technologies in this field. An error made by Engineers who designed the machinery the Demilitarization company and associates employed on the project used. A fundamental design assumption made early in the design process rendered the basic machinery potentially lethal. Researchers and Designers of the ammunition disposal kilns assumed the combustible compounds within the ammunition would burn away at 350 degrees Celsius. Documents available from the US military state, and Thermochemical and Thermodynamic calculations will verify the combustible compounds within the ammunition being disposed of at Gerdec burn to give out a heat amounting to 4500 degrees Celsius. Such an energy would, without further sufficient and adequate designed machine components, lead to vaporization and explosion of the machines used to dispose of the ammunition dumps.

3 – Contracts

The repacking/dismantling of ammunition at the dump was being carried out by an Albanian company that had been subcontracted by Southern Ammunition Company Inc. (SAC) of Loris, South Carolina, an U.S. company. SAC won the contract to destroy ammunition in Albania through industrial dismantling.

SAC was contracted in 2006 by the Albanian Ministry of Defence for the deactivation of 100 million 7.62 mm bullets, 20 million 12.7 mm bullets, and 20 million 14.5 mm bullets. A second contract involved ammunition from 40 mm up to 152 mm.

After signing the contract with the Mo D, SAC subcontracted the work to Alb - Demil, an Albanian subcontractor. According to news reports , SAC was repacking SALW ammunition on behalf of AEY, Inc., which was selling the ammunition to the Afghan National Army.

4 – Figures

Officially, Albanian authorities confirmed 26 deaths in the explosions. Officials report the number of injured people at over 300.[3] According to figures published by the Prime Minister's Office, 2,306 buildings were damaged or destroyed in the explosions. Of these, 318 houses were destroyed completely, 200 buildings were seriously damaged, and 188 buildings were less seriously damaged.

5 - Political consequences & investigation

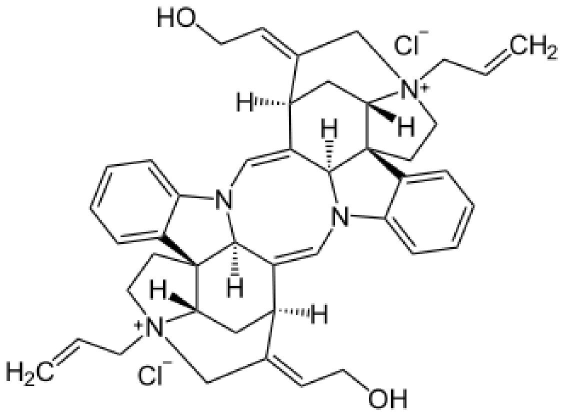
On 17 March 2008, Mr. Fatmir Mediu, Minister of Defence of the Republic of Albania, resigned from his governmental position.

As part of an investigation by the Albanian General Prosecution Office, authorities issued arrest orders for Mihail Delijorgji (president of the Alb-Demil Company), Ylli Pinari (director of MEICO, a state-controlled enterprise managed by the Ministry of Defence and authorized under Albanian laws to deal with the export and import of military goods), and Dritan Minxholi (an executive director with Alb - Demil).

A special group of prosecutors and investigators from Tirana, along with experts from the Albanian Ministry of Interior, the Tirana State Police, EOD specialists, military engineers and military police were said to be studying the facts of the case and collecting witnesses declarations.

The investigation group was expected to publish the names of the officials involved in the tragedy by the beginning of April 2008. The US Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) accepted a request from the Albanian General Prosecutors Office (GPO) to assist the investigation.

Alcuronium Chloride



Contents

1 - Introduction

Alcuronium is a neuromuscular blocking (NMB) agent, alternatively referred to as a skeletal muscle relaxant. It is a semi-synthetic substance prepared from C- toxiferine I , a *bis* - quaternary alkaloid obtained from *Strychnos toxifera*. C- toxiferine I itself has been tested for its pharmacological action and noted to be a very long acting neuromuscular blocking agent[2] For a formal definition of the durations of actions associated with NMB agents, see page for gantacurium. The replacement of both the *N*-methyl groups with *N-allyl* moieties yielded *N,N*-diallyl-*bis*-nortoxiferine, now recognized as alcuornium (and at one time marketed as the proprietary agent called Alloferin).

Inclusion of the allylic functions presented an enhanced potential area of biotransformation, and thus alcuronium is observed to have a much shorter duration of neuromuscular blocking action than its parent C-toxiferine I. It also has a more rapid onset of action, and is ~1.5 times as potent as tubocurarine . The pharmacological action of alcuronium is readily reversed by neostigmine, and it produced little histamine release. The major disadvantage of alcuronium is that it elicits a vagolytic effect produced by a selective atropine - like bloc kade of cardiac muscarinic receptors.

Systematic (IUPAC) name	
4,4'-Didemethyl-4,4'-di-propenyltoxiferin-1-dichloride	
Clinical data	
AHFS/Drugs.com	International Drug Names
Pharmacokinetic data	
Metabolism	not metabolized
Excretion	70 – 90 % unchanged in urine 1.3ml / kg / min t1 / 2 2–4 hours
Formula	$C_{44} H_{50} N_4 O_2^{+2}$
Mol. mass	667 g / mol

2 - Effects

Cardiovascular system: histamine release and blockage of the sympathetic ganglia including adrenal medulla could cause hypotension

Respiratory: apnea due to phrenic blockage but bronchoconstriction can occur from the histamine release

Central nervous system: no effect on intraoccular pressure

Autonomic ganglion blockade can cause decrease in gut motility

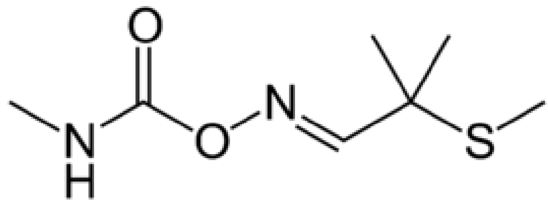
3 - Special points

Duration of action prolonged in states of low potassium, calcium and protein, also in states of high magnesium and acidosis.

Pharmaceutically incompatible with thiopentone

Infusion can cause fixed dilated pupils

Aldicarb



Contents

1 - Introduction

Aldicarb is a carbamate insecticide which is the active substance in the pesticide Temik. It is effective against thrips, aphids, spider mites, lygus, flea hoppers, and leaf miners, but is primarily used as a nematicide. Aldicarb is a cholinesterase inhibitor which prevents the breakdown of acetylcholine in the synapse. In case of severe poisoning, the victim dies of respiratory failure.

Aldicarb is effective where resistance to organophosphate insecticides has developed, and is extremely important in potato production, where it is used for the control of soil-borne nematodes and some foliar pests. Its weakness is its high level of solubility, which restricts its use in certain areas where the water table is close to the surface.

IUPAC name : 2-Methyl-2-(methyl thio) propanal *O*-(*N*-methyl carbamoyl) oxime	
Other names : Temik	
Molecular formula	$C_7 H_{14} N_2 O_2 S$
Molar mass	190 g mol^{-1}
Density	1.195 g/cm³

Melting point	100 °C
Boiling point	Decomposes before boiling point

2 - Regulatory status

Aldicarb was approved by the USEPA for use by professional pesticide applicators on a variety of crops, including cotton, beans, and others. It is not approved for household use.

Aldicarb was one of the "dirty dozen" pesticides that the environmental group Pesticide Action Network North America targeted in 1985. EPA put a ban in place in 2010, requiring an end to distribution by 2017. Use on citrus and potatoes is banned beginning in 2012, with a complete ban in place by 2018. New labeling requirements and protections to ground water near cotton, soybean and peanut farms were implemented in 2010.

"Tres Pasitos", a mouse, rat, and roach killer that contains high concentrations of aldicarb, has been illegally imported into the United States from Mexico and other Latin American countries. The product is highly toxic to animals and people, and according to the EPA "should never be used in [the] home."

3 – History

Aldicarb is manufactured by Bayer CropScience, but was formerly owned and produced by Union Carbide. Union Carbide's agricultural chemicals division was sold to Rhône-Poulenc. Later, Aventis Crop science was formed from Hoechst AG and Rhone-Poulenc Agrochemical, which lasted until Bayer acquired it in 2002.

In 1985, nearly 1000 people in the western United States and Canada were poisoned by residue of aldicarb in watermelons . Their symptoms included nausea, vomiting, blurred vision and muscle weakness. Although no one died, some of the victims were seriously ill, and two women later gave birth to stillborn babies. Later epidemiologic surveys of women who were pregnant at the time of the poisoning event failed to establish a causal relationship between the stillbirths and pesticide exposure .

In November 2009, corn treated with Temik was placed in and around peanut fields in Eastland County, Texas, near the town of Cisco. The corn was eaten by feral hogs, deer, and other animals, prompting the Texas Parks and Wildlife Department to issue a hunting ban.

For humans, it is the most toxic insecticide used on field crops.

4 - Toxicity in mammals

Aldicarb is a fast-acting cholinesterase inhibitor, causing rapid accumulation of acetylcholine at the synaptic cleft. It is widely used to study cholinergic neurotransmission in simple systems such as the nematode *C. elegans*.

Exposure to high amounts of aldicarb can cause weakness, blurred vision, headache, nausea, tearing, sweating, and tremors in humans. High doses can be fatal to humans because it can paralyze the respiratory system.

It has an LD_{50} of 0.5-1.5 mg / kg when in liquid form and an LD_{50} of 7 mg/kg when in solid form . Because of its toxicity, its use is highly restricted in the EU / UK with maximum residue limits for apples and oranges being 0.02 mg / kg and this amount is only allowed because this is the limit of detection.

In South Africa (where Aldicarb is popularly known as Two Step) it is widely used by burglars to poison dogs.

Chemical Weapons Were Used by British in World War

Contents

1 - Introduction

Chemical weapons were used by the United Kingdom in World War I, and while the use of chemical weapons was suggested by Churchill and others postwar in Mesopotamia and in World War II, it appears that they were not actually used, although some historians disagree. While the UK was a signatory of the Hague Conventions (1899 and 1907) which outlawed the use of poison gas shells, the conventions omitted mention of deployment from cylinders, probably because that had not been considered.

The United Kingdom ratified the Geneva Protocol on 9 April 1930. The UK signed the Chemical Weapons Convention on 13 January 1993 and ratified it on 13 May 1996.

2 - Use in World War I

During the First World War, in retaliation to the use of chlorine by Germany against British troops from April 1915 onwards, British forces deployed chlorine themselves for the first time during the Battle of Loos on 25 September 1915. By the end of the war, poison gas use had become widespread on both sides and by 1918 a quarter of artillery shells were filled with gas and Britain had produced around 25,400 tons of toxic chemicals.

Britain used a range of poison gases, originally chlorine and later phosgene, diphosgene and mustard gas. They also used relatively small amounts of the irritant gases chloro methyl chloro formate, chloropicrin, brom acetone and ethyl iodo acetate. Gases were frequently mixed, for example *white star* was the name given to a mixture of equal volumes of chlorine and phosgene, the chlorine helping to spread the denser but more toxic phosgene. Despite the technical developments, chemical weapons suffered from diminishing effectiveness as the war progressed because of the protective equipment and training which the use engendered on both sides.

3 - Between the wars

After the war, the Royal Air Force dropped diphenyl chloro arsine, an irritant agent designed to cause uncontrollable coughing, on Bolshevik troops in 1919 , and Winston Churchill, secretary of state for war and air, suggested that the RAF use various chemical agents in Iraq in 1920 during a major revolt there; see Alleged British use of chemical weapons in Mesopotamia in 1920. Historians are divided as to whether or not gas was in fact used.

Britain signed and ratified the Geneva Protocol in 1930 which banned the use of toxic gases and bacteria in war, although not the development and production of these weapons, and Britain carried out extensive testing of chemical weapons from the early 1930s onwards. In the Rawalpindi experiments, hundreds of Indian soldiers were exposed to Mustard gas in an attempt to determine the appropriate dosage to use on battlefields. Many of the subjects suffered severe burns from their exposure to the gas.[3]

4 - Proposed use in World War II

4 – 1 - Proposed use against German invasion

During World War II the British planned to use mustard gas and phosgene to help repel a German invasion in 1940 – 1941 , and had there been an invasion may have also deployed it against German cities . General Brooke, in command of British anti-invasion preparations of World War II said that he "*...had every intention of using sprayed mustard gas on the beaches*" in an annotation in his diary. The British manufactured Mustard, chlorine, lewisite, phosgene and Paris Green and stored it at airfields and depots for use on the beaches.

4 – 2 - Later plans

The mustard gas stockpile was enlarged in 1942 - 1943 for possible use by Bomber Command against German cities, and in 1944 for possible retaliatory use if German forces used chemical weapons against the D - Day landings.

Winston Churchill issued a memorandum advocating a chemical strike on German cities using poison gas and possibly anthrax. Although the idea was rejected, it has provoked debate.[8] In July 1944, fearing that rocket attacks on London would get even worse and hoping to "shorten the war by a year" , Churchill wrote a secret memorandum asking his military chiefs to "think very seriously over this question of using poison gas." He said "it is absurd to consider morality on this topic" and that :

I should be prepared to do *anything* [Churchill's emphasis] that would hit the enemy in a murderous place. I may certainly have to ask you to support me in using poison gas. We could drench the cities of the Ruhr and many other cities in Germany ..., and if we do it, let us do it one hundred per cent.

—Winston Churchill, *'Most Secret' PRIME MINISTER'S PERSONAL MINUTE to the Chiefs of Staff, 6 July 1944*

The Joint Planning Staff (JPS), however, advised against the use of gas because it would inevitably provoke Germany to retaliate with gas. They argued that this would be to the Allies' disadvantage in France both for military reasons and because it might "seriously impair our relations with the civilian population when it became generally known that chemical warfare was first employed by us." The JPS had similar concerns about public morale in Britain, fearing that people might become resentful if they felt a gas war could have been avoided. The Chiefs of Staff also warned that the Nazis would have no particular "difficulty in holding down the cowed German population, if they were subjected to gas attack," whereas the British population "are in no such inarticulate condition."

Churchill responded to this advice by saying:

I am not at all convinced by this negative report. But clearly I cannot make head against the parsons and the warriors at the same time. [...] The matter should be kept under review and brought up again when things get worse.

At the same time, the JPS examined the case of using anthrax bioweapons against six large German cities but ruled this out on the grounds that the anthrax bombs were not yet available.[11] A large batch of aerial bombs were ordered, but by the time the US factory was ready to produce them, they were deemed unnecessary since the war in Europe was almost over.

Robert Harris argues that as soon as another weapon of mass destruction—the atomic bomb — became available, and offered a chance to shorten the war, the Americans used it. "Why, from an ethical or political point of view, should germ warfare have been regarded any differently? [by British] "

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5 – Post - World War II

From 1939 to 1989 experiments on chemical weapons including nerve agents and countermeasures were carried out at at the Porton Down research establishment. Although volunteers were used, many ex-servicemen complained about suffering long term illnesses after taking part in the tests. It was alleged that before volunteering they were not provided with adequate information about the experiments and the risk, in breach of the Nuremberg Code of 1947. This became the subject of a lengthy police investigation called Operation Antler.

From 1950, a Chemical De fence Establishment was established as CDE Nancekuke for small - scale chemical agent production. A pilot production facility for Sarin was built, which produced about 20 tons of the nerve agent from 1954 until 1956. A full - scale production plant was planned, but with the 1956 decision to end UK's offensive chemical weapons programme it was never built.

An inquest was opened on 5 May 2004 into the death on 6 May 1953 of a serviceman, Ronald Maddison, during an experiment using sarin. His death had earlier been found by a private MoD inquest to have been as a result of "misadventure" but this was quashed by the High Court in 2002. The 2004 hearing closed on 15 November, after a jury found that the cause of Maddison's death was "application of a nerve agent in a non-therapeutic experiment".

Allies

Field Marshal Bernard Montgomery decorates Soviet generals at the Brandenburg Gate in Berlin, 12 July 1945.

In every day English usage, **allies** are people, groups, or states that have joined in an association for mutual benefit or to achieve some common purpose, whether or not explicit agreement has been worked out between them. When the term is used in the context of war or armed struggle, such associations may also be called **allied powers**, especially when discussing World War I or World War II.

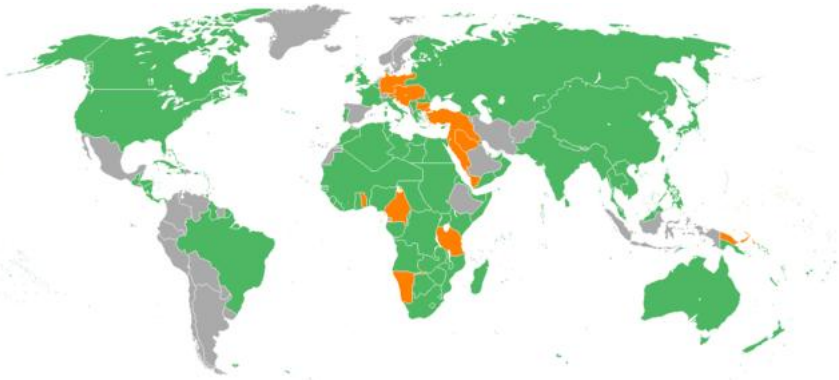
A formal military alliance is not required for being perceived as an ally — co-belligerence, fighting alongside someone, is enough. According to this usage, allies become so not when concluding an alliance treaty but when struck by war.

When spelled with a capital "A", the word "Allies" usually denotes the countries who fought together against the Central Powers in World War I (the Allies of World War I), or those who fought against the Axis Powers in World War II (the Allies of World War II). The term has also been used by the United States Army to describe the countries that gave assistance to the South Vietnam during the Vietnam War.

More recently, the term "Allied forces" has also been used to describe the coalition of the Gulf War, as opposed to forces the Multi-National Forces in Iraq which are commonly referred to as "Coalition forces" or, as by the George W. Bush administration, "the coalition of the willing".

The Allies in World War I (also known as the Entente Powers) were initially the United Kingdom, France, the Russian Empire, Belgium, Serbia, Montenegro and Japan, joined later by Italy, Portugal, Romania, the United States, Greece and Brazil. Some, such as the Russian Empire, withdrew from the war before the armistice due to revolution or defeat by the Central Powers.

Allies of World War I



A map of the World showing the Triple Entente participants in World War I. Those fighting on the Entente's side (at one point or another) are depicted in green, the Central Powers in orange, and neutral countries in grey.

European military alliances prior to the war.

Contents

1 - Introduction

The Entente Powers or **Allies** (French: *Forces de l'Entente / Alliés*; Italian: *Alleati*; Romanian: *Puterile Antantei / Aliații*; Russian: Союзники, *Soyuzniki*; Serbian: Савезници, *Saveznici*; Turkish: *İtilaf Devletleri*) were the countries at war with the Central Powers during World War I. The members of the Triple Entente were the French Republic, the British Empire and the Russian Empire; Italy ended its alliance with the Central Powers and entered the war on the side of the Entente in 1915. Japan, Belgium, Serbia, Greece, Montenegro, Romania and the Czechoslovak legions[1] were secondary members of the Entente.

The United States declared war on Germany in 1917 on the grounds that Germany violated U.S. neutrality by attacking international shipping and because of the Zimmermann Telegram sent to Mexico. The U.S. entered the war as an "associated power", rather than a formal ally of France and the United Kingdom, in order to avoid "foreign entanglements" . Although the Ottoman Empire and Bulgaria severed relations with the United States, neither declared war.

Although the Dominions and Crown Colonies of the British Empire made significant contributions to the Allied war effort, they did not have independent foreign policies during World War I. Operational control of British Empire forces was in the hands of the five-member British War Cabinet (BWC). However, the Dominion governments controlled recruiting, and did remove personnel from front - line duties as they saw fit.

From early 1917 the BWC was superseded by the Imperial War Cabinet, which had Dominion representation. The Australian Corps and Canadian Corps were placed for the first time under the command of Australian and Canadian Lieutenant Generals John Monash and Arthur Currie, respectively, who reported in turn to British generals. In April 1918, operational control of all Entente forces on the Western Front passed to the new supreme commander, Ferdinand Foch.

The only countries represented in the 1918 armistice which ended the combat were Britain, France and Germany.

2 – History

The original alliance opposed to the Central Powers was the Triple Entente, which was formed by three Great European Powers:

French Republic
British Empire
Russian Empire

The war began with the Austrian attack invasion of Serbia on 28 July 1914, in response to the assassination of Archduke Franz Ferdinand. The Austrian Empire followed with an attack on the Serbian ally Montenegro on 8 August.[*citation needed*] On the Western Front, the two neutral States of Belgium and Luxembourg were immediately occupied by German troops as part of the German Schlieffen Plan.

Of the two Low Countries, Luxembourg chose to capitulate, and was viewed as a collaborationist State by the Entente Powers: Luxembourg never became part of the Allies, and only narrowly avoided Belgian efforts of annexation, at the conclusion of hostilities in 1919. On 23 August Japan joined the Entente, which then counted seven members. . The entrance of the British Empire brought Nepal into the war.

On 23 May 1915, Italy entered the war on the Entente side and declared war on Austria; previously, Italy had been a member of the Triple Alliance but had remained neutral since the beginning of the conflict. In 1916, Montenegro capitulated and left the Entente, and two nations joined, Portugal and Romania.

On 6 April 1917 the United States and its American allies entered the war. Liberia, Siam and Greece also became allies. After the October Revolution, Russia left the alliance and ended formal involvement in the war, by the signing of the treaty of Brest Litovsk in November effectively creating a separate peace with the Central Powers. This was followed by Romanian cessation of hostilities, however the Balkan State declared war on Central Powers again on 10 November 1918. The Russian withdrawal allowed for the final structure of the alliance, which was based on five Great Powers:

French Republic
British Empire
United States
Italy
Japan

Statistics of the Allied Powers (in 1913)

	Population	**Land**
Russian Empire (plus Poland and Finland)	173.2m (176.4m)	21.7m km^2 (22.1m km^2)
French Third Republic	39.8m (88.1m)	0.5m km^2 (11.2m km^2)
The British Empire	446.1m	33.3m km^2
Empire of Japan (plus colonies)	55.1m (74.2m)	0.4m km^2 (0.7m km^2)
Kingdom of Italy (plus colonies)	35.6m (37.6m)	0.3m km^2 (2.3m ^{2})
United States (plus overseas dependencies),	96.5m (106.3m)	7.8m km^2 (9.6m km^2)
Allied approximate total	928.7m	79.2m km^2

3 - Major affiliated state combatants

3 – 1 - United Kingdom

British soldiers in a trench during the Battle of the Somme in 1916.

British Sop with Camel fighter aircraft during the war.

3 – 1 – 1 - War justifications

In response to Germany's invasion of neutral Belgium, the United Kingdom declared war on Germany on 4 August 1914.[9] The British Empire held several semi-autonomous dominions that were automatically brought into the war effort as a result of the British declaration of war, including Australia, Canada, Newfoundland, New Zealand, and South Africa.

3 – 1 – 2 - Colonies and dependencies

3 – 1 – 2 - 1 - In Europe

Gibraltar and Malta were two British dependencies in Europe.

3 – 1 – 2 - 2 - In Africa

The UK held several colonies, protectorates, and semi-autonomous dependencies at the time of World War I. In Eastern Africa the East Africa Protectorate, Nyasaland, both Northern and Southern Rhodesia, the Uganda Protectorate, were involved in conflict with German forces in German East Africa. In Western Africa, the colonies of Gold Coast and Nigeria were involved in military actions against German forces from Togoland and Kamerun. In Southwestern Africa, the semi-autonomous dominion of South Africa was involved in military actions against German forces in German South-West Africa.

3 – 1 – 2 - 3 - In the Americas

Canada and Newfoundland were two semi-autonomous dominions during the war that made major military contributions to the British war effort.

Other British dependent territories in the Americas included: British Honduras, the Falkland Islands, British Guiana, and Jamaica.

3 – 1 – 2 - 4 - In Asia

The UK held large possessions in Asia, including the British Raj that were an assortment of British imperial authorities in the territory then defined as India.

Australia and New Zealand were two semi-autonomous dominions of the UK in Asia during the war.

Other British territories at the time included: Cyprus located near the Ottoman Empire, British Malaya - referring to several Malay states under British control as a result of the Straits Settlements; North Borneo; and Hong Kong.

3 – 2 - Russia

Russian artillery firing.

In response to Austria-Hungary's invasion of Serbia in 1914, Russian government officials denounced the Austro - Hungarian invasion as an "ignoble war" on a "weak country". Russian government official Nikolaĭ N. Shebeko stated: "the attack on Serbia by a powerful empire such as Austria, supposedly in order to defend its existence, cannot be understood by anyone in my country; it has been considered simply as a means of delivering a death - blow to Serbia " . Russia held close diplomatic relations with Serbia, and Russian foreign minister Sergey Sazonov suspected the events were a conspiracy between Austria - Hungary and Germany to expel Russian influence in the Balkans. On 30 July 1914, Russia enacted a general mobilization. The day after general mobilization was enacted, Austria - Hungary's ally Germany declared war on Russia prior to expected Russian intervention against Austria - Hungary.

Following a raid by Ottoman warships on the Russian port of Odessa, Russia declared war on the Ottoman Empire in November 1914.

3 – 3 - France

French soldiers crossing a river on their way to Verdun during the Battle of Verdun.

After Germany declared war on Russia, France with its alliance with Russia prepared a general mobilization in expectation of war. On 3 August 1914, Germany declared war on France.

3 – 4 - Japan[edit]

Japanese soldiers landing in Tsingtao during the Siege of Tsingtao in which Allied forces seized control of Germany's Kiautschou Bay concession.

Japan declared war on Germany after it did not accept an ultimatum sent by Japan to Germany, demanding that Germany extinguish its title to the Kiautschou Bay concession and restore that territory to China. The Japanese government appealed to the Japanese public that Japan was not merely entering a "European War" on behalf of European powers, but that Japan was fighting on behalf of Asians against a belligerent European power, Germany, that Japan identified as the "source of evil in the Far East". Thus as a result of this, Japan was following through with the Anglo-Japanese Alliance.

3 – 5 - Italy

Italy had been a member of the Triple Alliance alongside Germany and Austria-Hungary since the 1880s, however the Triple Alliance stipulated that all parties must be consulted in the event of one country engaging in war and Italy was not informed of this.[14] As such Italy claimed that it was not obligated to join their war effort.[14] Italy's relations with Germany and Austria - Hungary in contrast to the Allies were additionally affected by the fact that in 1913, Britain supplied Italy with 90 percent of its annual imports of coal.[14] The war effort of the Central Powers meant that Germany and Austria-Hungary were using their coal supplies for the war, and little was available to be exported to Italy. Italy initially attempted to pursue neutrality from 1914 to 1915.

After diplomatic negotiations, Britain and France convinced Italy to join the war effort with promises that Italy would gain favourable territorial concessions from the Central Powers, including Italian-populated territories of Austria-Hungary.[15] Italy ordered mobilization on 22 May 1915, and issued an ultimatum to Austria-Hungary, and then declared war on Austria-Hungary, though it did not declare war on Germany.

4 - Minor affiliated state combatants

4 – 1 - Belgium

Belgium had declared its neutrality when the war began, however Germany disregarded Belgium's neutrality and invaded the country in order to launch an offensive against the French capital of Paris. As a result Belgium became a member of the Allies.

4 – 2 - Brazil

Brazilian soldiers in World War I.

Brazil entered the war in 1917 after the United States intervened on the basis of Germany's unrestricted submarine warfare sinking its merchant ships, which Brazil also cited as a reason to enter the war fighting against Germany and the Central Powers.

4 – 3 - Montenegro[edit]

Montenegro had very close cultural and political connections with Serbia and had cooperated with Serbia in the Balkan Wars of 1912-1913. Montenegro joined the war against Austria-Hungary.

4 – 4 - Serbia

Serbian soldiers during World War I.

Serbia was invaded by Austria-Hungary after Austria-Hungary placed a stringent ultimatum to the Serbian government demanding full compliance to an Austro - Hungarian investigation of complicity by the Serbian government in the assassination of Archduke Francis Ferdinand. Serbia agreed to most of Austria - Hungary's demands but because it did not fully comply, Austria - Hungary invaded.

Serbia had the diplomatic support of Russia and both Serbia and Russia resented Austria-Hungary's absorption of Bosnia and Herzegovina that held a substantial Serb population, and Serbia had expanded in size through its actions in the Balkan Wars of 1912-1913 when the Ottoman Empire's control in the Balkans collapsed.

During the war, Serbia justified the war as being the result of Austro-Hungarian imperialism towards Serbs and South Slavs, Serbia cooperated with Yugoslavists including the Yugoslav Committee who sought pan-South-Slav unification, particularly through liberating South Slavs from Austria-Hungary. In the Corfu Declaration in 1917, the Serbian government officially declared its intention to form a state of Yugoslavia.

The first two allied victories in the war were won by Serbian army, on the mountains of Cer and Kolubara, in the western Serbia. The Austro-Hungarian army was expelled from the country suffering great losses. Serbia had suffered great losses in the war, losing almost 50% of all men and around 30 % of the entire country population. On July 28, 1918, the Serbian flag was raised at American public buildings, including the White House, on the order of President Woodrow Wilson as a sign of recognition for Serbia's resistance against the Central Powers.

5 - Major co - belligerent state combatants

5 - 1 - United States

The United States declared war on Germany in 1917 on the grounds that Germany violated U.S. neutrality by attacking international shipping and because of the Zimmermann Telegram sent to Mexico . The U.S. entered the war as an "associated power," rather than a formal ally of France and the United Kingdom, in order to avoid "foreign entanglements " . Although the Ottoman Empire and

Bulgaria severed relations with the United States, neither declared war.

6 – Non - state combatants

Four Non-state combatants, which voluntarily fought with the Allies and seceded from the constituent states of the Central Powers at the end of the war, were allowed to participate as winning nations to the peace treaties :

Polish Legions

Czechoslovak Legions: armed by France, Italy and Russia

The Hejaz: armed by Britain in Arabia

Armenians: seceded from Russia and fought against Ottoman Empire.

7 – Leaders

7 – 1 – France

Raymond Poincaré – President of France

René Viviani – Prime Minister of France (13 June 1914 – 29 October 1915)

Aristide Briand – Prime Minister of France (29 October 1915 – 20 March 1917)

Alexandre Ribot – Prime Minister of France (20 March 1917 – 12 September 1917)

Paul Painlevé – Prime Minister of France (12 September 1917 – 16 November 1917)

Georges Clemenceau – Prime Minister of France (From 16 November 1917)

Joseph Joffre – Commander-in-Chief of the French Army (3 August 1914 – 13 December 1916) and Marshal of France

Robert Nivelle – Commander-in-Chief of the French Army (13 December 1916 – April 1917)

Philippe Pétain – Commander-in-Chief of the French Army (April 1917 – 11 November 1918)

Ferdinand Foch – Marshal of France, Supreme Allied Commander (26 March 1918 – 11 November 1918)

Milan Rastislav Stefanik – General of French Army, Commander of Czechoslovak Legions

Georges Thenault – Commander of the Lafayette Escadrille

7 – 2 - British Empire

George V – King of the United Kingdom, Emperor of India

H. H. Asquith – Prime Minister of the United Kingdom (Until 5 December 1916)

David Lloyd George – Prime Minister of the United Kingdom (From 7 December 1916)

Horatio Herbert Kitchener – Secretary of State for War (5 August 1914 – 5 June 1916)

William Robertson – Chief of the Imperial General Staff (23 December 1915 – February 1918)

John French – Commander-in-Chief of the British Expeditionary Force (4 August 1914 – 15 December 1915)

Douglas Haig – Commander-in-Chief of the British Expeditionary Force (15 December 1915 – 11 November 1918)

Hugh Trenchard – Commander of Royal Flying Corps – (August 1915 – January 1918)

Winston Churchill – First Lord of the Admiralty – (1911 – May 1915)

Arthur Balfour- First Lord of the Admiralty – (May 1915 – December 1916)

Edward Carson – First Lord of the Admiralty – (10 December 1916 – 17 July 1917)

Eric Geddes – First Lord of the Admiralty – (July 1917 – January 1919)

"Jackie" Fisher – First Sea Lord – (1914 – May 1915)

Henry Jackson – First Sea Lord – (May 1915 – November 1916)

John Jellicoe – First Sea Lord (November 1916 – December 1917)

Rosslyn Wemyss – First Sea Lord (December 1917 – November 1919)

7 – 2 - 1 - Dominion of Canada

Robert Borden – Prime Minister of Canada (1914 –18)

Sam Hughes – Minister of Militia and Defence (1914 – January 1915)

Joseph Flavelle- Chairman of Imperial Munitions Board (1915–19)

Julian Byng (June 1916 – June 1917) Canadian Corps commander

Edwin Alderson – Commander of the unified Canadian Corps of the Canadian Expeditionary Force (26 January 1915 – September 1915)

Arthur Currie – Commander of the unified Canadian Corps of the Canadian Expeditionary Force (June 1917 –)[17]

7 – 2 - 2 - Commonwealth of Australia

Joseph Cook – Prime Minister of Australia (until 17 September 1914)

Andrew Fisher – Prime Minister of Australia (17 September 1914 – 27 October 1915)

Billy Hughes – Prime Minister of Australia (from 27 October 1915)

John Monash – Commander of the Australian Corps (all five Australian infantry divisions serving on the Western Front) (May 1918 –)

William Holmes – Commander of the Australian Naval and Military Expeditionary Force (August 1914 – February 1915)

Harry Chauvel – Commander of Desert Mounted Corps (Sinai and Palestine) (August 1917 –)

7 – 2 - 3 - British India

Charles Hardinge, 1st Baron Hardinge of Penshurst – Viceroy of India 1910–1916

Frederic Thesiger, 1st Viscount Chelmsford – Viceroy of India 1916–1921

Austen Chamberlain – Secretary of State for India

John Nixon commander of the British Indian Army (active in the Middle East)

7 – 2 - 4 - Union of South Africa

Louis Botha – Prime Minister of South Africa

Jan Smuts – Led forces in South-West Africa Campaign and East African Campaign, later member of the Imperial War Cabinet

7 – 2 - 5 - New Zealand

William Massey – Prime Minister of New Zealand

General Sir Alexander Godley – Commandant of New Zealand Military Forces (to October 1914); Commander of the New Zealand Expeditionary Force

Major General Sir Alfred William Robin – Quartermaster-General and Commandant of New Zealand Military Forces (from October 1914)

7 – 3 - Russia

Nicholas II — Russian Emperor, King of Poland, and Grand Prince of Finland. (Until 15 March 1917)

Grand Duke Nicholas Nikolaevich – Commander-in-chief (1 August 1914 – 5 September 1916) and viceroy in the Caucasus

Alexander Samsonov – Commander of the Russian Second Army for the invasion of East Prussia (1 August 1914 – 29 August 1914)

Paul von Rennenkampf – Commander of the Russian First Army for the invasion of East Prussia (1 August 1914 – November 1914)

Nikolai Ivanov – Commander of the Russian army on the Southwestern Front, (1 August 1914 – March 1916) responsible for much of the action in Galicia

Aleksei Brusilov – Commander of the South-West Front, then provisional Commander-in-Chief after the Tsar's abdication (February 1917 – August 1917)

Lavr Georgievich Kornilov – Commander of the South-West Front, then Commander-in-Chief (August 1917)

Aleksey Kuropatkin – Commander of the Northern Front (October 1915 – 1917)

Nikolai Yudenich – Commander of the Caucasus (January 1915 – May 1917)

Andrei Eberhardt – Commander of Black Sea Fleet (1914–16)

Aleksandr Kolchak – Commander of Black Sea Fleet (1916–17)

Nikolai Essen – Commander of Baltic Fleet (1913 – May 1915)

7 – 4 - Serbia

Peter I – King of Serbia

Crown Prince Alexander – Regent, Commander-in-Chief

Nikola Pašić – Prime Minister

Radomir Putnik – Field Marshal, Chief of the General Staff of the Serbian Army (1914-1915)

Živojin Mišić – General / Field Marshal, Commander of First Army (1914-1915) (1917), later Chief of General Staff (1918)

Petar Bojović – General / Field Marshal, Commander of First Army (1914), Deputy Chief of General Staff (1915-1916), Chief of General Staff (1916-1917) later Commander of First Army (1918)

Stepa Stepanović – General / Field Marshal, Commander of Second Army (1914-1918)

Pavle Jurišić Šturm – General, Commander of Third Army (1914-1916)

Dragutin Gavrilović - Major

7 – 5 - Montenegro

Nicholas I – King of Montenegro

Serdar Janko Vukotić – Prime Minister, Commander of 1st Montenegrin Army

Božidar Janković – Chief of the General Staff of the Montenegrin Army (1914-1915)

Petar Pešić – Chief of the General Staff of the Montenegrin Army (1915-1916)

Crown Prince Danilo II Petrović-Njegoš – In the staff of the 1st Montenegrin Army

Brigadier General Krsto Zrnov Popović – In the staff of the 1st Montenegrin Army, Aide-de-camp to Serdar Janko Vukotić

General Anto Gvozdenović – King's Aide-de-camp

Divisional General Mitar Martinović – Commander of several detachments in the Montenegrin army (Drina and Herzegovina detachments together in 1914–1915, Kotor detachment in 1916)

7 – 6 - Greece

Eleftherios Venizelos: Prime minister of Greece after 13 June 1917.

Constantin I: King of Greece, he retired from the throne, without formally resigned.

Alexander: King of Greece, he became King of Greece after his father retired from the throne.

Panagiotis Danglis: Greek general in the Hellenic Army.

7 – 7 - Belgium

Albert I of Belgium – King of the Belgians (23 December 1909 – 17 February 1934) and Commander-in-chief of the Belgian army

Charles de Broqueville - Prime Minister (1912-1918); replaced by Gérard Cooreman in June 1918 shortly before the end of the war.

Félix Wielemans - Chief of Staff of the Belgian Army

Gérard Leman – general commanding the defense of Liège

Theophile Figeys – general in the Hundred Days' Offensive

Charles Tombeur - commander of the colonial *Force Publique* in the East African theater

7 – 8 - Italy

Victor Emmanuel III – King of Italy

Antonio Salandra – Prime Minister (until 18 June 1916)

Paolo Boselli – Prime Minister (18 June 1916 – 29 October 1917)

Vittorio Emanuele Orlando – Prime Minister (from 29 October 1917)

Luigi Cadorna – Commander-in-Chief of the Italian army

Armando Diaz – Chief of General Staff of the Italian army

Luigi, Duke of Abruzzi – Commander-in-Chief of the Adriatic Fleet of Italy (1914–17)

Paolo Thaon di Revel – Admiral of the Royal Italian Navy

7 – 9 - Romania

Ferdinand I – King of Romania

Constantin Prezan – Chief of the General Staff of Romania

Vintilă Brătianu - Secretary of War

Alexandru Averescu – Commander of the 2nd Army, 3rd Army, then Army Group South

Eremia Grigorescu - Commander of the 1st Army

7 – 10 - United States

The use of naval convoys to transport U.S. troops to France, 1917.

Woodrow Wilson – President of the United States/Commander-In-Chief of the U.S. armed forces

Newton D. Baker – U.S. Secretary of War

Josephus Daniels - United States Secretary of the Navy

John J. Pershing – Commander of the American Expeditionary Force

William Sims - Commander of U.S. Naval Forces in European Waters

Mason Patrick - Commander of the United States Army Air Service

7 – 11 - Japan

Emperor Taishō – Emperor of Japan

Ōkuma Shigenobu – Prime Minister of Japan (16 April 1914 – 9 October 1916)

Terauchi Masatake – Prime minister of Japan (9 October 1916 – 29 September 1918)

Hara Takashi – Prime minister of Japan (29 September 1918 – 4 November 1921)

Kōzō Satō - Commander of the Second Special Task Fleet

Kamio Mitsuomi - Commander of Allied land forces at Tsingtao

7 – 12 - Portugal

Bernardino Machado – President of Portugal (until 12 December 1917)

Afonso Costa – Prime Minister of Portugal (until 15 March 1916; then again 25 April 1917 – 10 December 1917)

António José de Almeida – Prime Minister of Portugal (15 March 1916 – 25 April 1917)

Sidónio Pais – Prime Minister of Portugal and War Minister (11 December 1917 – 9 May 1918) and President of Portugal (from 9 May 1918)

José Maria Norton de Matos – War Minister (until 10 December 1917)

João Tamagnini Barbosa – Interim War Minister (9 May 1918 – 15 May 1918)

Amílcar Mota – Secretary of State for War (15 May 1918 – 8 October 1918)

Álvaro de Mendonça – Secretary of State for War (from 8 October 1918)

Fernando Tamagnini de Abreu – Commander of the Portuguese Expeditionary Corps (CEP)

José Augusto Alves Roçadas – Commander of the Portuguese Forces in Southern Angola

José Luís de Moura Mendes – Commander of the Portuguese Forces in Eastern Africa (until June 1916)

José César Ferreira Gil – Commander of the Portuguese Forces in Eastern Africa (from June 1916)

Sousa Rosa – Commander of the Portuguese Forces in Eastern Africa (from 1917)

7 – 13 - Siam

See main Article: Siam in World War I

Vajiravudh – King of Siam

Chakrabongse Bhuvanadh – Commander of Siamese Expeditionary Forces in Western Front.

7 – 14 - Brazil

See main Article: Brazil during World War I

Venceslau Bras – President of Brazil

Admiral Pedro Frontin, Chief of DNOG (Brazilian Expeditionary Fleet)

General Napoleão Felipe Aché, Chief of Brazilian Military Mission in France (1918-1919)

M.D. Nabuco Gouveia – Chief of Brazilian Military Medical Commission

8 - Personnel and casualties

A pie-chart showing the military deaths of the Allied Powers.

These are estimates of the cumulative number of different personnel in uniform 1914–1918, including army, navy and auxiliary forces. At any one time, the various forces were much smaller. Only a fraction of them were frontline combat troops. The numbers do not reflect the length of time each country was involved. (See also: World War I casualties.) ,

Allied power	Mobilized personnel	Killed in action	Wounded in action	Total casualties	Casualties as % of total mobilized
Australia	412,953	61,928	152,171	214,099	52 %
Belgium	267,000	38,172	44,686	82,858	31 %
Canada	628,964	64,944	149,732	214,676	34 %
France	8,410,000	1,397,800	4,266,000	5,663,800	67 %
Greece	230,000	26,000	21,000	47,000	20 %
India	1,440,437	74,187	69,214	143,401	10 %
Italy	5,615,000	651,010	953,886	1,604,896	29 %

Japan	800,000	415	907	1,322	< 1 %
Monaco	80	8	0	8	10 %
Montenegro	50,000[3]	3,000	10,000	13,000	26 %
Nepal	200,000	30,670	21,009	49,823	25 %
New Zealand	128,525	18,050	41,317	59,367	46 %
Portugal	100,000	7,222	13,751	20,973	21 %
Romania	750,000	250,000	120,000	370,000	49 %
Russia	12,000,000	1,811,000	4,950,000	6,761,000	56 %
Serbia	707,343	275,000	133,148	408,148	58 %
Siam	1,284	19	0	19	2 %
South Africa	136,070	9,463	12,029	21,492	16 %
United Kingdom	6,211,922	886,342	1,665,749	2,552,091	41 %
United States	4,355,000	116,708	205,690	322,398	7 %
Total	**42,244,409**	**5,741,389**	**12,925,833**	**18,744,547**	**49%**

9 - Summary of Declarations of War

The following table shows the timeline of the several declarations of war among the belligerent powers. Entries on a yellow background show severed diplomatic relations only, not actual declarations of war. Unless stated otherwise, declarations of war by and on the United Kingdom include *de facto* declarations by and on other members of the British Empire.

Date	Declarer	On
1914		
28 July	Austria - Hungary	Serbia
30 July	Russia	Austria-Hungary
1 August	Germany	Russia
1 August	Monaco	Germany
3 August	Germany	France
4 August	Germany	Belgium
	United Kingdom	Germany
5 August	Montenegro	Austria-Hungary

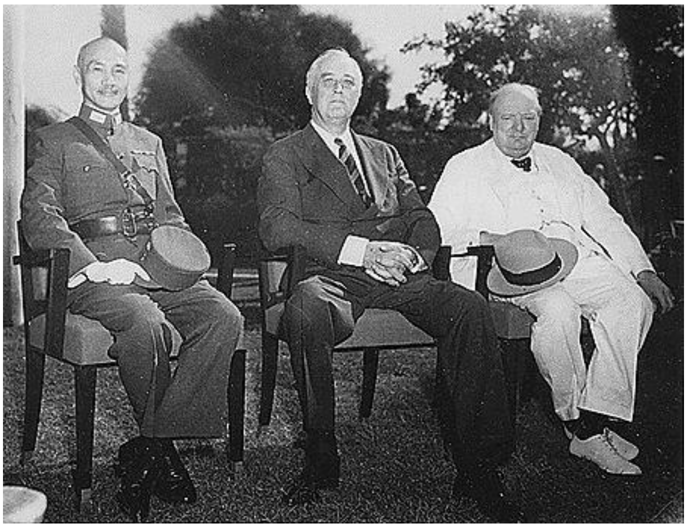
6 August	Austria - Hungary Serbia	Russia Germany
9 August	Montenegro	Germany
11 August	France	Austria-Hungary
12 August	United Kingdom	Austria-Hungary
22 August	Austria-Hungary	Belgium
23 August	Japan	Germany
25 August	Japan	Austria-Hungary
1 November	Russia	Ottoman Empire
2 November	Serbia	Ottoman Empire
3 November	Montenegro	Ottoman Empire
5 November	United Kingdom France	ttoman Empire
1915		
23 May	Italy	Austria-Hungary
3 June	San Marino	Austria-Hungary
21 August	Italy	Ottoman Empire
14 October	Bulgaria	Serbia
15 October	United Kingdom Montenegro	Bulgaria
16 October	France	Bulgaria
19 October	Italy - Russia	Bulgaria
1916		
9 March	Germany	Portugal
15 March	Austria-Hungary	Portugal
27 August	Romania Italy	Austria-Hungary Germany
28 August	Germany	Romania
30 August	ttoman Empire	Romania
1 September	Bulgaria	Romania
1917		
6 April	United States	Germany

7 April	Cuba	Germany
10 April	Bulgaria	United States
13 April	Bolivia	Germany
20 April	Ottoman Empire	United States
2 July	Greece	Germany Austria-Hungary Ottoman Empire Bulgaria
22 July	Siam	Germany Austria-Hungary
4 August	Liberia	Germany
14 August	China	Germany Austria-Hungary
6 October	Peru	Germany
7 October	Uruguay	Germany
26 October	Brazil	Germany
7 December	United States	Austria-Hungary
7 December	Ecuador	Germany
10 December	Panama	Austria-Hungary
16 December	Cuba	Austria-Hungary
1918		
23 April	Guatemala	Germany
8 May	Nicaragua	Germany Austria-Hungary
23 May	Costa Rica	Germany
12 July	Haiti	Germany
19 July	Honduras	Germany
10 November	Romania	Germany

Allies of World War II

Contents

"The Big Three": Joseph Stalin, Franklin D. Roosevelt and Winston Churchill meeting at the Tehran Conference in 1943



The Allied leaders of the Asian and Pacific Theater: Generalissimo Chiang Kai-shek, Franklin D. Roosevelt, and Winston Churchill meeting at the Cairo Conference in 1943

Charles de Gaulle sits down with rival Henri Giraud (left) after shaking hands with him in the presence of Franklin Roosevelt and Winston Churchill at the Casablanca Conference, 14 January 1943.

Clement Attlee, Harry S. Truman, and Joseph Stalin at the Potsdam Conference in August 1945 after the defeat of Germany but prior to the surrender of Japan.

1 - Introduction

The **Allies of World War II** were the countries that opposed the Axis powers during the Second World War (1939–1945). The Allies promoted the alliance as seeking to stop German, Italian and Japanese aggression.

The anti - German coalition at the start of the war (1 September 1939) consisted of France, Poland and Great Britain, soon to be joined by the British Commonwealth (Australia, Canada, New Zealand, Newfoundland and South Africa.) After first having cooperated with Germany in partitioning Poland whilst remaining neutral in the Allied-Axis conflict, the Soviet Union joined the Allies in June-1941 after being invaded by Germany and its allies. The United States joined in December 1941 after the Japanese attack on Pearl Harbor. As of 1942, the "Big Three" leaders of Britain, the Soviet Union, and the United States controlled Allied policy; relations between Britain and the U.S. were especially close. Other key Allies included China, Canada, British Raj (India), the Netherlands, Norway and Yugoslavia as well as Free France; there were numerous others. Together they called themselves the "United Nations" (and in 1945 created the modern UN).

2 - Origins and creation

The origins of the Allied powers stem from the Allies of World War I and cooperation of the victorious powers at the Paris Peace Conference, 1919. Germany deeply resented being forced to sign the Treaty of Versailles. The new Weimar republic's legitimacy became shaken. However the 1920s were peaceful.

With the Stock Market Crash of 1929 and the ensuing Great Depression, political unrest in Europe soared including the rise in support of revanchist nationalists in Germany who blamed the severity of the economic crisis on the Treaty of Versailles. By the early 1930s, the Nazi Party led by Adolf Hitler became the dominant revanchist movement in Germany and Hitler and the Nazis gained power in 1933. The Nazi regime demanded the immediate cancellation of the Treaty of Versailles, and made claims to German-populated Austria, and German-populated territories of Czechoslovakia. The likelihood of war was high, and the questions was whether it could be avoided through strategies such as Appeasement

.

In Asia, when Japan seized Manchuria in 1931, the League of Nations condemned it for aggression against China. Japan responded by leaving the League of Nations in March 1933. After four quiet years, the Sino-Japanese War erupted in 1937 with Japanese forces invading China. The League of Nations condemned Japan's actions and initiated sanctions on Japan. The United States in particular was angered at Japan and sought to support China.

In March 1939, Germany invaded Czechoslovakia, violating the Munich Agreement signed six months before, and demonstrating that appeasement was a failure. Britain and France decided that Hitler had no intention to uphold diplomatic agreements and responded by preparing for war. They tried in 1939 tried to avert a German move east by promising go to war with Germany if it invaded Poland, and seeking an alliance with the USSR. Hitler ended the risk of a war with Stalin by a non-aggression pact with the USSR in August 1939. It secretly divided the independent nations of eastern Europe between the two powers and assured adequate oil supplies for the German war machine. On 1 September 1939, Germany invaded Poland; two days later Britain and France declared war on Germany. Poland fell in a matter of days. A government in exile was set up and it became one of the Allies, a model followed by other invaded countries. After a quiet winter Germany in April 1940 invaded and quickly defeated Scandinavia, Belgium, Holland and France. Britain and its Empire stood alone against Hitler and Mussolini. In June 1941, however., Germany invaded the USSR. In December Japan attacked the US and Britain. The main lines of World War II had formed.

3 - Major affiliated state combatants

During December 1942 , U.S. President Franklin D. Roosevelt devised the name "United Nations" for the Allies. He referred to the Big Three and China as a "trusteeship of the powerful", and then later the "Four Policemen". The *Declaration by United Nations* on 1 January 1942 was the basis of the modern United Nations (UN) . At the Potsdam Conference of July – August 1945, Roosevelt's successor, Harry S. Truman, proposed that the foreign ministers of China, France, the Soviet Union, United Kingdom, and the United States "should draft the peace treaties and boundary settlements of

Europe", which led to the creation of the Council of Foreign Ministers.

3 – 1 - Soviet Union

Soviet soldiers fighting in the ruins of Stalingrad during the Battle of Stalingrad.

Soviet Il-2 ground attack aircraft attacking German ground forces during the Battle of Kursk.

3 – 1 – 1 - War justifications

General Secretary Joseph Stalin and the government of the Soviet Union justified the Soviet war effort that resulted from the German invasion of the Soviet Union with Operation Barbarossa in 1941, as a defensive war being fought by patriotic Soviet people for their survival.[6] Stalin had supported popular front movements of anti-fascists including communists and non-communists from 1935 to 1939 . The popular front strategy was terminated from 1939 to 1941 when the Soviet Union cooperated with Germany in 1939 in the occupation and partitioning of Poland while the Soviet Union refused to endorse either the Allies or the Axis from 1939 to 1941, as it called the Allied-Axis conflict an "imperialist war".[7] After the invasion of the Soviet Union in 1941, Stalin endorsed the Western Allies as part of a renewed popular front strategy against Germany and called for the international communist movement to make a coalition with all those who opposed the Nazis.

The Soviet Union intervened against Japan and its client state in Manchuria in 1945, cooperating with the Nationalist Government of China and Nationalist Party led by Chiang Kai Shek; though also cooperating, preferring, and encouraging the Communist Party led by Mao Zedong to take effective control of Manchuria after expelling Japanese forces.

3 – 1 – 2 - History

On 20 August 1939, forces of the Union of Soviet Socialist Republics under General Georgy Zhukov, together with the People's Republic of Mongolia eliminated the threat of conflict in the east with a decisive victory over Japan at the Battle of Khalkhin Gol in eastern Mongolia.

On the same day, Soviet party leader Joseph Stalin received a telegram from German Chancellor Adolf Hitler, suggesting that German Foreign Minister Joachim von Ribbentrop fly to Moscow for diplomatic talks. (After receiving a lukewarm response throughout the spring and summer, Stalin abandoned attempts for a better diplomatic relationship with France and the United Kingdom.)

On 23 August Ribbentrop and Soviet Foreign Minister Vyacheslav Molotov signed the non-aggression pact including secret protocols dividing Eastern Europe into defined "spheres of influence" for the two regimes, and specifically concerning the partition of the Polish state in the event of its "territorial and political rearrangement".

On 15 September 1939, Stalin concluded a durable ceasefire with Japan, to take effect the following day (it would be upgraded to a nonaggression pact in April 1941).[11] The day after that, 17 September, Soviet forces invaded Poland from the east. Although some fighting continued until 5 October, the two invading armies held at least one joint military parade on 25 September, and reinforced their non - military partnership with a German – Soviet Treaty of Friendship, Cooperation and Demarcation on 28 September.

On 30 November, the Soviet Union attacked Finland, for which it was expelled from the League of Nations. In the following year of 1940, while the world's attention was focused upon the German invasion of France and Norway, the USSR militarily occupied the Baltic states of Estonia, Latvia and Lithuania as well as parts of Romania.

German-Soviet treaties were brought to an end by the German surprise attack on the USSR on 22 June 1941. The Soviet Union so entered in alliance with the United Kingdom. Following the USSR, a number of other communist, pro - Soviet or Soviet-controlled forces fought against the Axis powers during the Second World War. They were as follows: the Albanian National Liberation Front, the Chinese Red Army, the Greek National Liberation Front, the Hukbalahap, the Malayan Communist Party, the People's Republic of Mongolia, the Polish People's Army, the Tuvan People's Republic (annexed by Soviet Union in 1944) , the Viet Minh and the Yugoslav Partisans.

3 – 2 - United States

American Douglas SBD Dauntless dive-bomber aircraft attacking the Japanese cruiser Mikuma during the Battle of Midway in June 1942.

American Marines during the Guadalcanal Campaign in November 1942 .

American soldiers depart landing craft during the Normandy landings on 6 June 1944 known as D-Day, in the Battle of Normandy.

3 – 2 - 1 - War justifications

The United States had indirectly supported Britain's war effort against Germany up to 1941 and declared its opposition to territorial aggrandizement. Material support to Britain was provided while the U.S. was officially neutral via the Lend Lease Act starting in 1941.

President Franklin D. Roosevelt and Prime Minister Winston Churchill in August 1941 promulgated the Atlantic Charter that pledged commitment to achieving "the final destruction of Nazi tyranny". Signing the Atlantic Charter, and thereby joining the "United Nations" was the way a nation joined the Allies, and also became eligible for membership in the United Nations world body that formed in 1945.

The US strongly supported the Nationalist Government in China in its war with Japan, and provided military equipment, supplies, and volunteers to the Nationalist Government of China to assist in its war effort. In December 1941 Japan opened the war with its attack on Pearl Harbor, the US declared war on Japan, and Japan's allies Germany and Italy declared war on the US, bringing the US into World War II.

3 – 2 - 2 – History

On 8 December 1941, following the attack on Pearl Harbor, the United States Congress declared war on Japan at the request of President Franklin D. Roosevelt. This was followed by Germany and Italy declaring war on the United States on 11 December, bringing the country into the European theatre.

The US led Allied forces in the Pacific theatre against Japanese forces from 1941 to 1945. From 1943 to 1945, the US led and coordinated the Western Allies' war effort in Europe under the leadership of General Dwight Eisenhower.

The surprise attack on Pearl Harbor followed by Japan's swift attacks on Allied locations throughout the Pacific, resulted in major US losses in the first several months in the war, including losing control of the Philippines, Guam, Wake Island and several Aleutian islands including Attu and Kiska to Japanese forces. American naval forces attained some early successes against Japan. One was the bombing of Japanese industrial centers in the Doolittle Raid. Another was repelling a Japanese invasion of Port Moresby in New Guinea during the Battle of the Coral Sea. A major turning point in the Pacific War was the Battle of Midway where American naval forces were outnumbered by Japanese forces that had been sent to Midway to draw out and destroy American aircraft carriers in the Pacific and seize control of Midway that would place Japanese forces in close proximity to Hawaii . However American forces managed to sink four of Japan's six large aircraft carriers that had initiated the attack on Pearl Harbor along with other attacks on Allied forces. Afterwards the US began an offensive against Japanese - captured positions. The Guadalcanal Campaign from 1942 to 1943 was a major contention point where American and Japanese forces struggled to gain control of Guadalcanal.

3 – 2 - 3 - Colonies and dependencies

3 – 2 – 3 - 1 - In the Americas

The United States held multiple dependencies in the Americas, such as Alaska, the Panama Canal Zone, Puerto Rico, and the U.S. Virgin Islands.

3 – 2 – 3 - 2 - In Asia

The United States held multiple island dependencies in Asia during World War II such as American Samoa, Guam, Hawaii, Midway Islands, Wake Island and others. These dependencies were directly involved in the Pacific campaign of the war.

3 – 2 – 4 - Self - governing sovereign dominions or protectorates

3 – 2 – 4 - 1 – Philippines

The Commonwealth of the Philippines was a sovereign protectorate referred to as an "associated state" of the United States. The Philippines were occupied by Japanese forces from late 1941 to 1944 who established a client regime there during their military occupation.

3 –3 - United Kingdom

British tanks during the North African Campaign.

British soldiers in Northwest Europe, 1944 or 1945.

3 – 3 - 1 – History

The United Kingdom and other members of the British Commonwealth, known as the Dominions, declared war on Germany separately, all within one week of each other; these countries were Canada, Australia, New Zealand, Newfoundland and the Union of South Africa. Southern Rhodesia, while self - governing, did not have independence in foreign policy.

The first major naval confrontation in the Atlantic Ocean was between British warships of the UK's Royal Navy versus the German cruiser *Admiral Graf Spee* of the *Kriegsmarine* during the Battle of the River Plate in 1939 whereby British warships badly damaged the *Admiral Graf Spee* that escaped and attempted to seek refuge in the neutral port of Montevideo, Uruguay, but was refused, resulting in the Captain of the German warship evacuating the crew and scuttling it.

Upon the entry of Italy into the war on the Axis side in June 1940, the British government recognized the dangerous threat posed to the UK's possessions and interests in the Mediterranean posed by Italy's large navy, the *Regia Marina*, as a result the British initiated the attack on Taranto in November 1940, where British naval aircraft sank three Italian battleships in the harbour of Taranto and destroyed the seaplane base there.

3 – 3 - 2 - Colonies and dependencies

3 – 3 – 2 - 1 - In Africa

Britain held multiple African colonies during World War II. Many West African countries participated in World War II. Two West African and one East African division served in the Burma Campaign.

3 – 3 – 2 - 2 - In the Americas

Newfoundland was a British dominion-dependency during the war after it decided to relinquish its self-governing dominion status to a semi-autonomous dominion - dependency status in 1934.

The Falkland Islands were a British dependency during the war.

Belize then known as British Honduras, was a British dependency during the war.

Guyana was a British dependency during the war.

Jamaica was a British dependency during the war.

3 – 3 – 2 - 3 - In Asia

The Cyprus Regiment was formed by the British Government during the Second World War and made part of the British Army structure. It was mostly Greek Cypriots volunteers and Turkish speaking Cypriot inhabitants of Cyprus but also included other Commonwealth nationalities. On a brief visit to Cyprus in 1943, Winston Churchill praised the "soldiers of the Cyprus Regiment who have served honorably on many fields from Libya to Dunkirk". About 30,000 Cypriots served in the Cyprus Regiment. The regiment was involved in action from the very start and served at Dunkirk, in the Greek Campaign (Battle of Greece) (about 600 soldiers were captured in Kalamata in 1941), North Africa (Operation Compass), France, the Middle East and Italy. Many soldiers were taken prisoner especially at the beginning of the war and were interned in various POW camps (Stalag) including Lamsdorf (Stalag VIII-B), Stalag IVC at Wistritz bei Teplitz and Stalag 4b near Most in the Czech Republic. The soldiers captured in Kalamata were transported by train to prisoner of war camps.

British India (including the areas and peoples covered by the later Republic of India, Bangladesh, Pakistan and Burma/Myanmar) and territories controlled by the Colonial Office, namely the Crown Colonies, were controlled politically by the UK and therefore also entered hostilities with Britain's declaration of war. At the outbreak of World War II, the Indian army numbered 205,000 men. Later during World War II the Indian Army became the largest all - volunteer force in history, rising to over 2.5 million men in size .] These forces included tank, artillery and airborne forces. Indian soldiers earned 30 Victoria Crosses during the Second World War. It suffered 1,500,000 civilian casualties (more than the United Kingdom), mainly from the Bengal famine of 1943 caused by the fall of Burma to the Japanese[21] and the transfer of food to the war effort, and 87,000 military casualties (more than any Crown colony but fewer than the United Kingdom). The UK suffered 382,000 military casualties.

Kuwait was a protectorate of the United Kingdom formally established in 1920.

Palestine was a mandate dependency created in the peace agreements after World War I from former territory of the Ottoman Empire.

3 – 3 – 3 - Self - governing sovereign dominions, colonies or protectorates

3 – 3 – 3 - 1 – Australia

Australia was a self-governing sovereign dominion under the British monarchy under the terms of the Balfour Declaration of 1926.

3 – 3 – 3 - 2 – Canada

Canada was a self-governing sovereign dominion under the Statute of Westminster in 1931. In a symbolic statement of autonomous foreign policy Prime Minister William Lyon Mackenzie King delayed Parliament's vote on a declaration of war for seven days after Britain had declared war. Canada was the last member of the Commonwealth to declare war on Germany.[22]

3 – 3 – 3 - 3 - New Zealand

New Zealand was a self - governing sovereign dominion under the British monarchy under the terms of the Balfour Declaration of 1926.

3 – 3 – 3 - 4 - South Africa

South Africa was a self - governing sovereign dominion under the British monarchy the terms of the Balfour Declaration of 1926. South Africa held authority over the mandate of South-West Africa.

3 – 3 – 3 - 5 - Southern Rhodesia

Southern Rhodesia was a self - governing colony, having received responsible government from the UK government in 1923, but not a sovereign dominion. It governed itself internally and controlled its own armed forces, but had no diplomatic autonomy, and therefore was officially at war as soon as Britain was at war. The Southern Rhodesian colonial government issued a symbolic declaration of war nevertheless on 3 September 1939, which made no difference diplomatically, but preceded the declarations of war made by all other British dominions and colonies.

3 – 4 – China

Chiang Kai-shek (first row, second from left side), Mao Zedong (first row, third from left), United States ambassador Patrick J. Hurley (first row, first on left), 1945.

In the 1920s the Soviet Union provided military assistance to Kuomintang, or the Nationalists and helped reorganized their party along Leninist lines: a unification of party, state, and army. In exchange the Nationalists agreed to let members of the Chinese

Communist Party join the Nationalists on an individual basis. However, following the nominal unification of China at the end of the Northern Expedition in 1928, Generalissimo Chiang Kai-shek purged leftists from his party and fought against the revolting Chinese Communist Party, former warlords, and other militarist factions. A fragmented China provided easy opportunities for Japan to gain territories piece by piece without engaging in total war. Following the 1931 Mukden Incident, the puppet state of Manchukuo was established. Throughout the early to mid-1930s, Chiang's anti-communist and anti-militarist campaigns continued while he fought small, incessant conflicts against Japan, usually followed by unfavorable settlements and concessions after military defeats.

In 1936 Chiang was forced to cease his anti-communist military campaigns after his kidnap and release by Zhang Xueliang, and reluctantly formed a nominal alliance with the Communists, while the Communists agreed to fight under the nominal command of the Nationalists against the Japanese. Following the Marco Polo Bridge Incident of 7 July 1937, China and Japan became embroiled in a full-scale war. The Soviet Union, wishing to keep China in the fight against Japan, supplied China with military assistance until 1941, when it signed a non aggression pact with Japan. Continuous clashes between the Communists and Nationalists behind enemy lines cumulated in a major military conflict between these two former allies that effectively ended their cooperation against the Japanese, and China had been divided between the internationally-recognized Nationalist China under the leadership of Generalissimo Chiang Kai-shek and the Communist China under the leadership of Mao Zedong until the Japanese surrendered in 1945.

3 – 4 – 1 - Factions

3 – 4 – 1 – 1 - Nationalists

Prior to the alliance of Germany and Italy to Japan, the Nationalist Government held close relations with both Germany and Italy. In the early 1930s, Sino - German cooperation between the Nationalist Government and Germany in military and industrial matters. Nazi Germany provided the largest proportion of Chinese arms imports and technical expertise. Relations between the Nationalist Government and Italy during the 1930s varied, however even after the Nationalist Government followed League of Nations sanctions against Italy for its invasion of Ethiopia, the international sanctions proved unsuccessful, and relations between the Fascist government in Italy and the Nationalist Government in China returned to normal shortly afterwards . Up until 1936, Mussolini had provided the Nationalists with Italian military air and naval missions to help the Nationalists fight against Japanese incursions and communist insurgents. Italy also held strong commercial interests and a strong commercial position in China. However after 1936 the relationship between the Nationalist Government and Italy changed due to a Japanese diplomatic proposal to recognize the Italian Empire that included occupied Ethiopia within it in exchange for Italian recognition of Manchukuo, Italian Foreign Minister Galeazzo Ciano accepted this offer by Japan, and on 23 October 1936 Japan recognized the Italian Empire and Italy recognized Manchukuo, as well as discussing increasing commercial links between Italy and Japan.

Soldiers of the National Revolutionary Army associated with Nationalist China, during the Sino - Japanese War.

The Nationalist Government held close relations with the United States. The United States opposed Japan's invasion of China in 1937 that it considered an illegal violation of China's sovereignty, and offered the Nationalist Government diplomatic, economic, and military assistance during its war against Japan. In particular, the United States sought to bring the Japanese war effort to a complete halt by imposing a full embargo on all trade between the United States to Japan, Japan was dependent on the United States for 80 percent of its petroleum, resulting in an economic and military crisis for Japan that could not continue its war effort with China without access to petroleum. In November 1940, American military aviator Claire Lee Chennault upon observing the dire situation in the air war between China and Japan, set out to organize a volunteer squadron of American fighter pilots to fight alongside the Chinese against Japan, this squadron was known as the Flying Tigers . US President Franklin D. Roosevelt accepted dispatching the Flying Tigers to China in early 1941. However, the Flying Tigers only became operational shortly after the attack on Pearl Harbor.

The Soviet Union recognized the Republic of China but urged reconciliation with the Communist Party of China and inclusion of Communists in the government. The Soviet Union also urged military and cooperation between Nationalist China and Communist China during the war.

Even though the Republic of China had been fighting the longest among all the Allied powers, it only officially joined the Allies after the attack on Pearl Harbor, on 7 December 1941. Generalissimo Chiang Kai - shek thought Allied victory was assured with the entrance of the United States into the war, and he declared war on Germany and the other Axis nations. However, Allied aid remained low because the Burma Road was closed and the Allies suffered a series of military defeats against Japan early on in the campaign. General Sun Li-jen led the R.O.C. forces to the relief of 7,000 British forces trapped by the Japanese in the Battle of Yenangyaung. He then reconquered North Burma and re - established the land route to China by the Ledo Road. But the bulk of military aid did not arrive until the spring of 1945. More than 1.5 million Japanese troops were trapped in the China Theatre, troops that otherwise could have been deployed elsewhere if China had collapsed and made a separate peace.

3 – 4 – 1 - 2 – Communists

Soldiers of the First Workers' and Peasants' Army associated with Communist China, during the Sino-Japanese War.

Communist China had been tacitly supported by the Soviet Union since the 1920s, though the Soviet Union diplomatically recognized the Republic of China, Joseph Stalin supported cooperation between the Nationalists and the Communists — including pressuring the Nationalist Government to grant the Communists state and military positions in the government. This was continued into the 1930s that fell in line with the Soviet Union's policy of popular fronts that sought to increase communists' influence in governments. The Soviet Union urged military and cooperation between Soviet China and Nationalist China during China's war against Japan. Initially Mao Zedong accepted the demands of the Soviet Union and in 1938 had recognized Chiang Kai-Shek as the "leader" of the "Chinese people".[29] In turn, the Soviet Union accepted Mao's tactic of "continuous guerilla warfare" in the countryside that involved a goal of extending the Communist bases, even if it would result in increased tensions with the Nationalists.

After the breakdown of their cooperation with the Nationalists in 1941, the Communists prospered and grew as the war against Japan dragged on, building up their sphere of influence wherever opportunities were presented, mainly through rural mass organizations, administrative, land and tax reform measures favoring poor peasants; while the Nationalists attempted to neutralize the spread of Communist influence by military blockade and fighting the Japanese at the same time.

The Communist Party's position in China was boosted further upon the intervention of the Soviet Union in Manchuria against the Japanese puppet state of Manchukuo and Japanese military forces in China. Upon the intervention of the Soviet Union against Japan in World War II in 1945, Mao Zedong in April and May 1945 had planned to mobilize 150,000 to 250,000 soldiers from across China to work with forces of the Soviet Union in capturing Manchuria.

3 – 5 –France
3 – 5 –1 - War justifications

FAFL Free French GC II/5 "LaFayette" receiving ex-USAAF Curtiss P-40 fighters at Casablanca, French Morocco on 9 January 1943.

Free French M4 Sherman tank during the Normandy Campaign in 1944.

After Germany repudiated the Munich Agreement and invaded Czechoslovakia and then invaded Poland, France declared war on Germany anticipating that Germany would eventually declare war on France. In January 1940, French Prime Minister Édouard Daladier made a major speech denouncing the actions of Germany:

"At the end of five months of war, one thing has become more and more clear. It is that Germany seeks to establish a domination of the world completely different from any known in world history."

"The domination at which the Nazis aim is not limited to the displacement of the balance of power and the imposition of the supremacy of one nation. It seeks the systematic and total destruction of those conquered by Hitler and it does not treaty with the nations which it has subdued. He destroys them. He takes from them their whole political and economic existence and seeks even to deprive them of their history and culture. He wishes only to consider them as vital space and a vacant territory over which he has every right."

"The human beings who constitute these nations are for him only cattle. He orders their massacre or migration. He compels them to make room for their conquerors. He does not even take the trouble to impose any war tribute on them. He just takes all their wealth and, to prevent any revolt, he scientifically seeks the physical and moral degradation of those whose independence he has taken away."[32]

France experienced several major phases of action during World War II :

The "Phoney War" of 1939 – 1940, also called *drôle de guerre* in France, *dziwna wojna* in Poland (both meaning "Strange War"), or the *"Sitzkrieg"* ("Sitting War") in Germany.

The Battle of France in May–June 1940, which resulted in the defeat of the Allies, the fall of the French Third Republic and the creation of the rump state Vichy France which received diplomatic recognition by the major part of the international community, including the government of the United States.

The period of French Resistance and Free French Forces, from 1940–1944, until the June 1944 D-Day invasions part of the Battle of Normandy and the August 1944 invasion of southern France in Operation Dragoon, which led to the Liberation of Paris on 25 August 1944 and the liberation of France by the allies. Free France was a government-in-exile recognized, between major Allies, only by Britain.

The political creation of the Provisional Government of the French Republic, and the military actions following the redesignation of "French Army B" as the First French Army, including the final drive on Germany, which culminated in V-E Day, on 7 May 1945.

3 – 5 – 2 – Colonies and dependencies

3 – 5 – 2 – 1 - In Africa

In Africa these included: French West Africa, Madagascar, the protectorate and dependency of Tunisia, the mandate of French Cameroon, the mandate of French Togo and Djibouti.

3 – 5 – 2 – 2 - In the Americas

In the Americas these included: French Guiana, Saint Pierre and Miquelon, and others.

3 – 5 – 2 – 3 - In Asia

In Asia these included: French Indochina, French India, the mandate of Lebanon, French Polynesia, and others.

3 – 5 – 3 – Self - governing sovereign dominions or protectorates

3 – 5 – 3 – 1 – Syria

The French government in 1936 attempted to grant independence to its mandate of Syria in the Franco - Syrian Treaty of Independence of 1936 signed by France and Syria. However opposition to the treaty grew in France and the treaty was not ratified. Syria had become an official republic in 1930 and was largely self-governing.

The fall of Damascus to the Allies, late June 1941. A car carrying Free French commanders General Georges Catroux and General Paul Louis Le Gentilhomme enters the city, escorted by French Circassian cavalry (Gardes Tcherkess).

In 1941, forces loyal to the Vichy regime took control of Syria. However in 1941, a British - invasion supported by Free French forces expelled Vichy French forces.

3 – 6 – Poland

Polish soldiers in combat during the invasion of Poland.

The invasion of Poland on 1 September 1939, started the war in Europe, and the United Kingdom and France declared war on Germany on 3 September. Poland fielded the third biggest army[34] among the European Allies, after the Soviet Union and United Kingdom, but before France. The country never officially surrendered to the Third Reich and continued the war effort under the Polish government in exile. However, the Soviet Union unilaterally considered the flight to Romania of President Ignacy Mościcki and Marshal Edward Rydz - Śmigły on 17 September as an evidence of *debellatio* causing the extinction of Polish State, and consequently declared itself allowed to invade (according to Soviet position: "to protect") Eastern Poland starting from the same day.[35] It must be noted that the Red Army had invaded the Second Polish Republic several hours before Polish president fled to Romania. The Soviets invaded on Sept. 17 at 3 a.m., while president Mościcki crossed the Polish-Romanian border at 21:45 on the same day.

Polish soldiers fought under the command of the Polish Government in Exile in many parts of the world. They were major contributors to the allies in the theatre of war west of Germany and in the theatre of war east of Germany, with the Soviet Union. They also had minor contributions in the Atlantic Ocean and in Scandinavia. The Polish Air Force fought in the Battle of Britain. The Polish expeditionary corps played minor roles in the Battle of France, and important ones in the Italian and North African Campaigns.[38][39] They are particularly well remembered for their conduct at the Battle of Monte Cassino, a conflict which culminated in the raising of a Polish flag over the ruins of the mountain-top abbey by the 12th Podolian Uhlans. The Polish forces in the theatre of war east of Germany were commanded by Lieutenant General Władysław Anders. The Polish People's Army took part in the Battle of Berlin, the closing battle of the European theater of war. They occupied the city alongside the Soviet Red Army.

Home Army, the largest underground force in Europe, and other resistance organizations in occupied Poland provided intelligence that enabled successful operations later in the war and led to uncovering the Nazi war crimes (i.e., death camps) to the Western Allies. Notable Polish units fought in every campaign in Europe and North Africa (outside the Balkans). Polish Armed Forces in the West were created in France and, after its fall, in the United Kingdom. The Soviet Union recognized the London - based government but broke diplomatic relations after the revelation of the Katyn massacre. In 1943, the Soviet Union organized the Polish People's Army under Zygmunt Berling , around which it constructed the post-war successor state People's Republic of Poland.

Warsaw Uprising

On 1 August 1944 at 5:00 PM the Warsaw Uprising has begun - it was the largest, coordinated armed revolt of WWII taken against Axis powers. Home Army and several other Polish resistance organisations took an effort of liberating Warsaw from the hands of occupying German troops. After initial successes they were ultimately defeated after 63 days of struggles at the streets of the city - on 2 October gen. Tadeusz Bór - Komorowski issued an order of surrender, ending The Rising. Polish resistance soldiers were heavily outclassed both in number as well as equipment. In addition they did received very little outside support. As a revenge for the revolt Germans destroyed remnants of the city (85 % of original architecture samples demolished by January 1945).

3 – 7 – Netherlands

The Netherlands became an Allied member after being invaded in 1940 by Germany. During the ensuing campaign, the Netherlands were defeated and occupied by Germany. The Netherlands was liberated by Canadian, British, American and other allied forces during the campaigns of 1944 and 1945. The Prinses Irene brigade, formed from escapees from the German invasion, took part in several actions in 1944 in Arromances and in 1945 in the Netherlands. Navy vessels saw action in the British Channel, the North Sea and the Mediterranean, generally as part of Royal Navy units. Dutch airmen flying British aircraft participated in the air war over Germany.

3 – 7 – 1 - Colonies and dependencies

The Dutch East Indies (modern - day Indonesia) was the principal Dutch colony in Asia, and was attacked by Japan in 1942. During the Dutch East Indies Campaign, the Netherlands played a significant role in the Allied effort to halt the Japanese advance as part of the American-British-Dutch-Australian (ABDA) Command. The ABDA fleet finally encountered the Japanese surface fleet at the Battle of Java Sea, at which Doorman gave the order to engage. During the ensuing battle the ABDA fleet suffered heavy losses, and was mostly destroyed after several naval battles around Java; the ABDA Command was later dissolved. The Japanese finally occupied the Dutch East Indies in February–March 1942. Dutch troops, aircraft and escaped ships continued to fight on the Allied side and also mounted a guerrilla campaign in Timor.

3 – 8 – Belgium

Before the war, Belgium had pursued a policy of neutrality and only became an Allied member after being invaded by Germany on 10 May 1940. During the ensuing fighting, Belgian forces fought alongside French and British forces against the invaders. While the British and French were struggling against the fast German advance elsewhere on the front, the Belgian forces were pushed into a pocket to the north. Finally on 28 May, the King Leopold III surrendered himself and his military to the Germans, having decided the Allied cause was lost. The legal Belgian government was reformed as a government in exile in London. Belgian troops and pilots continued to fight on the Allied side as the Free Belgian Forces. Belgium itself was occupied, but a sizeable Resistance was formed and was loosely coordinated by the government in exile and other Allied powers.

British and Canadian troops arrived in Belgium in September 1944 and the capital, Brussels, was liberated on 6 September. Because of the Ardennes Offensive, the country was only fully liberated in early 1945.

3 – 8 – 1 - Colonies and dependencies

Belgium had one colony and one mandate dependency in Africa, the colony of the Belgian Congo and the mandate of Ruanda-Urundi. The Belgian Congo was not occupied and remained loyal to the Allies as an important economic asset while its deposits of Uranium were key to the Allied efforts to develop the atomic bomb. Troops from the Belgian Congo participated in the East African Campaign against the Italians. The colonial *Force Publique* also served in other theatres including Madagascar, the Middle-East, India and Burma alongside British forces.

4 - Minor affiliated state combatants

4 – 1 – Albania

Albanian Partisans in Tirana in 1944.

Albania was occupied by Italy in 1939, King Zog was forced into exile, and Albania was turned into an Italian protectorate. After Italy capitulated to the Allies in 1943, Albania came under German occupation and a German puppet state was established. Albanian resistance to Axis control arose during the war, particularly communist Partisans led by Enver Hoxha.

4 – 2 – Brazil

Brazilian soldiers of the Brazilian Expeditionary Force the city of Massarosa, Italy in September 1944.

Initially, Brazil maintained a position of neutrality, trading with both the Allies and the Axis Powers, while Brazilian president Getúlio Vargas's quasi-Fascist policies indicated a leaning toward the Axis powers. However, as the war progressed, trade with the Axis countries became almost impossible and the United States initiated forceful diplomatic and economic efforts to bring Brazil onto the Allied side.

At the beginning of 1942, Brazil permitted the United States to set up air bases on its territory, especially in Natal, strategically located at the easternmost corner of the South American continent, and on 28 January the country severed diplomatic relations with Germany, Japan, and Italy. After that, 36 Brazilian merchant ships were sunk by the German and Italian navies, which led the Brazilian government to declare war against Germany and Italy on 22 August 1942.

Brazil then sent a 25,700 strong Expeditionary Force to Europe that fought mainly on the Italian front, from September 1944 to May 1945. Also, the Brazilian Navy and Air Force acted in the Atlantic Ocean from the middle of 1942 until the end of war. Brazil was the only South American country to send troops to fight in the European theatre in the Second World War.

4 – 3 - Czechoslovakia

Ludvík Svoboda with Czechoslovak soldiers of the 1st Czechoslovak Army Corps in the Eastern Front in 1943.

Czechoslovakia along with the United Kingdom and France attempted to resolve German irredentist claims to the Sudetenland region in 1938 with the Munich Agreement, however in March 1939, Czechoslovakia was invaded by Germany and partitioned between Germany, Hungary, and a German client state of Slovakia. The Czechoslovak government - in - exile joined the Allies, the occupation and partition of Czechoslovakia amongst the Axis powers was not accepted by the Allied powers. Czechoslovakian military units took part in the war.

4 – 4 – Greece

Greece was invaded by Italy in 1940 and subsequently joined the Allies. The Greek Army managed to reverse the Italian offensive from Italy's protectorate of Albania, and Greek forces pushed Italian forces back into Albania. However after German intervention, German forces managed to occupy Greece. The Greek government went into exile. Axis forces were expelled from Greece by 1944.

4 – 5 – Korea

Korean soldiers of the Korean Liberation Army.

Since 1919, Korea had been occupied by Japan. The Provisional Government of the Republic of Korea operated in exile in China. The Provisional Government declared war on Japan and Germany on 9 December 1941. The Korean Liberation Army fought alongside Chinese forces against Japan during the war.

4 – 6 – Mexico

Mexico declared war on Germany in 1942 after German submarines attacked the Mexican oil tankers *Potrero del Llano* and *Faja de Oro* that were transporting crude oil to the United States. These attacks prompted President Manuel Ávila Camacho to declare war on the Axis powers.

Mexico formed Escuadrón 201 fighter squadron as part of the Fuerza Aérea Expedicionaria Mexicana (FAEM — "Mexican Expeditionary Air Force") . The squadron was attached to the 58th Fighter Group of the United States Army Air Forces and carried out tactical air support missions during the liberation of the main Philippine island of Luzon in the summer of 1945.

Some 300,000 Mexican citizens went to the United States to work in factories that produced war supplies and to help in any way that would benefit the Allies. Around 15,000 US nationals of Mexican origin and Mexican residents in the US enrolled in the US Armed Forces and fought in various fronts around the world.

4 – 7 – Yugoslavia

Yugoslavia entered the war on the Allied side after invasion by the Axis powers in 1941. The country was occupied, with the anti-Axis resistance movement split between the royalist Chetniks and the communist Yugoslav Partisans of Josip Broz Tito who fought against each other during the war. The Yugoslav Partisans managed to put up considerable resistance to the Axis occupation, forming various liberated territories during the war. In 1944, the leading Allied powers persuaded Tito's Yugoslav Partisans and the royalist Yugoslav government led by Prime Minister Ivan Šubašić to sign the Treaty of Vis that created Democratic Federal Yugoslavia.

4 – 7 - 1 – Factions

4 – 7 - 1 - 1 – Partisans

Partisan leader Josip Broz Tito (right) with Partisans in 1944.

The Partisans were a major Yugoslav resistance movement against the Axis occupation and partition of Yugoslavia. Initially the Partisans were in rivalry with the Chetniks over control of the resistance movement. However the Partisans were recognized by both the Eastern and Western Allies as the primary resistance movement in 1943.

4 – 7 - 1 - 2 – Chetniks

Chetnik leader Draža Mihailović conferring with Chetniks. The Chetniks initially were recognized as an Allied resistance movement however after collaborating with the Axis to destroy the Partisans, both Eastern and Western Allies recognized the Partisans as the primary resistance movement.

The Chetniks, the short name given to the movement titled the Yugoslav Army of the Fatherland, were initially a major Allied Yugoslav resistance movement, however due to their royalist and anti-communist views, Chetniks began collaborating with the Axis as a tactical move to focus on destroying their Partisan rivals. The Chetniks presented themselves as a Yugoslav movement, but were primarily a Serb movement.

5 - Major co - belligerent state combatants

5 – 1 – Italy

The dead bodies of Benito Mussolini, his mistress, and several Fascist leaders, hanging for public display after they were executed by Italian partisans in 1945.

Italy initially had been a leading member of the Axis powers, however after facing multiple military losses including the loss of all of Italy's colonies to advancing Allied forces, *Duce* Benito Mussolini was deposed and arrested in July 1943 by order of King Victor Emmanuel III of Italy in co - operation with members of the Grand Council of Fascism who viewed Mussolini as having led Italy to ruin by allying with Germany in the war. Victor Emmanuel III dismantled the remaining apparatus of the Fascist regime and appointed Field Marshall Pietro Badoglio as Prime Minister of Italy. On 8 September 1943, Italy signed the Armistice of Cassibile with the Allies, ending Italy's war with the Allies and ending Italy's participation with the Axis powers. Expecting immediate German retaliation, Victor Emmanuel III and the Italian government relocated to southern Italy under Allied control. Germany viewed the Italian government's actions as an act of betrayal, and German forces immediately occupied all Italian territories outside of Allied control.

Italy became a co - belligerent of the Allies, and the Italian Co-Belligerent Army was created to fight against the German occupation of Italy. Italy also descended into civil war after the deposition and arrest of Mussolini, with Fascists loyal to Mussolini allying with German forces against the Italian government. German forces rescued Mussolini from arrest and he was placed in charge of a German puppet state known as the Italian Social Republic (RSI).

6 - Client states

6 – 1 – Soviet

6 – 1 – 1 - Albania (Hoxha regime)

In 1944, after Soviet forces entered Albania, a communist regime was established that was led by Enver Hoxha.

6 – 1 – 2 – Bulgaria

Bulgaria had been a member of the Axis powers from 1941 to 1944, but abandoned the Axis and joined the Allies upon facing invasion by the Soviet Union.

6 – 1 – 3 – Mongolia

Mongolia fought against Japan during Battles of Khalkhin Gol in 1939 and the Soviet – Japanese War in August 1945 to protect its independence and to liberate Southern Mongolia from Japan and China. Mongolia had been a Soviet sphere of influence since the 1920s.

6 – 1 – 4 - Poland (Gomułka regime)

Soldiers of the Polish Second Army in the area of Nysa Łuzycka River after fording it in April 1945.

By 1944 Poland entered the Soviet sphere of influence with Władysław Gomułka forming a communist government. Polish forces fought alongside Soviet forces against Germany.

6 – 1 – 5 – Romania

Romania had initially been a member of the Axis powers but switched allegiance upon facing invasion by the Soviet Union. In a radio broadcast to the Romanian people and army on the night of 23 August 1944 King Michael issued a cease-fire,[42] proclaimed Romania's loyalty to the Allies, announced the acceptance of an armistice (to be signed on September 12) offered by Great Britain, the United States, and the USSR, and declared war on Germany.[44]

The coup accelerated the Red Army's advance into Romania, but did not avert a rapid Soviet occupation and capture of about 130,000 Romanian soldiers, who were transported to the Soviet Union where many perished in prison camps. The armistice was signed three weeks later on 12 September 1944, on terms virtually dictated by the Soviet Union. Under the terms of the armistice, Romania announced its unconditional surrender to the USSR and was placed under occupation of the Allied forces with the Soviet Union as their representative, in control of media, communication, post, and civil administration behind the front.

6 – 1 – 6 - Tannu Tuva

Tannu Tuva was a partially recognized state founded from the former Tuvan protectorate of Imperial Russia. It was a client state of the Soviet Union and was annexed into the Soviet Union in 1944.

6 – 2 – British

6 – 2 – 1 – Egypt

The Kingdom of Egypt was nominally an independent state since 1922 but effectively remained in a British sphere of influence with the British Mediterranean fleet being stationed in Alexandria and British army forces being stationed in the Suez Canal zone. Egypt faced an Axis campaign led by Italian and German forces during the war. Frustration by the UK over Egypt's King Farouk's rule resulted in the Abdeen Palace Incident of 1942 where British army forces surrounded the Abdeen palace, a residence of King Farouk, demanding a new government be established, that nearly forced the abdication of Farouk until he submitted to British demands.

7 - United Nations

7 – 1 – Declaration by United Nations

The alliance was formalized in the *Declaration by United Nations* on 1 January 1942. There were 26 signatories:

Australia
Belgium
British India
Canada

China
Costa Rica
Cuba
Czechoslovakia
Dominican Republic
El Salvador
Greece
Guatemala
Haiti
Honduras
Luxembourg
Netherlands
New Zealand
Nicaragua
Norway
Panama
Poland
Soviet Union
South Africa
United Kingdom
United States of America
Yugoslavia

7 – 2 - Alliance growing

The United Nations began growing immediately after their formation. In 1942, Mexico, the Philippines and Ethiopia adhered to the declaration. The African nation had been restored in its independence by British forces after the Italian defeat on Amba Alagi in 1941, while the Philippines, still dependent on Washington but granted international diplomatic recognition, was allowed to join on 10 June despite their occupation by Japan.

During 1943, the Declaration was signed by Iraq, Iran, Brazil, Bolivia and Colombia. A Tripartite Treaty of Alliance with Britain and USSR formalized Iran's assistance to the Allies . In Rio de Janeiro, Brazilian dictator Getúlio Vargas was considered near to fascist ideas, but realistically joined the United Nations after their evident successes.

In 1944, Liberia and France signed. The French situation was very confused. Free France forces were recognized only by Britain, while United States considered Vichy France as the legal government of the country until Operation Over lord, also preparing US occupation francs. Winston Churchill urged Roosevelt restoring France in its status of a major Power after the liberation of Paris in August 1944: the Prime Minister feared that after the war, Britain could remain the sole great Power in Europe facing Communist threat, as it was in 1941 against Nazism.

During the early part of 1945, Peru, Chile, Paraguay, Venezuela, Uruguay, Turkey, Egypt, Saudi Arabia, Lebanon, Syria (these latter two French colonies had been declared independent nations by British occupation troops, despite big protests by Petain before, and De Gaulle after) and Ecuador became signatories. Ukraine and Belarus, which were not independent nations but parts of the Soviet Union, were accepted as members of the United Nations as way to provide greater influence to Stalin, who had only Yugoslavia as a communist partner in the alliance.

7 – 3 - Charter of the United Nations

The Charter of the United Nations was agreed to during the war at the United Nations Conference on International Organization, held between April and July 1945. The Charter was signed by 50 nations on 26 June (Poland had its place reserved and later became the 51st "original" signatory), and was formally ratified shortly after the war on 24 October 1945. The four leading Allied nations, namely China, the Soviet Union, the United Kingdom, and the United States met repeatedly during the war, such as at the 1944 conference at Dumbarton Oaks where the formation and permanent seats of the United Nations Security Council were decided. The Security Council met for the first time in the immediate aftermath of war on 17 January 1946.

The first version of the flag of the United Nations, introduced in April 1945

hese are the original 51 signatories (Security Council Permanent members are asterisked):

Argentine Republic
Commonwealth of Australia
Kingdom of Belgium
Republic of Bolivia
Republic of the United States of Brazil
Byelorussian Soviet Socialist Republic
Dominion of Canada
Republic of Chile
Republic of China*
Republic of Colombia
Republic of Costa Rica
Republic of Cuba
Czechoslovakia
Kingdom of Denmark
Dominican Republic
Republic of Ecuador
Kingdom of Egypt
Republic of El Salvador
Imperial State of Ethiopia
French Republic*
Kingdom of Greece
Imperial Kingdom of Iran
Kingdom of Iraq
Lebanese Republic
Republic of Liberia
Grand Duchy of Luxembourg
United Mexican States
Kingdom of the Netherlands
Dominion of New Zealand
Republic of Nicaragua
Kingdom of Norway
Republic of Panama
Republic of Paraguay
Republic of Peru
Commonwealth of the Philippines
Republic of Poland
Kingdom of Saudi Arabia
Union of South Africa
Syrian Republic
Republic of Turkey
Ukrainian Soviet Socialist Republic
Union of Soviet Socialist Republics*
United Kingdom of Great Britain and Northern Ireland*
United States of America*

Republic of Guatemala
Republic of Haiti
Republic of Honduras
Indian Empire
Oriental Republic of Uruguay
United States of Venezuela Democratic
Federal Yugoslavia

8 - Summary of United Nations members' joining the war on Axis Powers

8 – 1 - After the German invasion of Poland

September 1939

Poland: 1 September 1939
Australia: 3 September 1939
France: 3 September 1939 [48]
New Zealand: 3 September 1939
United Kingdom: 3 September 1939
British India: 3 September 1939 (automatically effected by the UK declaration of war)
Kingdom of Nepal: 4 September 1939
Union of South Africa: 6 September 1939
Canada: 10 September 1939

April 1940

Denmark: 9 April 1940
Norway: 9 April 1940

8 – 2 - After the Phoney War

Belgium: 10 May 1940
Luxembourg: 10 May 1940
Netherlands: 10 May 1940
Greece: 28 October 1940
Yugoslavia: 6 April 1941[53]

8 – 3 - After the invasion of the USSR

Soviet Union: 22 June 1941
Ukrainian SSR: 22 June 1941 [54]
Byelorussian SSR: 22 June 1941

8 – 4 - After the attack on Pearl Harbor

United States of America: 7 December 1941
Commonwealth of the Philippines: 8 December 1941[55]

Panama: 7 December 1941
Costa Rica: 8 December 1941
Dominican Republic: 8 December 1941
El Salvador: 8 December 1941
Haiti: 8 December 1941
Honduras: 8 December 1941
Nicaragua: 8 December 1941
China: 9 December 1941[56]
Cuba: 9 December 1941
Guatemala: 9 December 1941
Free Czechoslovak: 16 December 1941[57]

8 – 5 - After the Declaration by United Nations
Mexico: 22 May 1942
Brazil: 22 August 1942
Ethiopia: 14 December 1942[58]
Bolivia: 7 April 1943
Colombia: 26 July 1943
Iran: 9 September 1943[59]
Liberia: 27 January 1944
Peru: 12 February 1944

8 – 6 - After D-Day
Ecuador: 2 February 1945
Paraguay: 7 February 1945
Uruguay: 15 February 1945
Venezuela: 15 February 1945
Turkey: 23 February 1945
Egypt: 24 February 1945
Lebanon: 27 February 1945
Syria: 27 February 1945
Saudi Arabia: 1 March 1945
Finland: 3 March 1945 (effectively from 15 September 1944)
Argentina: 27 March 1945
Chile: 11 April 1945 (only declares war on Japan, participated only sending economic resources)

Amatol

Contents

- Introduction

Amatol is a highly explosive material made from a mixture of TNT and ammonium nitrate. The British name originates from the words ammonium and toluene (a raw material of TNT). Similar mixtures were known as **Schneiderite** in France. Amatol was used extensively during World War I and World War II, typically as an explosive in military weapons such as aircraft bombs, shells, depth charges, and naval mines. It was eventually replaced with alternative explosives such as Composition B , torpex, and tritonal.

2 - Manufacture and use

Amatol exploits synergy between TNT and ammonium nitrate. TNT has higher explosive velocity and brisance, but is deficient in oxygen. Oxygen deficiency causes black smoke residue from a pure TNT explosion. The oxygen surplus of ammonium nitrate increases the energy release of TNT during detonation. Depending on the ratio of ingredients used, amatol leaves a residue of white or grey smoke after detonation. Amatol has a lower explosive velocity and correspondingly lower brisance than TNT but is cheaper to make.

Amatol allowed supplies of TNT to be expanded considerably, with little reduction in the destructive power of the final product, so long as the amount of TNT in the mixture did not fall below 60%. Mixtures containing as little as 20 % TNT were for less demanding uses.

It must be remembered that TNT is 50 % deficient in oxygen. Amatol is oxygen balanced and is therefore more effective than pure TNT when exploding underground or underwater. RDX is also has a negative oxygen balance. Oxygen balanced filaments also have application for nuclear weapons; the Hiroshima bomb used Amatol.

Relatively unsophisticated cannery equipment can be adapted to Amatol production. TNT is gently heated with steam or hot water until it melts, acquiring the physical characteristics of a syrup. Then the correct weight ratio of powdered ammonium nitrate is added and mixed in. Whilst this mixture is still in a molten state, it is poured into empty bomb casings and allowed to cool and solidify. However, the lowest grades of amatol could not be produced by casting molten TNT. Instead, flaked TNT was thoroughly mixed with powdered ammonium nitrate and then compressed or extruded.

The colour of amatol ranges from off - white to slightly yellow or pinkish brown, depending on the mixture used and remains soft for long periods of storage. It is also hygroscopic, which complicates long-term storage. To prevent moisture problems, amatol charges were coated with a thin layer of pure molten TNT or alternatively bitumen. Long-term storage was rare during wars because munitions charged with amatol were generally used soon after manufacture.

Amatol should not be stored in containers made from copper or brass, as it can form unstable compounds sensitive to vibration. Pressed, it is relatively insensitive but may be detonated by severe impact, whereas when cast, it is extremely insensitive. Primary explosives such as mercury fulminate were often used as a detonator, in combination with an explosive booster charge such as tetryl.

The explosive charges hidden in HMS *Campbeltown* during the St. Nazaire Raid of 1942 contained amatol. The British X class midget submarines which planted explosive charges beneath the German battleship *Tirpitz* in September 1943 used two "saddle charges" containing four tons of amatol. Warheads for the German V-1 flying bomb and V-2 rockets also contained amatol.

A derivative of amatol is amatex, consisting of 51% ammonium nitrate, 40 % TNT, and 9 % RDX.

3 - Ammonite

Amatol is rare today, except in legacy munitions or unexploded ordnance. A form of amatol exists under a different name —

ammonite. Ammonite is a civilian explosive, generally comprising a 20 / 80 mixture of TNT and ammonium nitrate. Typically, it is used for quarrying or mining purposes. It is a popular civilian explosive in Eastern Europe and China.

Because the proportion of TNT is significantly lower than in its military counterpart, ammonite has much less destructive power; given ammonite's use, this is not a problem. In general, a 30 kilogram charge of ammonite is roughly equivalent to 20 kilograms of TNT.

4 – Amatol , the town

Amatol was the name given to a munitions factory and planned community built by the United States government in Mullica Township, New Jersey during the First World War

American Champion Scout

Scout on (non-standard) tundra tires.

8GCBC Scout	
Role	Light utility aircraft
Manufacturer	American Champion Aircraft
Designer	Bellanca
Introduction	1974
Number built	more than 500, as of 2008

Contents

1 - Introduction

The **8GCBC Scout** is a two - seat, high-wing, single - engine fixed conventional gear general aviation airplane that entered production in the United States in 1974. Designed for personal and commercial use, it is commonly found in utility roles such as bush flying—thanks to its short take off and landing (STOL) ability—as well as agriculture, pipeline patrol, and glider and banner towing.

2 - Production history

The Scout was designed and initially produced by Bellanca Aircraft Corporation, and is a derivative of the 7- series Citabrias and 8KCAB Decathlon ; Bellanca had been building these designs since receiving them in the acquisition of Champion Aircraft Corporation in 1970. The Scout is one of two wholly Bellanca-developed contributions to these aircraft series, and is also one of only two airplanes Bellanca produced in the 7 and 8 series not certified for aerobatics. (The other model, in both categories, is the 7ACA.) The Scout carries the model designation 8GCBC, which makes it both a sibling of the 8KCAB Decathlon and descendent of the 7GCBC Citabria. Bellanca produced more than 350 Scouts before production ended when the company's assets were liquidated in 1981.

The Scout design passed through the hands of a number of companies through the 1980s, including a Champion Aircraft Company, which was unrelated to the Champion Aircraft of the 1960s. In that period, only one Scout was built, in 1984. American Champion Aircraft Corporation acquired the Scout design, along with the Decathlon and the group of Citabria and Champ variants, in 1990 and brought the Scout back into production in 1993.

3 - Design

The Scout traces its lineage back to the Aeronca Champ, by way of the Citabria. Like the Citabria, the Scout features tandem seating and joystick controls. The fuselage and tail surfaces are constructed of welded metal tubing. The outer shape of the fuselage is created by a combination of wooden formers and longerons, covered with fabric. The cross - section of the metal fuselage truss is triangular, a design feature traceable to the earliest Aeronca C-2 design of the late 1920s.

The strut-braced wings of the Scout are, like the fuselage and tail surfaces, fabric covered, utilizing aluminum ribs. The wings of Bellanca Scouts were built with wooden spars. American Champion has been using aluminum spars in the aircraft it has produced and has, as well, made the aluminum - spar wings available for retrofit installation on older aircraft. Compared to the Citabria's wingspan of 10.2 m , the Scout's wingspan is significantly longer, at over 11 m . The Scout also carries wing flaps, a design feature it shares with the 7GCBC variant of the Citabria. The added wing area and the flaps contribute to the Scout's STOL abilities and its capacity as a utility aircraft.

The landing gear of the Scout is in a conventional arrangement. The main gear legs of most Scouts are made of spring steel, though American Champion began to use aluminum gear legs in 2004. Compared to the Citabria's gear, the Scout's gear legs are considerably taller and the tires larger, again contributing to its capabilities as a utility aircraft.

Bellanca made the Scout available with several Lycoming O-360 engine variants, all of 180 horse power (134 kW), and with the choice of a fixed-pitch or constant speed propeller. American Champion's Scouts feature the Lycoming O-360-C1G and a choice of a two-blade constant speed propeller (standard) or a three-blade constant speed propeller (as an option).

4 - Operational history

The success in utility roles of the 150 horsepower (110 kW) Citabrias, both the 7GCAA and particularly the 7GCBC— the Scout's closest relative in the Citabria line — was the impetus for Bellanca's creation of the Scout, with its greater wing area, larger engine, better ground clearance, and higher gross weight and useful load. Though the Scout went out of production within less than a decade of its introduction, this was not due to any fault in the design but rather to the slump in general aviation in the United States at the end of the 1970s and the beginning of the 1980s. Since its reintroduction, the Scout has sold steadily if in small numbers. Scouts remain popular as bush planes — including versions fitted with floats or skis — , for glider and banner towing, for pipeline patrol, in agricultural uses, and as personal aircraft. The largest single operator of the type is Western Australia's Department of Environment and Conservation (DEC), who operate a fleet of ten aircraft in the fire surveillance and Forward Air Control (FAC) roles. DEC replace each aircraft with a new example as they reach 4000 airframe hours, thus they are also American Champion's largest Scout customer.

4 – 1 - Wood spar Airworthiness Directive

A number of Scouts were involved in accidents — many fatal — that involved wing spar failures. More than a few of these accidents involved aerobatics, maneuvers the aircraft was neither designed nor approved for. (The Scout suffered, in this respect, from a close resemblance to the Citabria line of aircraft, all of which are capable of aerobatics. To some pilots, the similar appearance suggested similar ability.) Other cases of spar failure occurred during normal operations, such as banner towing. The failures occurred during high-stress portions of the flights, but under stresses the design should have withstood. Typically, investigations found that these failures during normal operation had been preceded by undetected overstressing conditions from flight outside the aircraft's limitations (such as aerobatics) or accidents where the wings contacted the ground (including ground loops and nose-overs in which the airplane ended up on its back).

This series of failures led the Federal Aviation Administration to issue an Airworthiness Directive (AD 2000-25-02 R1) that affected all wood-spar wing Scouts. The AD called for immediate and thorough inspections of the wing spars of any Scouts involved in accidents. Further, the AD mandates meticulous yearly inspections for all Scouts with wood-spar wings. Scouts built by American Champion, as well as those retrofitted with the factory metal-spar wings, are exempt from the AD's inspection requirements.

5 - Specifications (2006 8GCBC Scout)

General characteristics

Crew: one pilot
Capacity: one passenger
Length: 7 m
Wingspan: 11 m
Height: 2.9 m
Wing area: 16.7 m²
Airfoil: NACA 4412
Empty weight: 635 kg
Loaded weight: 975 kg
Useful load: 340 kg
Max. takeoff weight: 975 kg
Power plant : 1 × Lycoming O-360-C1G, 180 hp (134.2 kW)

Performance

Never exceed speed: 260.7 km / h
Maximum speed: 225.3 km / h
Cruise speed: 180.2 km / h (at 55 % power)
Stall speed:
Clean: 86.9 km / h
With full flaps: 78.9 km / h
Range: 684 km,
Service ceiling: 5,181.6 m
Rate of climb: 5.46 m / s
Wing loading: 58.4 kg / m²
Power / mass: 7.3 kg / kW

American Civil Liberties Union

American Civil Liberties Union	
Motto	Because Freedom Can't Protect Itself
Predecessor	National Civil Liberties Bureau
Formation	1920
Type	Non-profit corporation
Purpose/focus	Civil liberties advocacy
Headquarters	New York City
Region served	United States
Membership	500,000 members[1]
President	Susan Herman
Executive Director	Anthony Romero
Budget	$106M (2011; excludes affiliates)
Staff	100 attorneys (2011; excludes affiliates)
Volunteers	2,000 attorneys
Website	aclu.org

Contents

1- Introduction

The **American Civil Liberties Union** (**ACLU**) is a nonpartisan non-profit organization whose stated mission is "to defend and preserve the individual rights and liberties guaranteed to every person in this country by the Constitution and laws of the United States."[5] It works through litigation, lobbying, and community education. Founded in 1920 by Roger Baldwin, Crystal Eastman, Helen Keller, and Walter Nelles, the ACLU has over 500,000 members and has an annual budget over $ 100 million. Local affiliates of the ACLU are active in all 50 states and Puerto Rico. The ACLU provides legal assistance in cases when it considers civil liberties to be at risk. Legal support from the ACLU can take the form of direct legal representation, or preparation of *amicus curiae* briefs expressing legal arguments (when another law firm is already providing representation) .

When the ACLU was founded in 1920, its focus was on freedom of speech, primarily for anti-war protesters. During the 1920s, the ACLU expanded its scope to include protecting the free speech rights of artists and striking workers, and working with the National Association for the Advancement of Colored People (NAACP) to combat racism and discrimination. During the 1930s, the ACLU started to engage in work combating police misconduct and for Native American rights. Most of the ACLU's cases came from the Communist party and Jehovah's Witnesses. In 1940, the ACLU leadership was caught up in the Red Scare, and voted to exclude Communists from its leadership positions. During World War II, the ACLU defended Japanese-American citizens, unsuccessfully trying to prevent their forcible relocation to internment camps. During the Cold War, the ACLU headquarters was dominated by anti - communists, but many local affiliates defended members of the Communist Party.

By 1964, membership had risen to 80,000, and the ACLU participated in efforts to expand civil liberties. In the 1960s, the ACLU continued its decades-long effort to enforce separation of church and state. It defended several anti-war activists during the Vietnam War. The ACLU was involved in the *Miranda* case, which addressed misconduct by police during interrogations; and in the *New York Times* case, which established new protections for newspapers reporting on government activities. In the 1970s and 1980s, the ACLU ventured into new legal areas, defending homosexuals, students, prisoners, and the poor. In the twenty-first century, the ACLU has fought the teaching of creationism in public schools and challenged some provisions of anti-terrorism legislation as infringing on privacy and civil liberties.

In addition to representing persons and organizations in lawsuits, the ACLU lobbies for policies that have been established by its board of directors. Current positions of the ACLU include: opposing the death penalty; supporting same-sex marriage and the right of gays to adopt; supporting birth control and abortion rights; eliminating discrimination against women, minorities, and homosexuals; supporting the rights of prisoners and opposing torture; supporting the right of religious persons to practice their faiths without government interference; and opposing government preference for religion over non-religion, or for particular faiths over others.

2 – Organization

2 – 1 – Leadership

The ACLU is led by an executive director and a president, Anthony Romero and Susan Herman, respectively, in 2011. The president acts as chairman of the ACLU's board of directors, leads fundraising, and facilitates policy - setting. The executive director manages the day-to-day operations of the organization.[6][7] The board of directors consists of 80 persons, including representatives from each state affiliate, as well as at-large delegates.

The leadership of the ACLU does not always agree on policy decisions; differences of opinion within the ACLU leadership have sometimes grown into major debates. In 1937, an internal debate erupted over whether to defend Henry Ford's right to distribute anti-union literature. In 1939, a heated debate took place over whether to prohibit communists from serving in ACLU leadership roles. During the early 1950s the board was divided on whether to defend communists persecuted under McCarthyism.[10] In 1968, a schism formed over whether to represent Dr. Spock's anti-war activism . In 1973, there was internal conflict over whether to call for the impeachment of Richard Nixon . In 2005, there was internal conflict about whether or not a gag rule should be imposed on ACLU employees to prevent publication of internal disputes.

2 – 2 – Funding

The ACLU consists of two separate non-profit organizations: the ACLU, and the ACLU Foundation. Both organizations engage in litigation, advocacy of civil rights, and education. The ACLU is a 501(c)(4) corporation which also engages in political lobbying, and donations to that component of the ACLU are not tax deductible. The ACLU Foundation is a 501(c)(3) non-profit corporation, which does not engage in lobbying, and donations to it are tax deductible.

In 2011, the ACLU and the ACLU Foundation had a combined income of $ 109 million, originating from grants (60%), membership donations (23 %) , and bequests (17 %) . Membership dues account for $25 million per year and are treated as donations; members choose the amount they pay annually, averaging $50 per member per year.[15] In 2011, the combined expenses of the ACLU and ACLU Foundation were $106 million, spent on Programs (88 %) , management (7 %), and fundraising (5 %). The ACLU Foundation accounts for about 75 % of the combined budget, and the ACLU about 25 %.

The ACLU solicits donations to its charitable foundation. The ACLU is accredited by the Better Business Bureau, and the Charity Navigator has ranked the ACLU with a four-star rating. The local affiliates also solicit their own funding, and some receive funds from the national ACLU. The distribution and amount of funding for state affiliates varies from state to state. Smaller affiliates with fewer resources, such as that in Nebraska, receive subsidies from the national ACLU.

In October 2004, the ACLU rejected $1.5 million from both the Ford Foundation and Rockefeller Foundation because the Foundations had adopted language from the USA PATRIOT Act in their donation agreements, including a clause stipulating that none of the money would go to "underwriting terrorism or other unacceptable activities." The ACLU views this clause, both in Federal law and in the donors' agreements, as a threat to civil liberties, saying it is overly broad and ambiguous.

Due to the nature of its legal work, the ACLU is often involved in litigation against governmental bodies, which are generally protected from adverse monetary judgments; a town, state or federal agency may be required to change its laws or behave differently, but not to pay monetary damages except by an explicit statutory waiver. In some cases, the law permits plaintiffs who successfully sue government agencies to collect money damages or other monetary relief. In particular, the Civil Rights Attorney's Fees Award Act of 1976 leaves the government liable in some civil rights cases. Fee awards under this civil rights statute are considered "equitable relief" rather than damages, and government entities are not immune from equitable relief. Under laws such as this, the ACLU and its state affiliates sometimes share in monetary judgments against government agencies. In 2006, the Public Expressions of Religion Protection Act sought to prevent monetary judgments in the particular case of violations of church-state separation.

The ACLU has received court awarded fees from opponents, for example, the Georgia affiliate was awarded $150,000 in fees after suing a county demanding the removal of a Ten Commandments display from its courthouse; a second Ten Commandments case in the State, in a different county, led to a $ 74,462 judgment. The State of Tennessee was required to pay $ 50,000, the State of Alabama $175,000, and the State of Kentucky $ 121,500, in similar Ten Commandments cases.

2 – 3 - State affiliates

Most of the organization's workload is performed by the 53 local affiliates. There is an affiliate in each state and in Puerto Rico. California has three affiliates. The affiliates operate autonomously from the national organization; each affiliate has its own staff, executive director, board of directors, and budget. Each affiliate consists of two non-profit corporations: a 501(c) corporation that does not perform lobbying, and a 501(c) corporation which is entitled to lobby.

ACLU affiliates are the basic unit of the ACLU's organization and engage in litigation, lobbying, and public education. For example, in a twenty-month period beginning January 2004, the ACLU's New Jersey chapter was involved in fifty - one cases according to their annual report — thirty-five cases in state courts, and sixteen in federal court. They provided legal representation in thirty-three of those cases, and served as amicus in the remaining eighteen. They listed forty-four volunteer attorneys who assisted them in those cases.

2 – 4 – Positions

The ACLU's official position statements, as of January 2012, included the following policies :

Affirmative action – The ACLU supports affirmative action.

Birth control and abortion – The ACLU supports the right to abortion, as established in the *Roe v. Wade* decision. The ACLU believes that everyone should have affordable access to the full range of contraceptive options. The ACLU's Reproductive Freedom Project manages efforts related to reproductive rights.

Criminal law reform – The ACLU seeks an end to excessively harsh sentences that it feels "stand in the way of a just and equal society". The ACLU's Criminal Law Reform Project focuses on this issue.

Death penalty – The ACLU is opposed to the death penalty in all circumstances. The ACLU's Capital Punishment Project focuses on this issue.

Free speech – The ACLU supports free speech, including the right to express unpopular ideas, such as flag desecration.

Campaign funding – The ACLU believes that the current system is badly flawed, and supports a system based on public funding. The ACLU supports full transparency to identify donors. However, the ACLU opposes attempts to control political spending. The ACLU supported the Supreme Court's decision in *Citizens United*, which allowed corporations and unions more political speech rights.

Gun rights – The national ACLU's position is that the Second Amendment protects a collective right to own guns, rather than an individual right (some state affiliates consider the Second Amendment to refer to individual gun rights). The national organization's position is based on the phrases "a well regulated Militia" and "the security of a free State". However, the ACLU opposes any effort to create a registry of gun owners and has worked with the National Rifle Association to prevent a registry from being created and has favored protecting the right to carry guns under the 4th Amendment.

HIV / AIDS – The policy of the ACLU is to "create a world in which discrimination based on HIV status has ended, people with HIV have control over their medical information and care, and where the government’s HIV policy promotes public health and respect and compassion for people living with HIV and AIDS." This effort is managed by the ACLU's AIDS Project .

Human rights – The ACLU's Human Rights project advocates (primarily in an international context) for children's rights, immigrants rights, gay rights, and other international obligations.

Immigrants' rights – The ACLU supports civil liberties for immigrants to the United States.

Lesbian, gay, bisexual and transgender rights – The ACLU's LGBT Rights Project supports equal rights for all gays and lesbians, and works to eliminate discrimination. The ACLU supports equal employment, housing, civil marriage and adoption rights for LGBT couples.

National security – The ACLU is opposed to compromising civil liberties in the name of national security. In this context, the ACLU has condemned government use of spying, indefinite detention without charge or trial, and government-sponsored torture. This effort is led by the ACLU's National Security Project.

Prisoners' rights – The ACLU's National Prison Project believes that incarceration should only be used as a last resort, and that prisons should focus on rehabilitation. The ACLU works to ensure that prisons treat prisoners in accordance with the Constitution and domestic law.

Single Sex Public Education - The ACLU opposes single sex public education options. It believes that single-sex education contributes to gender stereotyping and compares single-sex education to racial segregation.

Privacy and technology – The ACLU's Project on Speech, Privacy, and Technology promotes "responsible uses of technology that enhance privacy protection", and opposes uses "that undermine our freedoms and move us closer to a surveillance society".[45]

Child Pornography - The ACLU believes that production of child pornography should be illegal, but that possessing it is protected by the right to privacy. "Our policy is that possessing even pornographic material about children should not itself be a crime. The way to deal with this issue is to prosecute the makers of child pornography for exploiting minors." The ACLU also considers virtual child pornography to be Constitutionally protected.

Racial issues – The ACLU's Racial Justice Program combats racial discrimination in all aspects of society, including the educational system, justice system, and the application of the death penalty.

Religion – The ACLU supports the right of religious persons to practice their faiths without government interference. The ACLU believes the government should neither prefer religion over non-religion, nor favor particular faiths over others. The ACLU is opposed to school-led prayer, but protects students' right to pray in school.

Voting rights – The ACLU believes that impediments to voting should be eliminated, particularly if they disproportionately impact minority or poor citizens. The ACLU believes that misdemeanor convictions should not lead to a loss of voting rights. The ACLU's Voting Rights Project leads this effort.

Women's rights – The ACLU works to eliminate discrimination against women in all realms. The ACLU encourages government to be proactive in stopping violence against women. These efforts are led by the ACLU's Women's Rights project.

2 – 5 - Support and opposition

The ACLU is supported by a variety of persons and organizations. There were over 500,000 members in 2011, and the ACLU annually receives thousands of grants from hundreds of charitable foundations. Allies of the ACLU in legal actions have included the National Association for the Advancement of Colored People, the American Jewish Congress, People For the American Way, the National Rifle Association, the Electronic Frontier Foundation, Americans United for Separation of Church and State, and the National Organization for Women.

The ACLU has been criticized by liberals, such as when it excluded communists from its leadership ranks, when it defended Neo-Nazis, when it declined to defend Paul Robeson, or when it opposed the passage of the National Labor Relations Act.[51][52] Conversely, it has been criticized by conservatives, such as when it argued against official prayer in public schools, or when it opposed the Patriot Act. The ACLU has supported conservative figures such as Rush Limbaugh, George Wallace, Henry Ford, and Oliver North; and it has supported liberal figures such as Dick Gregory, H. L. Mencken, Rockwell Kent, and Dr. Benjamin Spock.

A major source of criticism are legal cases in which the ACLU represents an individual or organization that promotes offensive or unpopular viewpoints, such as the Ku Klux Klan, Neo-Nazis, Nation of Islam, North American Man/Boy Love Association, or Westboro Baptist Church. The ACLU responded to these criticisms by stating "It is easy to defend freedom of speech when the message is something many people find at least reasonable. But the defense of freedom of speech is most critical when the message is one most people find repulsive."

3 - Early years

3 – 1 - CLB era

The ACLU developed from the National Civil Liberties Bureau (CLB), co - founded in 1917 during the Great War by Crystal Eastman, an attorney activist, and Roger Nash Baldwin . The focus of the CLB was on freedom of speech, primarily anti - war speech, and on supporting conscientious objectors who did not want to serve in World War I.

Three United States Supreme Court decisions in 1919 each upheld convictions under laws against certain kinds of anti-war speech. In 1919, the Court upheld the conviction of Socialist Party leader Charles Schenck for publishing anti - war literature.[64] In *Debs v. United States*, the court upheld the conviction of Eugene Debs. While the Court upheld a conviction a third time in *Abrams v. United States*, Justice Oliver Wendell Holmes wrote an important dissent which has gradually been absorbed as an American principle: he urged the court to treat freedom of speech as a fundamental right, which should rarely be restricted.

In 1918 Crystal Eastman resigned from the organization due to health issues.[66] After assuming sole leader ship of the CLB, Baldwin insisted that the organization be reorganized. He wanted to change its focus from litigation to direct action and public education.

The CLB directors concurred, and on January 19, 1920, they formed an organization under a new name, the American Civil Liberties Union . Although a handful of other organizations in the United States at that time focused on civil rights, such as the National Association for the Advancement of Colored People (NAACP) and Anti-Defamation League (ADL), the ACLU was the first that did not represent a particular group of persons, or a single theme.[67] Like the CLB, the NAACP pursued litigation to work on civil rights, including efforts to overturn the disfranchisement of African Americans in the South that had taken place since the turn of the century.

During the first decades of the ACLU, Baldwin continued as its leader. His charisma and energy attracted many supporters to the ACLU board and leadership ranks . Baldwin was ascetic, wearing hand - me - down clothes, pinching pennies, and living on a very small salary. The ACLU was directed by an executive committee, but it was not particularly democratic or egalitarian. The ACLU's base in New York resulted in its being dominated by people from the city and state. Most ACLU funding came from philanthropies, such as the Garland Fund.

3 – 2 - Free speech era

In the 1920s, government censorship was commonplace. Magazines were routinely confiscated under the anti-obscenity Comstock laws; permits for labor rallies were often denied; and virtually all anti - war or anti-government literature was outlawed.[71] Right-wing conservatives wielded vast amounts of power, and activists that promoted unionization, socialism, or government reform were often denounced as un - American or unpatriotic. In one typical instance in 1923, author Upton Sinclair was arrested for trying to read the First Amendment during an Industrial Workers of the World rally.

ACLU leadership was divided on how to challenge the civil rights violations. One faction, including Baldwin, Arthur Garfield Hays and Norman Thomas, believed that direct, militant action was the best path. Hays was the first of many successful attorneys that relinquished their private practices to work for the ACLU.[73] Another group, including Walter Nelles and Walter Pollak felt that lawsuits taken to the Supreme Court were the best way to achieve change.[73] Both groups worked in tandem, but equally worshipped the Bill of Rights and the US Constitution.

During the 1920s, the ACLU's primary focus was on freedom of speech in general, and speech within the labor movement particularly.[74] Because most of the ACLU's efforts were associated with the labor movement, the ACLU itself came under heavy attack from conservative groups, such as the American Legion, the National Civic Federation, and Industrial Defense Association and the Allied Patriotic Societies.

In addition to labor, the ACLU also led efforts in non-labor arenas, for example, promoting free speech in public schools.[76] The ACLU itself was banned from speaking in New York public schools in 1921.[77] The ACLU, working with the NAACP, also supported racial discrimination cases . The ACLU defended free speech regardless of the opinions being espoused. For example, the reactionary, anti - Catholic, anti - black Ku Klux Klan (KKK) was a frequent target of ACLU efforts, but the ACLU defended the KKK's right to hold meetings in 1923. There were some civil rights that the ACLU did not make an effort to defend in the 1920s, including censorship of the arts, government search and seizure issues, right to privacy, or wiretapping.

The Communist party of the United States was routinely harassed and oppressed by government officials, leading it to be the primary client of the ACLU. The Communists were very aggressive in their tactics, often engaging in illegal or unethical conduct, and this led to frequent conflicts between the Communists and ACLU. Communist leaders often attacked the ACLU, particularly when the ACLU defended the free speech rights of conservatives. This uneasy relationship between the two groups continued for decades.

3 – 3 - Scopes trial[edit]

When 1925 arrived – five years after the ACLU was formed – the organization had virtually no success to show for its efforts.[82] That changed in 1925, when the ACLU persuaded John T. Scopes to defy Tennessee's anti - evolution law in a court test. Clarence Darrow, a member of the ACLU National Committee, headed Scopes' legal team. The prosecution, led by William Jennings Bryan, contended that the Bible should be interpreted literally in teaching creationism in school. The ACLU lost the case and Scopes was fined $100. The Tennessee Supreme Court later upheld the law but overturned the conviction on a technicality.

The Scopes trial was a phenomenal public relations success for the ACLU.[85] The ACLU became well known across America, and the case led to the first endorsement of the ACLU by a major U.S. newspaper.[86] The ACLU continued to fight for the separation of church and state in schoolrooms, decade after decade, including the 1982 case *McLean v. Arkansas* and the 2005 case *Kitzmiller v. Dover Area School District*.

Baldwin himself was involved in an important free speech victory of the 1920s, after he was arrested for attempting to speak at a rally of striking mill workers in New Jersey. Although the decision was limited to the state of New Jersey, the appeals court's judgement in 1928 declared that constitutional guarantees of free speech must be given "liberal and comprehensive construction", and it marked a major turning point in the civil rights movement, signaling the shift of judicial opinion in favor of civil rights.

The most important ACLU case of the 1920s was *Gitlow v. New York*, in which Benjamin Gitlow was arrested for violating a state law against inciting anarchy and violence, when he distributed literature promoting communism . Although the Supreme Court did not overturn Gitlow's conviction, it adopted the ACLU's stance (later termed the incorporation doctrine) that the First Amendment freedom of speech applied to state laws, as well as federal laws.

3 – 4 - First victories

Leaders of the ACLU were divided on the best tactics to use to promote civil liberties. Felix Frankfurter felt that legislation was the best long-term solution, because the Supreme Court could not (and – in his opinion – should not) mandate liberal interpretations of the Bill of Rights. But Walter Pollack, Morris Ernst, and other leaders felt that Supreme Court decisions were the best path to guarantee civil liberties. A series of Supreme Court decisions in the 1920s foretold a changing national atmosphere ; anti - radical emotions were diminishing, and there was a growing willingness to protect freedom of speech and assembly via court decisions.

3 – 5 - Free speech

Censorship was commonplace in the early 20th century. State laws and city ordinances routinely outlawed speech deemed to be obscene or offensive, and prohibited meetings or literature that promoted unions or labor organization . Starting in 1926, the ACLU began to expand its free speech activities to encompass censorship of art and literature. In that year, H. L. Mencken deliberately broke Boston law by distributing copies of his banned *American Mercury* magazine; the ACLU defended him and won an acquittal.[59] The ACLU went on to win additional victories, including the landmark case *United States v. One Book Called Ulysses* in 1933, which reversed a ban by the Customs Department against the book *Ulysses* by James Joyce. The ACLU only achieved mixed results in the early years, and it was not until 1966 that the Supreme Court finally clarified the obscenity laws in the *Roth v. United States* and *Memoirs v. Massachusetts* cases.

The Comstock laws banned distribution of sex education information, based on the premise that it was obscene and led to promiscuous behavior Mary Ware Dennett was fined $300 in 1928, for distributing a pamphlet containing sex education material. The ACLU, led by Morris Ernst, appealed her conviction and won a reversal, in which judge Learned Hand ruled that the pamphlet's main purpose was to "promote understanding".

The success prompted the ACLU to broaden their freedom of speech efforts beyond labor and political speech, to encompass movies, press, radio and literature. The ACLU formed the National Committee on Freedom from Censorship in 1931 to coordinate this effort.[94] By the early 1930s, censorship in the United States was diminishing.

Two major victories in the 1930s cemented the ACLUs campaign to promote free speech. In *Stromberg v. California*, decided in 1931, the Supreme Court sided with the ACLU and affirmed the right of a communist party member to salute a communist flag. The result was the first time the Supreme Court used the Due Process Clause of the 14th amendment to subject states to the requirements of the First Amendment. In *Near v. Minnesota*, also decided in 1931, the Supreme Court ruled that states may not exercise prior restraint and prevent a newspaper from publishing, simply because the newspaper had a reputation for being scandalous.

4 - 1930s

The late 1930s saw the emergence of a new era of tolerance in the United States. National leaders hailed the Bill of Rights, particularly as it protected minorities, as the essence of democracy.[97] The 1939 Supreme Court decision in *Hague v. Committee for Industrial Organization* affirmed the right of communists to promote their cause. Even conservative elements, such as the American Bar Association began to campaign for civil liberties, which were long considered to be the domain of left - leaning organizations. By 1940, the ACLU had achieved many of the goals it set in the 1920s, and many of its policies were the law of the land.

4 – 1 – Expansion

In 1929, after the Scopes and Dennett victories, Baldwin perceived that there was vast, untapped support for civil liberties in the United States. Baldwin proposed an expansion program for the ACLU, focusing on police brutality, Native American rights, African American rights, censorship in the arts, and international civil liberties. The board of directors approved Baldwin's expansion plan, except for the international efforts.

The ACLU played a major role in passing the 1932 Norris – La Guardia Act, a federal law which prohibited employers from preventing employees from joining unions, and stopped the practice of outlawing strikes, unions, and labor organizing activities with the use of injunctions. The ACLU also played a key role in initiating a nationwide effort to reduce misconduct (such as extracting false confessions) within police departments, by publishing the report *Lawlessness in Law Enforcement* in 1931, under the auspices of Herbert Hoover's Wickersham Commission.[98] In 1934, the ACLU lobbied for the passage of the Indian Reorganization Act, which restored some autonomy to Native American tribes, and established penalties for kidnapping native American children.

Although the ACLU deferred to the NAACP for litigation promoting civil liberties for African Americans, the ACLU did engage in educational efforts, and published *Black Justice* in 1931, a report which documented institutional racism throughout the South, including lack of voting rights, segregation, and discrimination in the justice system. Funded by the Garland Fund, the ACLU also participated in producing the influential Margold Report, which outlined a strategy to fight for civil rights for blacks.[100][101] The ACLU's plan was to demonstrate that the "separate but equal" policies governing the Southern discrimination were illegal because blacks were never, in fact, treated equally.

4 – 2 - Depression era and the New Deal

In 1932 – twelve years after the ACLU was founded – it had achieved significant success; the Supreme Court had embraced the free speech principles espoused by the ACLU, and the general public was becoming more supportive of civil rights in general.[102] But the Great Depression brought new assaults on civil liberties; the year 1930 saw a large increase in the number of free speech prosecutions, a doubling of the number of lynchings, and all meetings of unemployed persons were banned in Philadelphia.

The Franklin D. Roosevelt administration proposed the New Deal to combat the depression. ACLU leaders were of mixed opinions about the New Deal, since many felt that it represented an increase in government intervention into personal affairs, and because the National Recovery Administration suspended anti - trust legislation. Roosevelt was not personally interested in civil rights, but did appoint many civil libertarians to key positions, including Interior Secretary Harold Ickes, a member of the ACLU.

The economic policies of the New Deal leaders were often aligned with ACLU goals, but social goals were not.[105] In particular, movies were subject to a barrage of local ordinances banning screenings that were deemed immoral or obscene.[106] Even public health films portraying pregnancy and birth were banned; as was *Life* magazine's April 11, 1938 issue which included photos of the birth process. The ACLU fought these bans, but did not prevail.

The Catholic Church attained increasing political influence in the 1930s, and used its influence to promote censorship of movies, and to discourage publication of birth control information. This conflict between the ACLU and the Catholic Church led to the resignation of the last Catholic priest from ACLU leadership in 1934; a Catholic priest would not be represented there again until the 1970s.

The ACLU took no official position on president Franklin Delano Roosevelt's 1937 court-packing plan, which threatened to increase the number of Supreme Court justices, unless the Supreme Court reversed its course and began approving New Deal legislation. The Supreme Court responded by making a major shift in policy, and no longer applied strict constitutional limits to government programs, and also began to take a more active role in protecting civil liberties.

The first decision that marked the court's new direction was *De Jonge v. Oregon*, in which a communist labor organizer was arrested for calling a meeting to discuss unionization. The ACLU attorney Osmond Fraenkel, working with International Labor Defense, defended De Jonge in 1937, and won a major victory when the Supreme Court ruled that "peaceable assembly for lawful discussion cannot be made a crime." · The De Jong case marked the start of an era lasting for a dozen years, during which Roosevelt appointees (led by Hugo Black, William O. Douglas, and Frank Murphy) established a body of civil liberties law. In 1938, Justice Harlan F. Stone wrote the famous "footnote four" in *United States v. Carolene Products Co.* in which he suggested that state laws which impede civil liberties would – henceforth – require compelling justification.

Senator Robert F. Wagner proposed the National Labor Relations Act in 1935, which empowered workers to unionize. Ironically, the ACLU, after 15 years of fighting for workers rights, initially opposed the act (it later took no stand on the legislation) because some ACLU leaders feared the increased power the bill gave to the government . The newly formed National Labor Relations Board (NLRB) posed a dilemma for the ACLU, because in 1937 it issued an order to Henry Ford, prohibiting Ford from disseminating anti-union literature. Part of the ACLU leadership habitually took the side of labor, and that faction supported the NLRB's action. But part of the ACLU supported Ford's right to free speech. ACLU leader Arthur Garfield Hays proposed a compromise (supporting the auto workers union, yet also endorsing Ford's right to express personal opinions), but the schism highlighted a deeper divide that would become more prominent in the years to come.

The ACLU's support of the NRLB was a major development for the ACLU, because it marked the first time it accepted that a government agency could be responsible for upholding civil liberties.

Until 1937, the ACLU felt that civil rights were best upheld by citizens and private organizations.

Some factions in the ACLU proposed new directions for the organization. In the late 1930s, some local affiliates proposed shifting their emphasis from civil liberties appellate actions, to becoming a legal aid society, centered on store front offices in low income neighborhoods. The ACLU directors rejected that proposal. Other ACLU members wanted the ACLU to shift focus into the political arena, and to be more willing to compromise their ideals in order to strike deals with politicians. This initiative was also rejected by the ACLU leadership.

4 – 3 - Jehovah's Witnesses

The ACLU's support of defendants with unpopular, sometimes extreme, viewpoints have produced many landmark court cases and established new civil liberties. One such defendant was the Jehovah's Witnesses, who were involved in a large number of Supreme Court cases. Cases that the ACLU supported included *Lovell v. Griffin* (which struck down a city ordinance that required a permit before a person could distribute "literature of any kind"); *Martin v. Struthers* (which struck down an ordinance prohibiting door-to-door canvassing); and *Cantwell v. Connecticut* (which reversed the conviction of a Witness who was reciting offensive speech on a street corner).

The most important cases involved statutes requiring flag salutes. The Jehovah's Witnesses felt that saluting a flag was contrary to their religious beliefs. Two children were convicted in 1938 of not saluting the flag . The ACLU supported their appeal to the Supreme Court, but the court affirmed the conviction, in 1940.[118] But three years later, in *West Virginia State Board of Education v. Barnette*, the Supreme court reversed itself and wrote "If there is any fixed star in our constitutional constellation, it is that no official, high or petty, can prescribe what shall be orthodox in politics, nationalism, religion, or other matters of opinion or force citizens to confess by word or act their faith therein." To underscore its decision, the Supreme Court announced it on Flag Day.

4 – 4 - Communism and totalitarianism

The rise of totalitarianism in Germany, Russia, and Italy during World War II had a tremendous impact on the civil liberties movement. On the one hand, the oppression of the totalitarian states put into sharp relief the virtue of freedom of speech and association in the United States; on the other hand, they prompted an anti-communist hysteria in America which eroded many civil liberties.

The ACLU leadership was divided over whether or not to defend pro-Nazi speech in the United States; pro-labor elements within the ACLU were hostile towards Nazism and fascism, and objected when the ACLU defended Nazis.[121] Several states passed laws outlawing the hate speech directed at ethnic groups.[122] The first person arrested under New Jersey's 1935 hate speech law was a Jehovah's Witness who was charged with disseminating anti-Catholic literature. The ACLU defended the Jehovah's Witnesses, and the charges were dropped. The ACLU proceeded to defend numerous pro-Nazi groups, defending their rights to free speech and free association.

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In the late 1930s, the ACLU allied itself with the Popular Front, a coalition of liberal organizations coordinated by the United States Communist Party. The ACLU benefited because affiliates from the Popular Front could often fight local civil rights battles much more effectively than the New York-based ACLU. The association with the Communist Party led to accusations that the ACLU was a "communist front", particularly because Harry F. Ward was both chairman of the ACLU and chairman of the American League Against War and Fascism, a communist organization.

The House Unamerican Activities Committee (HUAC) was created in 1938 to uncover sedition and treason within the United States. When witnesses testified at its hearings, the ACLU was mentioned several times, leading the HUAC to mention the ACLU prominently in its 1939 report . This damaged the ACLU's reputation severely, even though the report said that it could not "definitely state whether or not" the ACLU was a communist organization.

While the ACLU rushed to defend its image against allegations of being a communist front, it also worked to protect witnesses who were being harassed by the HUAC. The ACLU was one of the few organizations to protest (unsuccessfully) against passage of the Smith Act in 1940, which would later be used to imprison many persons who supported Communism. The ACLU defended many persons who were prosecuted under the Smith Act, including labor leader Harry Bridges.

ACLU leadership was split on whether to purge its leadership of communists. Norman Thomas, John Haynes Holmes, and Morris Ernst were anti-communists who wanted to distance the ACLU from communism; opposing them were Harry Ward, Corliss Lamont and Elizabeth Flynn who rejected any political test for ACLU leadership. A bitter struggle ensued throughout 1939, and the anti-communists prevailed in February 1940, when the board voted to prohibit anyone who supported totalitarianism from ACLU leadership roles. Chairman Harry Ward immediately resigned, and – following a contentious six-hour debate – legendary activist Elizabeth Flynn was voted off the ACLU's board. The 1940 resolution was a disaster for the ACLU, and considered by many to be a betrayal of its fundamental principles. The resolution was rescinded in 1968, and Flynn was posthumously reinstated to the ACLU in 1970.

5 – Mid - century

5 – 1 - World War II

When World War II engulfed the United States, the Bill of Rights was enshrined as a hallowed document, and numerous organizations defended civil liberties. Chicago and New York proclaimed "Civil Rights" weeks, and President Franklin Delano Roosevelt announced a national Bill of Rights day. Eleanor Roosevelt was the keynote speaker at the 1939 ACLU convention. In spite of this newfound respect for civil rights, Americans were becoming adamantly anti-communist, and believed that excluding communists from American society was an essential step to preserve democracy.

Contrasted with World War I, there was relatively little violation of civil liberties during World War II. President Roosevelt was a strong supporter of civil liberties, but – more importantly – there were few anti-war activists during World War II. The most significant civil rights issue during the war was the internment of Japanese-Americans.[134] Two months after the Japanese attack on Pearl Harbor, Roosevelt authorized the detention of all Japanese Americans in internment camps. In addition to encompassing Japanese citizens, it also swept up American citizens of Japanese ancestry. The ACLU immediately protested to Roosevelt, comparing the evacuations to Nazi concentration camps. Not all ACLU leaders wanted to defend the Japanese Americans; Roosevelt loyalists such as Morris Ernst wanted to support Roosevelt's war effort, but pacifists such as Baldwin and Norman Thomas felt that the Japanese-Americans needed individual due process hearings before they were imprisoned. The ACLU was the only major organization that objected to the internment plan, and their position was very unpopular. ACLU attorney A. L. Wirin lost private clients because of his defense of Japanese - Americans.

The ACLU wanted a test case to take to court, but they had a difficult time finding a Japanese-American who would violate the internment order; of the 120,000 Japanese-Americans affected by the order, only 12 disobeyed; the cases of four of those resisters eventually made it to the Supreme Court. The ACLU managed two of those cases. In early 1943, the Supreme court, in *Hirabayashi v. United States*, upheld the government's right to intern the Japanese-Americans. In late 1944, the second case, *Korematsu v. United States*, also upheld the government's right to relocate the Japanese-Americans. Their convictions were later overturned in the 1980s.

Although the ACLU defended the Japanese-Americans, it was more reluctant to defend anti - war protesters. A majority of the board passed a resolution in 1942 which declared the ACLU unwilling to defend anyone who interfered with the United States' war effort.

When the war ended in 1945, the ACLU was 25 years old, and had accumulated an impressive set of legal victories . President Harry S. Truman sent a congratulatory telegram to the ACLU on the occasion of their 25 th anniversary. American attitudes had changed since World War I, and dissent by minorities was tolerated with more willingness. The Bill of Rights was more respected, and minority rights were becoming more commonly championed. During their 1945 annual conference, the ACLU leaders composed a list of important civil rights issues to focus on in the future, and the list included racial discrimination and separation of church and state.

The ACLU supported the African-American defendants in *Shelley v. Kraemer*, when they tried to occupy a house they had purchased in a neighborhood which had racially restrictive housing covenants. The African - American purchasers won the case in 1945.

5 – 2 - Cold War era

Anti-communist sentiment gripped the United States during the Cold War beginning in 1946. Federal investigations caused many persons with communist or left-leaning affiliations to lose their jobs, become blacklisted, or be jailed. During the Cold War, although the United States collectively ignored the civil rights of communists, other civil liberties — such as due process in law and separation of church and state — continued to be reinforced and even expanded.

The ACLU was internally divided when it purged communists from its leadership in 1940, and that ambivalence continued as it decided whether to defend alleged communists during the late 1940s. Some ACLU leaders were anti - communist, and felt that the ACLU should not defend any victims. Some ACLU leaders felt that communists were entitled to free speech protections, and the ACLU should defend them. Other ACLU leaders were uncertain about the threat posed by communists, and tried to establish a compromise between the two extremes . This ambivalent state of affairs would last until 1954, when the civil liberties faction prevailed, leading to the resignation of most of the anti-communist leaders.

In 1947, President Truman issued Executive Order 9835, which created the Federal Loyalty Program. This program authorized the Attorney General to create a list of organizations which were deemed to be subversive. Any association with these programs was ground for barring the person from employment. Listed organizations were not notified that they were being considered for the list, nor did they have an opportunity to present counterarguments; nor did the government divulge any factual basis for inclusion in the list. Although ACLU leadership was divided on whether to challenge the Federal Loyalty Program, some challenges were successfully made.

Also in 1947, the House Un-American Activities Committee (HUAC) subpoenaed ten Hollywood directors and writers, the *Hollywood Ten*, intending to ask them to identify Communists, but the witnesses refused to testify. All were imprisoned for contempt of Congress. The ACLU supported the appeals of several of the artists, but lost on appeal. The Hollywood establishment panicked after the HUAC hearings, and created a blacklist which prohibited anyone with leftist associations from working. The ACLU supported legal challenges to the blacklist, but those challenges failed. The ACLU was more successful with an education effort; the 1952 report *The Judges and the Judged*, prepared at the ACLU's direction in response to the blacklisting of actress Jean Muir, described the unfair and unethical actions behind the blacklisting process, and it helped gradually turn public opinion against McCarthyism.

The federal government took direct aim at the U.S. communist party in 1948 when it indicted its top twelve leaders in the Foley Square trial. The case hinged on whether or not mere membership in a totalitarian political party was sufficient to conclude that members advocated the overthrow of the United States government.[153] The ACLU chose to not represent any of the defendants, and they were all found guilty and sentenced to three to five years in prison. Their defense attorneys were all cited for contempt, went to prison and were disbarred. When the government indicted additional party members, the defendants could not find attorneys to represent them.[143] Communists protested outside the courthouse ; a bill to outlaw picketing of courthouses was introduced in Congress, and the ACLU supported the anti-picketing law.

The ACLU, in a change of heart, supported the party leaders during their appeal process. The Supreme Court upheld the convictions in the *Dennis v. United States* decision by softening the free speech requirements from a "clear and present danger" test, to a "grave and probable" test. The ACLU issued a public condemnation of the *Dennis* decision, and resolved to fight it. One reason for the Supreme Court's support of cold war legislation was the 1949 deaths of Supreme Court justices Frank Murphy and Wiley Rutledge, leaving Hugo Black and William O. Douglas as the only remaining civil libertarians on the Court.

The *Dennis* decision paved the way for the prosecution of hundreds of other communist party members.[156] The ACLU supported many of the communists during their appeals (although most of the initiative originated with local ACLU affiliates, not the national headquarters) but most convictions were upheld. The two California affiliates, in particular, felt the national ACLU headquarters was not supporting civil liberties strongly enough, and they initiated more cold war cases than the national headquarters did.

The ACLU also challenged many loyalty oath requirements across the country, but the courts upheld most of the loyalty oath laws.[157] California ACLU affiliates successfully challenged the California state loyalty oath. The Supreme Court, until 1957, upheld nearly every law which restricted the liberties of communists.

The ACLU, even though it scaled back its defense of communists during the Cold War, still came under heavy criticism as a "front" for communism. Critics included the American Legion, Senator Joseph McCarthy, the HUAC, and the FBI. Several ACLU leaders were sympathetic to the FBI, and as a consequence, the ACLU rarely investigated any of the many complaints alleging abuse of power by the FBI during the Cold War.

5 – 3 - Organizational change

In 1950, the ACLU board of directors asked executive director Baldwin to resign, feeling that he lacked the organizational skills to lead the 9,000 (and growing) member organization. Baldwin objected, but a majority of the board elected to remove him from the position, and he was replaced by Patrick Murphy Malin. Under Malin 's guidance, membership tripled to 30,000 by 1955 – the start of a 24-year period of continual growth leading to 275,000 members in 1974. Malin also presided over an expansion of local ACLU affiliates.

The ACLU, which had been controlled by an elite of a few dozen New Yorkers, became more democratic in the 1950s. In 1951, the ACLU amended its bylaws to permit the local affiliates to participate directly in voting on ACLU policy decisions.[164] A bi-annual conference, open to the entire membership, was instituted in the same year, and in later decades it became a pulpit for activist members, who suggested new directions for the ACLU, including abortion rights, death penalty, and rights of the poor.

5 – 5 - McCarthyism era

During the early 1950s, the ACLU continued to steer a moderate course through the Cold War. When leftist singer Paul Robeson was denied a passport in 1950, even though he was not a communist and not accused of any illegal acts, the ACLU chose to not defend him. The ACLU later reversed their stance, and supported William Worthy and Rockwell Kent in their passport confiscation cases, which resulted in legal victories in the late 1950s.

In response to communist witch - hunts, many witnesses and employees chose to use the fifth amendment protection against self-incrimination to avoid divulging information about their political beliefs. Government agencies and private organizations, in response, established polices which inferred communist party membership for anyone who invoked the fifth amendment . The national ACLU was divided on whether to defend employees who had been fired merely for pleading the fifth amendment, but the New York affiliate successfully assisted teacher Harry Slochower in his Supreme Court case which reversed his termination.

The fifth amendment issue became the catalyst for a watershed event in 1954, which finally resolved the ACLU's ambivalence by ousting the anti-communists from ACLU leadership. In 1953, the anti-communists, led by Norman Thomas and James Fly, proposed a set of resolutions that inferred guilt of persons that invoked the fifth amendment. These resolutions were the first that fell under the ACLU's new organizational rules permitting local affiliates to participate in the vote; the affiliates outvoted the national headquarters, and rejected the anti - communist resolutions. Anti-communists leaders refused to accept the results of the vote, and brought the issue up for discussion again at the 1954 bi-annual convention. ACLU member Frank Graham, president of the University of North Carolina, attacked the anti-communists with a counter-proposal, which stated that the ACLU "stand[s] against guilt by association, judgment by accusation, the invasion of privacy of personal opinions and beliefs, and the confusion of dissent with disloyalty. The anti - communists continued to battle Graham's proposal, but were outnumbered by the affiliates. The anti-communists finally gave up and departed the board of directors in late 1954 and 1955, ending an eight-year reign of ambivalence within the ACLU leadership ranks. Thereafter, the ACLU proceeded with firmer resolve against Cold War anti-communist legislation. The period from the 1940 resolution (and the purge of Elizabeth Flynn) to the 1954 resignation of the anti-communist leaders is considered by many to be an era in which the ACLU abandoned its core principles.

McCarthyism declined in late 1954 after television journalist Edward R. Murrow and others publicly chastised McCarthy. The controversies over the Bill of Rights that were generated by the Cold War ushered in a new era in American Civil liberties. In 1954 in ''Brown v. Board of Education'', the Supreme Court unanimously overturned state-sanctioned school segregation, and thereafter a flood of civil rights victories dominated the legal landscape.

The Supreme Court handed the ACLU two key victories in 1957, in *Watkins v. United States* and *Yates v. United States,* both of which undermined the Smith Act and marked the beginning of the end of communist party membership inquiries. In 1965, the Supreme

Court produced some decisions, including *Lamont v. Postmaster General* (in which the plaintiff was Corliss Lamont, a former ACLU board member), which upheld fifth amendment protections and brought an end to restrictions on political activity.

6 – 1960 s

The decade from 1954 to 1964 was the most successful period in the ACLU's history. Membership rose from 30,000 to 80,000, and by 1965 it had affiliates in seventeen states. During the ACLU's bi-annual conference in Colorado in 1964, the Supreme Court issued rulings on eight cases in which the ACLU was involved; the ACLU prevailed on seven of the eight. The ACLU played a role in Supreme Court decisions reducing censorship of literature and arts, protecting freedom of association, prohibiting racial segregation, excluding religion from public schools, and providing due process protection to criminal suspects. The ACLU's success arose from changing public attitudes; the American populace was more educated, more tolerant, and more willing to accept unorthodox behavior.

6 – 1 - Separation of church and state

Legal battles concerning the separation of church and state originated in laws dating to 1938 which required religious instruction in school, or provided state funding for religious schools.[184] The Catholic church was a leading proponent of such laws; and the primary opponents (the "separationists") were the ACLU, Americans United for Separation of Church and State, and the American Jewish Congress. The ACLU led the challenge in the 1947 *Everson v. Board of Education* case, in which Justice Hugo Black wrote "[t]he First Amendment has erected a wall between church and state…. That wall must be kept high and impregnable." It was not clear that the Bill of Rights forbid state governments from supporting religious education, and strong legal arguments were made by religious proponents, arguing that the Supreme Court should not act as a "national school board", and that the Constitution did not govern social issues.[187] However, the ACLU and other advocates of church/state separation persuaded the Court to declare such activities unconstitutional.[187] Historian Samuel Walker writes that the ACLU's "greatest impact on

American life" was its role in persuading the Supreme Court to "constitutionalize" so many public controversies.

In 1948, the ACLU prevailed in the *McCollum v. Board of Education* case, which challenged public school religious classes taught by clergy paid for from private funds. The ACLU also won cases challenging schools in New Mexico which were taught by clergy and had crucifixes hanging in the classrooms . In the 1960s, the ACLU, in response to member insistence, turned its attention to in-class promotion of religion. In 1960, 42 percent of American schools included Bible reading. In 1962, the ACLU published a policy statement condemning in - school prayers, observation of religious holidays, and Bible reading. The Supreme Court concurred with the ACLU's position, when it prohibited New York's in-school prayers in the 1962 *Engel v. Vitale* decision. Religious factions across the country rebelled against the anti - prayer decisions, leading them to propose the School Prayer Constitutional Amendment, which declared in-school prayer legal. The ACLU participated in a lobbying effort against the amendment, and the 1966 congressional vote on the amendment failed to obtain the required two-thirds majority.

However, not all cases were victories; ACLU lost cases in 1949 and 1961 which challenged state laws requiring commercial businesses to close on Sunday, the Christian Sabbath. The Supreme court has never overturned such laws, although some states subsequently revoked many of the laws under pressure from commercial interests.

6 – 2 - Freedom of expression

During the 1940s and 1950s, the ACLU continued its battle against censorship of art and literature. In 1948, the New York affiliate of the ACLU received mixed results from the Supreme Court, winning the appeal of Carl Jacob Kunz, who was convicted for speaking without a police permit, but losing the ap **6 – 1 -** peal of Irving Feiner who was arrested to prevent a breach of the peace, based on his oration denouncing president Truman and the American Legion.[194] The ACLU lost the case of Joseph Beahharnais, who was arrested for group libel when he distributed literature impugning the character of African Americans.

Cities across America routinely banned movies because they were deemed to be "harmful", "offensive", or "immoral" – censorship which was validated by the 1915 *Mutual v. Ohio* Supreme Court decision which held movies to be mere commerce, undeserving of first amendment protection. The film *The Miracle* was banned in New York in 1951, at the behest of the Catholic Church, but the ACLU supported the film's distributor in an appeal of the ban, and won a major victory in the 1952 decision *Joseph Burstyn, Inc v. Wilson*. The Catholic Church led efforts throughout the 1950s attempting to persuade local prosecutors to ban various books and movies, leading to conflict with the ACLU when the ACLU published it statement condemning the church's tactics.[197] Further legal actions by the ACLU successfully defended films such as *M* and *la Ronde*, leading the eventual dismantling of movie censorship. Hollywood continued employing self-censorship with its own Production Code, but in 1956 the ACLU called on Holly wood to abolish the Code.

The ACLU defended beat generation artists, including Allen Ginsburg who was prosecuted for his poem "Howl"; and – in an unorthodox case – the ACLU helped a coffee house regain its restaurant license which was revoked because its Beat customers were allegedly disturbing the peace and quiet of the neighborhood.

The ACLU lost an important press censorship case when, in 1957, the Supreme Court upheld the obscenity conviction of publisher Samuel Roth for distributing adult magazines.[201] As late as 1953, books such as *Tropic of Cancer* and *From Here to Eternity* were still banned. But public standards rapidly became more liberal though the 1960s, and obscenity was notoriously difficult to define, so by 1971 prosecutions for obscenity had halted.

6 – 3 - Racial discrimination

A major aspect of civil liberties progress after World War II was the undoing centuries of racism in federal, state, and local governments – an effort generally known as the Civil Rights Movement.[202] Several civil liberties organizations worked together for progress, including the National Association for the Advancement of Colored People (NAACP), the ACLU, and the American Jewish Congress. The NAACP took primary responsibility for Supreme Court cases (often led by lead NAACP attorney Thurgood Marshall), with the ACLU focusing on police misconduct, and supporting the NAACP with amicus briefs. The NAACP achieved a key victory in 1950 with the *Henderson v. United States* decision that ended segregation in interstate bus and rail transportation.

In 1954, the ACLU filed an amicus brief in the case of *Brown v. Board of Education*, which led to the ban on racial segregation in U.S. public schools. Southern states instituted a McCarthyism - style witch-hunt against the NAACP, attempting it to disclose membership lists. The ACLU's fight against racism was not limited to segregation; in 1964 the ACLU provided key support to plaintiffs, primarily lower income urban residents, in *Reynolds v. Sims*, which required states to establish the voting districts in accordance with the "one person, one vote" principle.

6 – 4 - Police misconduct

The ACLU regularly tackled police misconduct issues, starting with the 1932 case *Powell v. Alabama* (right to an attorney), and including 1942's *Betts v. Brady* (right to an attorney), and 1951's *Rochin v. California* (involuntary stomach pumping). In the late 1940s, several ACLU local affiliates established permanent committees to address policing issues.[206] During the 1950s and 1960s, the ACLU was responsible for substantially advancing the legal protections against police misconduct. The Philadelphia affiliate was responsible for causing the City of Philadelphia, in 1958, to create the nation's first civilian police review board. In 1959, the Illinois affiliate published the first report in the nation, *Secret Detention by the Chicago Police*, which documented unlawful detention by police.

Some of the most well known ACLU successes came in the 1960s, when the ACLU prevailed in a string of cases limiting the power of police to gather evidence; in 1961's *Mapp v. Ohio*, the Supreme court required states to obtain a warrant before searching a person's home.[210] The *Gideon v. Wainwright* decision in 1963 provided legal representation to indigents. In 1964, the ACLU persuaded the Court, in *Escobedo v. Illinois*, to permit suspects to have an attorney present during questioning. And, in 1966, the *Miranda v. Arizona* decision required police to notify suspects of their constitutional rights. Although many law enforcement officials criticized the ACLU for expanding the rights of suspects, police officers themselves took advantage of the ACLU. For example when the ACLU represented New York policemen in their lawsuit which objected to searches of their workplace lockers. In the late 1960s, civilian review boards in New York and Philadelphia were abolished, over the ACLU’s objection.

6 – 5 - Civil liberties revolution of the 1960s

The 1960s was a tumultuous era in the United States, and public interest in civil liberties underwent an explosive growth.[216] Civil liberties actions in the 1960s were often led by young people, and often employed tactics such as sit ins and marches. Protests were often peaceful, but sometimes employed militant tactics. The ACLU played a central role in all major civil liberties debates of the 1960s, including new fields such as gay rights, prisoner's rights, abortion, rights of the poor, and the death penalty. Membership in the ACLU increased from 52,000 at the beginning of the decade, to 104,000 in 1970.[218] In 1960, there were affiliates in seven states, and by 1974 there were affiliates in 46 states. During the 1960s, the ACLU underwent a major transformation tactics; it shifted emphasis from legal appeals (generally involving amicus briefs submitted to the Supreme Court) to direct representation of defendants when they were initially arrested.[218] At the same time, the ACLU transformed its style from "disengaged and elitist" to "emotionally engaged". The ACLU published a breakthrough document in 1963, titled *How Americans Protest*, which was borne of frustration with the slow progress in battling racism, and which endorsed aggressive, even militant protest techniques.

African - American protests in the South accelerated in the early 1960s, and the ACLU assisted at every step. After four African-American college students staged a sit-in in a segregated North Carolina department store, the sit-in movement gained momentum across the United States. During 1960 - 61, the ACLU defended black students arrested for demonstrating in North Carolina, Florida, and Louisiana. The ACLU also provided legal help for the Freedom Rides in 1961, the integration of the University of Mississippi, the 1963 protests in Birmingham, Alabama, and the 1964 Freedom Summer.

The NAACP was responsible for managing most sit-in related cases that made it to the Supreme Court, winning nearly every decision. But it fell to the ACLU and other legal volunteer efforts to provide legal representation to hundreds of protestors – white and black – who were arrested while protesting in the South. The ACLU joined with other civil liberties groups to form the Lawyers Constitutional Defense Committee (LCDC) which subsequently provided legal representation to many of the protesters. The ACLU provided the majority of the funding for the LCDC.

In 1964, the ACLU opened up a major office in Atlanta, Georgia, dedicated to serving Southern issues. Much of the ACLU's progress in the South was due to Charles Morgan, Jr., the charismatic leader of the Atlanta office. He was responsible for desegregating juries (Whitus v. Georgia) , desegregating prisons (*Lee v. Washington*), and reforming election laws. The ACLU's southern office also defended African-American congressman Julian Bond in *Bond v. Floyd*, when the Georgia congress refused to formally induct Bond into the legislature.[229] Another widely publicized case defended by Morgan was that of Army doctor Howard Levy, who was convicted of refusing to train Green Berets. Despite raising the defense that the Green Berets were committing war crimes in Vietnam, Levy lost on appeal in *Parker v. Levy*, 417 U.S. 733 (1974).

In 1969, the ACLU won a major victory for free speech, when it defended Dick Gregory after he was arrested for peacefully protesting against the mayor of Chicago. The court ruled in *Gregory v. Chicago* that a speaker cannot be arrested for disturbing the peace when the hostility is initiated by someone in the audience, as that would amount to a "heckler's veto".

6 – 6 - Vietnam war

The ACLU was at the center of several legal aspects of the Vietnam war: defending draft resisters, challenging the constitutionality of the war, the potential impeachment of Richard Nixon, and the use of national security concerns to preemptively censor newspapers.

David J. Miller was the first person prosecuted for burning his draft card. The New York affiliate of the ACLU appealed his 1965 conviction (367 F.2d 72: *United States of America v. David J. Miller*, 1966), but the Supreme Court refused to hear the appeal. Two years later, the Massachusetts affiliate took the card-burning case of David O'Brien to the Supreme court, arguing that the act of burning was a form of symbolic speech, but the Supreme Court upheld the conviction in *United States v. O'Brien*, 391 US 367 (1968). Thirteen year old Junior High student Mary Tinker wore a black armband to school in 1965 to object to the war, and was suspended from school. The ACLU appealed her case to the supreme court and won a victory in *Tinker v. Des Moines*. This critical case established that the government may not establish "enclaves" such as schools or prisons where all rights are forfeit.

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The ACLU defended Sydney Street, who was arrested for burning an American flag to protest the reported assassination of civil rights leader James Meredith. In the *Street v. New York* decision, the court agreed with the ACLU that encouraging the country to abandon one of its national symbols was constitutionally protected form of expression. The ACLU successfully defended Paul Cohen, who was arrested for wearing a jacket with the words "fuck the draft" on its back, while he walked through the Los Angeles courthouse. The Supreme Court, in *Cohen v. California*, held that the vulgarity of the wording was essential to convey the intensity of the message.[234]

Non-war related free speech rights were also advanced during the Vietnam war era; in 1969, the ACLU defended a Ku Klux Klan member who advocated long-term violence against the government, and the Supreme Court concurred with the ACLU's argument in the landmark decision *Brandenburg v. Ohio*, which held that only speech which advocated *imminent* violence could be outlawed.

A major crisis gripped the ACLU in 1968 when a debate erupted over whether to defend Benjamin Spock and the Boston Five against federal charges that they encouraged draftees to avoid the draft.[11] The ACLU board was deeply split over whether to defend the activists; half the board harbored anti - war sentiments, and felt that the ACLU should lend its resources to the cause of the Boston Five.[11] The other half of the board believed that civil liberties were not at stake, and the ACLU would be taking a political stance. Behind the debate was the longstanding ACLU tradition that it was politically impartial, and provided legal advice without regard to the political views of the defendants . The board finally agreed to a compromise solution that permitted the ACLU to defend the anti-war activists, without endorsing the activist's political views. Some critics of the ACLU suggest that the ACLU became a partisan political organization following the Spock case. After the Kent State shootings in 1970, ACLU leaders took another step towards politics by passing a resolution condemning the Vietnam war. The resolution was based in a variety of legal arguments, including civil liberties violations and a claim that the war was illegal.

Also in 1968, the ACLU held an internal symposium to discuss its dual roles: providing "direct" legal support (defense for accused in their initial trial, benefiting only the individual defendant), and appellate support (providing amicus briefs during the appeal process, to establish widespread legal precedent). Historically, the ACLU was known for its appellate work which led to landmark Supreme Court decisions, but by 1968 , 90 % of the ACLU's legal activities involved direct representation. The symposium concluded that both roles were valid for the ACLU.

7 - 1970s and 1980s

7 – 1 - Watergate era

The ACLU supported *The New York Times* in its 1971 suit against the government, requesting permission to publish the Pentagon papers. The court upheld the *Times* and ACLU in the *New York Times Co. v. United States* ruling, which held that the government could not preemptively prohibit the publication of classified information and had to wait until after it was published to take action.

As the Watergate saga unfolded, the ACLU became the first national organization to call for Nixon's impeachment.[12] This, following the resolution opposing the Vietnam war, was a second major decision that caused critics of the ACLU, particularly conservatives, to claim that the ACLU had evolved into a liberal political organization.

7 – 2 - Enclaves and new civil liberties

The decade from 1965 to 1975 saw an expansion of the field of civil liberties. Administratively, the ACLU responded by appointing Aryeh Neier to take over from Pemberton as Executive Director in 1970. Neier embarked on an ambitious program to expand the ACLU; he created the ACLU Foundation to raise funds, and he created several new programs to focus the ACLU's legal efforts. By 1974, ACLU membership had reached 275,000.

During those years, the ACLU led the way in expanding legal rights in three directions: new rights for persons within government-run "enclaves", new rights for victim groups, and privacy rights for mainstream citizens. At the same time, the organization grew substantially. The ACLU helped develop the field of constitutional law that governs "enclaves", which are groups of persons that live in conditions under government control. Enclaves include mental hospital patients, members of the military, and prisoners, and students (while at school). The term enclave originated with Supreme Court justice Abe Fortas's use of the phrase "schools may not be enclaves of totalitarianism" in the *Tinker v. Des Moines* decision.

The ACLU initiated the legal field of student's rights with the *Tinker v. Des Moines* case, and expanded it with cases such as *Goss v. Lopez* which required schools to provide students an opportunity to appeal suspensions.

As early as 1945, the ACLU had taken a stand to protect the rights of the mentally ill, when it drafted a model statute governing mental commitments. In the 1960s, the ACLU opposed involuntary commitments, unless it could be demonstrated that the person was a danger to himself or the community. In the landmark 1975 *O'Connor v. Donaldson* decision the ACLU represented a non-violent mental health patient who had been confined against his will for 15 years, and persuaded the Supreme Court to rule such involuntary confinements illegal. The ACLU has also defended the rights of mentally ill individuals who are not dangerous, but who create disturbances. The New York chapter of the ACLU defended Billie Boggs, a mentally ill woman who exposed herself and defecated and urinated in public.

Prior to 1960, prisoners had virtually no recourse to the court system, because courts considered prisoners to have no civil rights.[245] That changed in the late 1950s, when the ACLU began representing prisoners that were subject to police brutality, or deprived of religious reading material. In 1968, the ACLU successfully sued to desegregate the Alabama prison system; and in 1969, the New York affiliate adopted a project to represent prisoners in New York prisons. Private attorney Phil Hirschkop discovered degrading conditions in Virginia prisons following the Virginia State Penitentiary strike, and won an important victory in 1971's *Landman v. Royster* which prohibited Virginia from treating prisoners in inhumane ways. In 1972, the ACLU consolidated several prison rights efforts across the nation and created the National Prison Project. The ACLU's efforts led to landmark cases such as *Ruiz v. Estelle* (requiring reform of the Texas prison system) and in 1996 U.S. Congress enacted the Prison Litigation Reform Act (PLRA) which codified prisoners' rights.

7 – 3 - Victim groups

The ACLU, during the 1960s and 1970s, expanded its scope to include what it referred to as "victim groups", namely women, the poor, and homosexuals. Heeding the call of female members, the ACLU endorsed the Equal Rights Amendment in 1970 and created the Women's Rights Project in 1971. The Women's Rights Project dominated the legal field, handling more than twice as many cases as the National Organization for Women, including breakthrough cases such as *Reed v. Reed*, *Frontiero v. Richardson*, and *Taylor v. Louisiana*.

ACLU leader Harriet Pilpel raised the issue of the rights of homosexuals in 1964, and two years later the ACLU formally endorsed gay rights. In 1973 the ACLU created the Sexual Privacy Project (later the Gay and Lesbian Rights Project) which combated discrimination against homosexuals. This support continues even today. After then-Senator Larry Craig was arrested for soliciting sex in a public bathroom, the ACLU wrote an amicus brief for Craig, saying that sex between consenting adults in public places was protected under privacy rights.

Rights of the poor was another area that was expanded by the ACLU. In 1966 and again in 1968, activists within the ACLU encouraged the organization to adopt a policy overhauling the welfare system, and guaranteeing low - income families a baseline income; but the ACLU board did not approve the proposals.[253] The ACLU played a key role in the 1968 *King v. Smith* decision, where the Supreme Court ruled that welfare benefits for children could not be denied by a state simply because the mother cohabited with a boyfriend.

7 – 4 – Privacy

The right to privacy is not explicitly identified in the U.S. Constitution, but the ACLU led the charge to establish such rights in the indecisive 1961 *Poe v. Ullman* case, which addressed a state statute outlawing contraception. The issue arose again in *Griswold v. Connecticut* (1965), and this time the Supreme Court adopted the

ACLUs position, and formally declared a right to privacy. The New York affiliate of the ACLU pushed to eliminate anti-abortion laws starting in 1964, a year before *Griswold* was decided, and in 1967 the ACLU itself formally adopted the right to abortion as a policy.[255] The ACLU led the defense in *United States v. Vuitch* which expanded the right of physicians to determine when abortions were necessary. These efforts culminated in one of the most controversial Supreme Court decisions of all time, *Roe v. Wade*, which legalized abortion in the first three months of pregnancy. The ACLU successfully argued against state bans on interracial marriage, in the case of *Loving v. Virginia* (1967).

Related to privacy, the ACLU engaged in several battles to ensure that government records about individuals were kept private, and to give individuals the right to review their records. The ACLU supported several measures, including the 1970 Fair Credit Reporting Act required credit agencies to divulge credit information to individuals; the 1973 Family Educational Rights and Privacy Act, which provided students the right to access their records; and the 1974 Privacy Act which prevented the federal government from disclosing personal information without good cause.

7 – 5 - Allegations of bias

In the early 1970s, conservatives and libertarians began to criticize the ACLU for being too political and too liberal . Legal scholar Joseph W. Bishop wrote that the ACLU's trend to partisanship started with its defense of Dr. Spock's anti - war protests . Critics also blamed the ACLU for encouraging the Supreme Court to embrace judicial activism . Critics claimed that the ACLU's support of controversial decisions like *Roe v. Wade* and *Griswold v. Connecticut* violated the intention of the authors of the Bill of Rights. The ACLU became an issue in the 1988 presidential campaign, when Republican candidate George H. W. Bush accused Democratic candidate Michael Dukakis (a member of the ACLU) of being a "card carrying member of the ACLU".

7 – 6 - The Skokie case

It is the policy of the ACLU to support the civil liberties of defendants regardless of their ideological stance. The ACLU takes pride in defending individuals with unpopular or bigoted viewpoints, such as George Wallace, George Lincoln Rockwell, and KKK members. The ACLU has defended American Nazis many times, and their actions often brought protests, particularly from American Jews.

In 1977, a small group of American Nazis, led by Frank Collin, applied to the town of Skokie, Illinois for permission to hold a demonstration in the town park. Skokie at the time had a majority population of Jews, totaling 40,000 of 70,000 citizens, some of whom were survivors of Nazi concentration camps. Skokie refused to grant permission, and an Illinois judge supported Skokie and prohibited the demonstration. Skokie immediately passed three ordinances aimed at preventing the group from meeting in Skokie. The ACLU assisted Collins and appealed to federal court. The appeal dragged on for a year, and the ACLU eventually prevailed in *Smith v. Collin*, 447 F . Supp. 676.

The Skokie case was heavily publicized across America, partially because Jewish groups such as the Jewish Defense League and Anti Defamation League strenuously objected to the demonstration, leading many members of the ACLU to cancel their memberships. The Illinois affiliate of the ACLU lost about 25% of its membership and nearly one - third of its budget. The financial strain from the controversy led to layoffs at local chapters . After the membership crisis died down, the ACLU sent out a fund - raising appeal which explained their rationale for the Skokie case, and raised over $500,000 ($ 1,926,139 in 2014 dollars).

7 – 7 - Reagan era

The inauguration of Ronald Reagan as president in 1981, ushered in an eight-year period of conservative leadership in the U.S. government. Under his leadership, the government pushed a conservative social agenda, including outlawing abortion, inserting prayer in schools, banning pornography, and resisting gay rights.

Fifty years after the Scopes trial, the ACLU found itself fighting another classroom case, the Arkansas 1981 creationism statute, which required schools to teach the biblical account of creation as a scientific alternative to evolution. The ACLU won the case in the *McLean v. Arkansas* decision.

In 1982, the ACLU became involved in a case involving the distribution of child pornography (*New York v. Ferber*). In an amicus brief, the ACLU argued that child pornography that violates the three prong obscenity test should be outlawed, but that the law in question was overly restrictive because it outlawed artistic displays and otherwise non-obscene material. The court did not adopt the ACLU's position.

During the 1988 presidential election, Vice President George H. W. Bush noted that his opponent Massachusetts Governor Michael Dukakis had described himself as a "card-carrying member of the ACLU" and used that as evidence that Dukakis was "a strong, passionate liberal" and "out of the mainstream" . The phrase subsequently was used by the organization in an advertising campaign.

In 1990 the ACLU defended Lieutenant Colonel Oliver North, whose conviction was tainted by coerced testimony – a violation of his fifth amendment rights – during the Iran–Contra affair, where Oliver North was involved in illegal weapons sales to Iran in order to illegally fund the Contra guerillas .

8 - Modern era

8 – 1 - 1990 to 2000

In 1997, ruling unanimously in the case of *Reno v. American Civil Liberties Union*, the Supreme Court voted down anti-indecency provisions of the Communications Decency Act (the CDA), finding they violated the freedom of speech provisions of the First Amendment. In their decision, the Supreme Court held that the CDA's "use of the undefined terms 'indecent' and 'patently offensive' will provoke uncertainty among speakers about how the two standards relate to each other and just what they mean." .

The ACLU's position on spam is considered controversial by a broad cross-section of political points of view. In 2000, Marvin Johnson, a legislative counsel for the ACLU, stated that proposed anti-spam legislation infringed on free speech by denying anonymity and by forcing spam to be labeled as such, "Standardized labeling is compelled speech." He also stated, "It's relatively simple to click and delete." The debate found the ACLU joining with the Direct Marketing Association and the Center for Democracy and Technology in criticizing a bipartisan bill in the House of Representatives in 2000. As early as 1997 the ACLU had taken a strong position that nearly all spam legislation was improper, although it has supported "opt-out" requirements in some cases. The ACLU opposed the 2003 CAN-SPAM act suggesting that it could have a chilling effect on speech in cyberspace.

In November 2000, 15 African-American residents of Hearne, Texas, were indicted on drug charges after being arrested in a series of "drug sweeps". The ACLU filed a class action lawsuit, *Kelly v. Paschall*, on their behalf, alleging that the arrests were unlawful. The ACLU contended that 15 percent of Hearne's male African American population aged 18 to 34 were arrested based on the "uncorroborated word of a single unreliable confidential informant coerced by police to make cases." On May 11, 2005, the ACLU and Robertson County announced a confidential settlement of the lawsuit, an outcome which "both sides stated that they were satisfied with." The District Attorney dismissed the charges against the plaintiffs of the suit. The 2009 film American Violet depicts this case.

In 2000, the ACLU's Massachusetts affiliate represented the North American Man Boy Love Association (NAMBLA), on first amendment grounds, in the *Curley v. NAMBLA* wrongful death civil suit that was based solely on the fact that a man who raped and murdered a child had visited the NAMBLA website . Also In 2000, the ACLU lost the *Boy Scouts of America v. Dale* case, which had asked the Supreme Court to require the Boy Scouts of America to drop their policy of prohibiting homosexuals from becoming Boy Scout leaders.

8 – 2 – Twenty - first century

In March 2004, the ACLU, along with Lambda Legal and the National Center for Lesbian Rights, sued the state of California on behalf of six same-sex couples who were denied marriage licenses. That case, *Woo v. Lockyer*, was eventually consolidated into *In re Marriage Cases*, the California Supreme Court case which led to same-sex marriage being available in that state from June 16, 2008 until Proposition 8 was passed on November 4, 2008.

During the 2004 trial regarding allegations of Rush Limbaugh's drug abuse, the ACLU argued that his privacy should not have been compromised by allowing law enforcement examination of his medical records. In June 2004, the school district in Dover, Pennsylvania, required that its high school biology students listen to a statement which asserted that the theory of evolution is not fact and mentioning intelligent design as an alternative theory. Several parents called the ACLU to complain, because they believed that the school was promoting a religious idea in the classroom and violating the Establishment Clause of the First Amendment. The ACLU, joined by Americans United for Separation of Church and State, represented the parents in a lawsuit against the school district. After a lengthy trial, Judge John E. Jones III ruled in favor of the parents in the *Kitzmiller v. Dover Area School District* decision, finding that intelligent design is not science and permanently forbidding the Dover school system from teaching intelligent design in science classes.

In April, 2006, Edward Jones and the ACLU sued the City of Los Angeles, on behalf of Robert Lee Purrie and five other homeless people, for the city's violation of the 8th and 14th Amendments to the U.S. Constitution, and Article I, sections 7 and 17 of the California Constitution (supporting due process and equal protection, and prohibiting cruel and unusual punishment). The Court ruled in favor of the ACLU, stating that, "the LAPD cannot arrest people for sitting, lying, or sleeping on public sidewalks in Skid Row." Enforcement of section 41.18(d) 24 hours a day against persons who have nowhere else to sit, lie, or sleep, other than on public streets and sidewalks, is breaking these amendments. The Court said that the anti-camping ordinance is "one of the most restrictive municipal laws regulating public spaces in the United States". Jones and the ACLU wanted a compromise in which the LAPD is barred from enforcing section 41.18(d) (arrest, seizure, and imprisonment) in Skid Row between the hours of 9:00 p.m. and 6:30 a.m. The compromise plan permits the homeless to sleep on the sidewalk, provided they are not "within 10 feet of any business or residential entrance" and only between these hours. One of the motivations for the compromise is the shortage of space in the prison system. Downtown development business interests and the Central City Association (CCA) were against the compromise. Police Chief William Bratton said the case had slowed the police effort to fight crime and clean up Skid Row, and that when he was allowed to clean up Skid Row, real estate profited.[289] On September 20, 2006, the Los Angeles City Council voted to reject the compromise. On October 3, 2006, police arrested Skid Row's transients for sleeping on the streets for the first time in months.

In 2006, the ACLU of Washington State joined with a pro-gun rights organization, the Second Amendment Foundation, and prevailed in a lawsuit against the North Central Regional Library District (NCRL) in Washington for its policy of refusing to disable restrictions upon an adult patron's request. Library patrons attempting to access pro-gun web sites were blocked, and the library refused to remove the blocks . In 2012, the ACLU sued the same library system for refusing to temporarily, at the request of an adult patron, disable internet filters which blocked access to Google Images.

In 2006, the ACLU challenged a Missouri law that prohibited picketing outside of veterans' funerals. The suit was filed in support of the Westboro Baptist Church and Shirley Phelps-Roper, who were threatened with arrest. The Westboro Baptist Church is well known for their picket signs that contain messages such as, "God Hates Fags", "Thank God for Dead Soldiers" and "Thank God for 9/11".

The ACLU issued a statement calling the legislation a "law that infringes on Shirley Phelps - Roper's rights to religious liberty and free speech".[297] The ACLU prevailed in the lawsuit.[298] In 2008, the ACLU was part of a consortium of legal advocates, including Lambda Legal and the National Center for Lesbian Rights, that challenged California's Proposition 8 , which declared same - sex marriages illegal. The ACLU and its allies prevailed.

In light of the Supreme Court's *Heller* decision recognizing that the Constitution protects an individual right to bear arms, ACLU of Nevada took a position of supporting "the individual's right to bear arms subject to constitutionally permissible regulations" and pledged to "defend this right as it defends other constitutional rights". Since 2008, the ACLU has increasingly assisted gun owners recover firearms that have been seized illegally by law enforcement.

In 2009, the ACLU filed an amicus brief in *Citizens United v. Federal Election Commission*, arguing that the Bipartisan Campaign Reform Act of 2002 violated the First Amendment right to free speech by curtailing political speech . This stance on the landmark *Citizens United* case caused considerable disagreement within the organization, resulting in a discussion about its future stance during a quarterly board meeting in 2010. On March 27, 2012, the ACLU reaffirmed its stance in support of the Supreme Court's *Citizens United* ruling, at the same time voicing support for expanded public financing of election campaigns and stating the organization would firmly oppose any future constitutional amendment limiting free speech.

On January 7, 2013, the ACLU reached a settlement with the federal government in *Collins v. United States* that provided for the payment of full separation pay to service members discharged under "don't ask, don't tell" since November 10, 2004, who had previously been granted only half that. Some 181 were expected to receive about $ 13,000 each.

8 – 3 - Anti - terrorism issues

After the September 11, 2001 attacks, the federal government instituted a broad range of new measures to combat terrorism, including the passage of the USA PATRIOT Act. The ACLU challenged many of the measures, claiming that they violated rights regarding due process, privacy, illegal searches, and cruel and unusual punishment. An ACLU policy statement states :

Our way forward lies in decisively turning our backs on the policies and practices that violate our greatest strength: our Constitution and the commitment it embodies to the rule of law. Liberty and security do not compete in a zero-sum game; our freedoms are the very foundation of our strength and security. The ACLU's National Security Project advocates for national security policies that are consistent with the Constitution, the rule of law, and fundamental human rights. The Project litigates cases relating to detention, torture, discrimination, surveillance, censorship, and secrecy.

During the ensuing debate regarding the proper balance of civil liberties and security , the membership of the ACLU increased by 20 % , bringing the group's total enrollment to 330,000. The growth continued, and by August 2008 ACLU membership was greater than 500,000. It remained at that level through 2011.

The ACLU has been a vocal opponent of the USA PATRIOT Act of 2001, the PATRIOT 2 Act of 2003, and associated legislation made in response to the threat of domestic terrorism. In response to a requirement of the USA PATRIOT Act, the ACLU withdrew from the Combined Federal Campaign charity drive. The campaign imposed a requirement that ACLU employees must be checked against a federal anti-terrorism watch list. The ACLU has stated that it would "reject $500,000 in contributions from private individuals rather than submit to a government 'blacklist' policy." .

In 2004, the ACLU sued the federal government in *American Civil Liberties Union v. Ashcroft (2004)* on behalf of Nicholas

Merrill, owner of an Internet Service Provider. Under the provisions of the PATRIOT act, the government had issued National Security Letters to Merrill to compel him to provide private internet access information from some of his customers. In addition, the government placed a gag order on Merrill, forbidding him from discussing the matter with anyone.

In January 2006, the ACLU filed a lawsuit, *ACLU v. NSA*, in a federal district court in Michigan, challenging government spying in the NSA warrantless surveillance controversy. On August 17, 2006, that court ruled that the warrantless wiretapping program is unconstitutional and ordered it ended immediately. However, the order was stayed pending an appeal. The Bush administration did suspend the program while the appeal was being heard.[317] In February 2008, the U.S. Supreme Court turned down an appeal from the ACLU to let it pursue a lawsuit against the program that began shortly after the Sept. 11 terror attacks.

The ACLU and other organizations also filed separate lawsuits around the country against telecommunications companies. The ACLU filed a lawsuit in Illinois (*Terkel v. AT&T*) which was dismissed because of the State Secrets Privilege and two others in California requesting injunctions against AT&T and Verizon. On August 10, 2006, the lawsuits against the telecommunications companies were transferred to a federal judge in San Francisco.

The ACLU represents a Muslim-American who was detained but never accused of a crime in *Al - Kidd v Ashcroft*, a civil suit against former Attorney General John Ashcroft.[322] In January 2010, the American military released the names of 645 detainees held at the Bagram Theater Internment Facility in Afghanistan, modifying its long-held position against publicizing such information. This list was prompted by a Freedom of Information Act lawsuit filed in September 2009 by the ACLU, whose lawyers had also requested detailed information about conditions, rules and regulations.

Ames Process

Contents

1 - Introduction

The **Ames process** is a process by which pure uranium metal is obtained. It can be achieved by mixing any of the uranium halides (commonly uranium tetra fluoride) with magnesium metal powder or aluminium metal powder.

2 – History

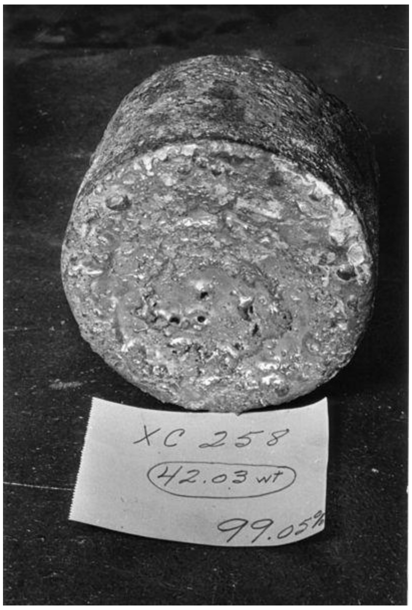
The Ames process was used on August 3, 1942 by a group of chemists led by Frank Spedding at the Ames Laboratory as part of the Manhattan Project. It is a type of thermite - purification, which was patented in 1895 by German chemist Hans Goldschmidt.[2] Development of the Ames process came at a time of increased research into mass uranium metal production. The desire for increased production was motivated by a fear of Nazi Germany developing nuclear weapons before the Allies. The process originally involved mixing powdered uranium tetra fluoride and powdered magnesium together. This mixture was placed inside an iron pipe that was welded shut on one side and capped shut on another side. This container, called a "bomb" by Spedding, was placed into a furnace. When heated to a temperature of 1,500 °C , the contents of the container reacted violently, leaving a 35-gram ingot of pure uranium metal. The process was quickly scaled up; by October 1942 the "Ames Project" was producing metal at a rate of 100 pounds per week. The uranium tetra fluoride and magnesium were sealed in a refractory lined reactor vessel, still referred to as a "bomb". The thermite reaction was initiated by furnace heating the assembly to 600 °C , the large difference in density between slag and metal allowed for complete separation in the liquid state, yielding slag - free metal.[4] By July 1943, the production rate exceeded 59,000 kg of uranium metal per month. Approximately 1000 tons of uranium ingots were produced at Ames before the process was transferred to industry.

he Ames project received the Army - Navy 'E' Award for Excellence in Production on October 12, 1945, signifying two-and-a-half years of excellence in industrial production of metallic uranium as a vital war material. Iowa State University is unique among educational institutions to have received this award for outstanding service, an honor normally given to industry.

Uranium refining at Ames

A "bomb" (pressure vessel) containing uranium halide and sacrificial metal, probably magnesium, being lowered into a furnace

After the reaction, remnant slag coats the interior of a bomb.



A uranium metal "biscuit" from the reduction reaction

3 - Ames process for rare earth metals

The metallothermic reduction of anhydrous rare earth fluorides to rare earth metals is also referred to as the Ames Process.

The study of rare earths was also advanced during World War II: Synthetic plutonium was believed to be rare – earth – like , it was assumed that knowledge of rare earths would assist in planning for and the study of transuranic elements; ion exchange methods developed for actinide processing were forerunners to processing methods for rare earth oxides; methods used for uranium were modified for plutonium which were subsequently the basis for rare-earth metal preparation.

AMMO (U.S. Air Force)

AMMO Pisspot

Contents

1 - Introduction

The **Munitions Systems Specialist** career field (AFSC 2W0X1, previously 461X0), commonly referred to as **AMMO**, is the munitions branch of the U.S. Air Force.

2 - Career Field Description

AMMO is responsible for maintaining the US Air Force's entire munitions stockpile. Various duties include shipping and receiving, building, testing, operating, protecting, inspecting, storing and performing maintenance on all types of conventional munition systems. AMMO personnel also operate and maintain a wide variety of equipment and electronic gear, from pallet jacks to 12 m tractor-trailer combination vehicles, all - terrain 10,000 pound fork lifts, all the way up to 50,000 pound fork lifts, and from small arms ammunition for rifles and pistols to large-scale guided bombs, to include AGM - 65 guidance testing units and computer databases. Upon graduation from Air Force Basic Military Training at Lackland Air Force Base, San Antonio, Texas, Airmen assigned to the field attend an 8-week tech school at Sheppard Air Force Base, Texas. Upon graduation from tech school, the new AMMO apprentice is sent to their assigned duty station.

3 - Ammo Isolation and Culture

Due to safety concerns with the possibility of explosives accidentally cooking off and damaging a large portion of a base, the Munitions Storage Area (or "Bomb Dump" as it is commonly called) is usually isolated or barricaded from the rest of base. At some bases, such as RAF Welford in United Kingdom, the ride to work can take as long as fifty minutes. Isolation from the main base breeds a culture within the Munitions section where the troops go out of their way to take care of their own.

The official motto of the Ammo career field as learned by Ammo troops on the first day of technical training is "If you ain't Ammo, you ain't shit". Often seen abbreviated as I.Y.A.A.Y.A.S. Weapons troop added a corollary to this motto: "if you are Ammo, you are shit". In recent months, however, directives to Ammo Chiefs from Air Force leadership have instructed that "AMMO Calls" will no longer be tolerated at official functions (ALS/NCOA graduations, Awards Banquets, etc.), determining that to allow such rowdiness to occur in public will offend the delicate sensibilities of the remainder of the base populace. Most AMMO chiefs appear to disagree with this directive, but follow it begrudgingly because it is a directive from the powers that be.

The Ammo career field has a very close family mentality. Ammo troops are expected to treat each other as brothers and sisters. They are expected to take care of each other and each other's families in times of need, especially true of the families of troops who are deployed. This also applies to former Ammo troops. Ammo troops are often known to be a rowdy but good-natured crowd with a reputation for drinking. As part of the family mentality and the reputation for drinking, Ammo troops are always expected to make sure other troops make it home safely no matter what hour the call should come, whether they personally provide a ride or arrange for a ride, all Ammo troops are generally held responsible for each other in this matter.

3 - 1 - Ammo Challenge coins

Ammo challenge coins come in many shapes and sizes. Normally they are a large metal coin with Ammo related graphics and phrases either printed or stamped on both sides

Once a person becomes an AMMO troop they are considered an AMMO troop for life. It is expected of them to carry an Ammo coin (Also referred to as an "Ammo challenge coin") on their person at all times, on duty and off duty, for the rest of their life. Should any Ammo troop be asked to present their Ammo coin (Known as getting coin checked) at any time by another Ammo troop and they fail to present it, it is expected that the Ammo troop who does not present their coin buys a beverage of choice (normally beer) for the Ammo troop(s) who coin checked them. However if the Ammo troop(s) being coin checked has their coin, the troop(s) who initiated the coin check is expected to buy the Ammo troop(s) that were checked a beverage of choice.

In order to coin check an Ammo troop, the person who initiates the coin check must have an Ammo coin and strike it on an object, normally a table or a bar or even purposely throw it on the ground to initiate the coin check. However if a person inadvertently drops their Ammo coin and fails to catch it before it strikes a surface, they will be considered to be initiating a coin check, and any Ammo troop present will be expected to produce their Ammo coin to Challenge the inadvertent coin check, in which case the troop dropping their coin and any troop not able to present their coin, will be expected to buy the troops who successfully present their coin a beverage of choice. Coin checks can not be performed during duty time.

4 - Specific Jobs

Currently AMMO has at least nine distinct working areas within the AFSC. While under the current Air Force structure Munitions personnel only are considered AMMO, the concept of AMMO was much more inclusive throughout the Viet Nam War era including all former 46 XX0 career fields, normally under the Munitions Maintenance Squadron (MMS) heading. 461x0 Munitions Maintenance (commonly called BB Stackers), 462x0 Weapons Maintenance (commonly called Loaders or Load Toads), 463x0 Nuclear Weapons Specialist (commonly called Nuke Pukes) and 464x0 Explosive Ordnance Disposal all shared a common heritage and were consolidated under one organization. They worked together, lived in common dormitories, fought together and partied together until the 1980s when the divisive CMU concept was implemented and MMS personnel were farmed out to EMS (Equipment Maintenance Squadron), AGS (Aircraft Generation Squadron) and even Supply Squadron. Now Munitions personnel were ignobly assigned with such diverse and unrelated occupations as Wheel & Tire Maintenance, Aerospace Ground Equipment, Corrosion Control, and Phase Docks often losing the commonality of experience and pride previously achieved under the MMS concept.

4 – 1 - Equipment Maintenance

'TM' or 'Maintenance' (previously called Trailer Maintenance), is the hub of all maintenance for the job - specific trailer equipment that is unique to AMMO. Maintenance and Inspections are performed on Munitions Material Handling Equipment (MMHE) such as the MHU-141, MHU-110, LALS, UALS, and the newer MHU-226 trailers. This shop is also known as the Punishment shop. It is usually where all the "dirt bags" are sent after getting DUIs.

4 – 2 - Precision Guided Munitions

'Missile Shop' or 'PGM' (Precision Guided Munitions) is responsible for the testing and maintenance of all conventional air-to-air and air-to-ground munitions used on aircraft. In some cases PGM will take responsibility for guided air-to-ground bombs as well.

4 – 3 - Line Delivery

'Line-D' drivers are dispatched by Munitions Control and are responsible for the safe and expedient handling and delivery of munitions from the bomb dump, or other storage locations, to aircraft. Drivers are held responsible for the accounting of their equipment and munitions movements via daily reconciliation, or "recon", which is an accounting of all these movements that is verified three ways between the flight line, Munitions Control, the Line-D driver, with a zero percent discrepancy tolerance.

4 – 4 - Conventional Maintenance

'Conventional' is responsible for the construction, maintenance, and testing of all conventional air-to-ground munitions used on aircraft, ranging from chaff and flares to cannon ammunition and guided and unguided bombs. There is a joke among AMMO troops regarding guided vs. unguided bombs. "The Air Force is an equal opportunity employer. Being that we employ smart bombs, dumb bombs as well as retarded bombs."

4 – 5 - Munitions Control

'Control' can be thought of as the nerve center of the bomb dump. Control tracks work crews, coordinates requirements, acts as a liaison for outside agencies, develops war plans, provides oversight for safety and security, and ensures the daily reconciliation of all munitions and related equipment against established inventories. A good control will always know where any assets are.

4 – 6 - Storage and Handling

'Storage' is responsible for storing and breaking out munitions required by Conventional Maintenance and Munitions Inspection, and is also responsible for the maintenance of the munitions storage facilities, usually called "igloos", "magazines", or revetments ("revvies"). Storage is also used to transport munitions over public right-of-ways to transfer munitions between different storage or shipping and receiving locations. Storage troops operate the majority of the heavier equipment found in the bomb dump, including "18 wheelers", heavy-rated forklifts, and cranes.

4 – 7 - Munitions Inspection

All munitions items at various times need to be inspected for safety and compliance with technical instructions. Specially trained NCOs and Airmen known as Munitions Inspectors accomplish this sometimes tedious task. Inspectors attend Inspector School, which lasts approximately 3 weeks and is usually conducted at the AMMO Schoolhouse located at Sheppard AFB, Texas. However, due to cost restraints, the two major commands of PACAF and USAFE have developed their own schools, allowing the school house the ability to come to the students. Inspectors are required to be appointed in writing by the Munitions Flight Chief after an interview process and a few months of tedious on-the-job training.

4 – 8 - Munitions Accountability

'AFK' is responsible for the accountability and logistics for the entire munitions stockpile. They are the core of Ammo. Those who worked in this area used to be classified under the 645X0A Supply career field, In 1986 the career field changed to a maintenance career field 465X0 rather than the 461X0 Maintenance career field the rest of AMMO was under. Personnel attended technical school at Lowry AFB, Colorado and arrived at their first base to find themselves standing part-way between the Base Supply world and the world of AMMO. In the early days before automation all Air Force logistics accounts were designated by a three position prefix i.e. AFB (Supplies), AFE (Equipment), AFK (Munitions). Thus this office became known as 'AFK'. With the introduction of automation the 'A' was dropped and the munitions account was identified as 'FK' as used in the automated Standard Base Supply System (SBSS) but the old name 'AFK' still remained. When 645X0A left the Supply career field and became its own career field 465X0, the accountability for munitions needed to be separated from SBSS. The account code was changed to "FV" to reflect accountability under a new, AMMO-specific system: the Combat Ammunition System, or "CAS." This new acronym never really caught on as a nickname the way AFK did and as the new 2W0X1 career field became homogenized, the shop became officially known as either "Accountability" or "Munitions Ops", though it is still referred to as "AFK" by most Ammo troops.

4 – 9 - Other specialized shops

Some shops only exist at one base, or a limited number of bases, and other shops are often combined, depending on the mission of the given base. Examples of such shops are as follows :

TARRP - "Tactical Airmunition Rapid Response Package." 18 MUNS, Kadena AB, Japan and 86 MUNS, Ram stein AB, Germany, implements TARRP. This shop is responsible for keeping bombs and missiles loaded on aircraft pallets ready to be deployed at a moment's notice. The TARRP arsenal consists of munitions including, but not limited to, MK82s, MK84s, BLU109s, AGM-65s, AIM-9s, and AIM-120s.

STAMP - "Standard Air Munitions Package." 649 MUNS, Hill AFB, Utah implements STAMP. Similar to TARRP with the exception that the bombs and missiles are not already loaded onto aircraft pallets.

ISO Maintenance/Fabrication - 18 MUNS, Kadena AB, Japan, repairs ISOs and maintains PACAF's largest AMMO blocking and bracing lumber stockpile. Fabrication personnel, along with their Okinawan counterparts, repair ISOs and construct blocking and bracing for various ISO outloads. They also build wooden furniture for the "bomb-dump" and maintain 18 MUNS haunted house, known as "the haunted castle".

At other bases, Line-D and TM, Conventional and PGM, and even Control and AFK are combined into one shop, and other munitions organizations include nuclear weapons handling and storage.

5 - Shakey the Pig

Shakey the Pig is the mascot of the 36th Air Base Wing's Munitions Squadron. Just within the gate of the bomb dump of Andersen AFB, a pig poke contains a living, wild pig that has become the bomb dump's "official" pet. Shakey has a "pig house" in the shape of a munitions igloo, a small pond, and a porcine play pen. Shakey has gone through numerous "upgrades"- as one pig dies, another wild piglet is caught in the wilds of the bomb dump's jungle and adopted as the next "Shakey". As late as December, 1994, the 36th MUNS was on version "Shakey the 5th", in November, 2006, the bomb dump at Andersen AFB was on version "Shakey the 8th", and as of November, 2009, the 36th MUNS was on "Shakey the 12th". Shakey was also known for his spuratic erections where he would display sounds of urgency when around female ammo troops. Shakey is considered a dear pet by the AMMO troops of the 36th MUNS, and visitors always stand in invitation to visit and feed him, despite the fact that Shakey is penned within a "Controlled Area". Shakey is well cared for by his fellow AMMO troops, and given medical and dental care by the base vet as needed. His diet is now closely regulated and he is taken care of by AMMO troops. He also has a Papaya tree growing in his pen.

Shakey appears to be the only living, sanctioned (unit funds pay for food and health care) mascot of any current unit in the U.S. Air Force.

An article on Shakey in Airman Magazine, an official publication of the U. S. Air Force, can be read here:[1]

6 - Duty Stations

Active Duty, Reserve, and Air National Guard AMMO personnel can be assigned any of a large number of military bases. Air Force bases that host non-combat aircraft or no aircraft such as Randolph AFB, TX and Vance AFB, OK have their Ammo mission accomplished by Air Force civil service personnel who are primarily made up of retired or prior service AMMO troops. Some past and present AMMO bases include:

6 – 1 – United States[edit]

Andersen AFB, Guam;
Barksdale AFB, Louisiana;
Bergstrom AFB, Texas (CLOSED 1993);
Beale AFB, California (Home of AFCOMAC);
Bolling AFB, Washington, DC;
Buckley AFB, Aurora, CO;
Burlington IAP, ANGB-VTANG, S. Burlington, VT;
Carswell AFB, Transferred to the Dept of the Navy and renamed NAS Fort Worth JRB Carswell
Creech AFB, Nevada;
Cannon AFB, New Mexico
Davis-Monthan AFB, Arizona;
Dover AFB, Delaware;
Dyess AFB, Texas;
Edwards AFB, California;
Eglin AFB, Florida;
Elmendorf AFB, Alaska;
Ellsworth AFB, South Dakota;
Eielson AFB, Alaska;
Fairchild AFB, Washington;
F.E. Warren AFB, Wyoming;
George AFB, California; (Closed 1992)
Gowen Field ANGB, Boise Airport, Boise, Idaho;
Hickam AFB, Hawaii;
Hill AFB, Utah;
Holloman AFB, New Mexico;
Homestead ARB, Florida;

Hurlburt Field, Florida;
Keesler AFB, Mississippi;
Kirtland AFB, New Mexico;
Lackland AFB, Texas;
Langley AFB, Virginia;
Luke AFB, Arizona;
Little Rock AFB, Arkansas;
Macdill AFB, Florida;
Malmstrom AFB, Montana;
McChord AFB, Washington;
Medina Annex - Lackland/Kelly AFB, Texas;
Mountain Home AFB, Idaho;
Minot AFB, North Dakota;
Moody AFB, Georgia;
Niagara Falls ARS, Niagara Falls, New York;
Nellis AFB, Nevada;
Offutt AFB, Nebraska;
Pope Field, North Carolina;
Reno ANGB, Nevada;
Seymour Johnson AFB, North Carolina;
Shaw AFB, South Carolina;
Sheppard AFB, Texas; (Technical school)
Travis AFB, California;
Tyndall AFB, Florida;
Vandenberg AFB, California;
Wheeler AFB, Hawaii (Transferred to U.S. Army November 1, 1991);
Whiteman AFB, Missouri;
Wright-Patterson AFB, Ohio;
Hancock Field ANGB, New York;

6 – 2 – Asia

Kunsan AB, South Korea;
Kwang Ju AB, South Korea;
Kadena AB, Okinawa, Japan;
Misawa AB, Japan;
Osan AB, South Korea;

Yokota AB, Japan;
Danang AB, Vietnam;
Tuy Hoa AB, Vietnam;
Korat AB, Thailand;
Takhli AB, Thailand;
Tainan AB, Taiwan;
Diego Garcia, British Indian Ocean Territory;
Udorn RTAFB, Thailand;

6 – 3 - Middle East

Al Kharj / Prince Sultan Air Base (PSAB), Saudi Arabia; Closed
Al Udeid, Qatar;
Dhahran, Saudi Arabia (Khobar Towers - Closed 1996);
Ali Al Salem, Kuwait;
Al Dhafra AB, United Arab Emirates;

6 – 4 – Europe

Araxos, Greece; closed at the end of May 2001.
Aviano AB, Italy;
Bitburg AB, Germany
Camp Darby, Italy;
Hahn Air Base, Germany; (Closed in mid-90's)
Incirlik, Turkey;
Morbach (Wenigerath) AMMO Storage Area Morbach, Germany; (Closed in 1995)
Naval Air Station Keflavik, Iceland; (Closed September, 2006)
Ramstein AB, Germany;
RAF Bentwaters, England; (Closed in 1993)
RAF Woodbridge, England; (Closed in 1993)
RAF Alconbury, England; (Bomb dump closed 1995)
RAF Molesworth, England; (GLCM)
RAF Wethersfield, England; (Closed in 1990)
RAF Croughton, England; (Host for RAF Welford)
RAF Welford, England;
RAF Greenham Common, England; (GLCM closed in 1992)
RAF Fairford, England; (Standby Base as of Sept. 2010)
RAF Upper Heyford, England; (Closed in 1994)

RAF Lakenheath, England;
RAF Mildenhall, England;
Rhein-Main AB, Germany; (Closed December, 2005)
Spangdahlem AB, Germany;
Lajes AB, Azores Islands, Portugal

Ammonal

Contents

1 - Introduction

Ammonal is an explosive made up of ammonium nitrate, tri nitro toluene and aluminum powder.

The ammonium nitrate functions as an oxidizer and the aluminum as fuel. The use of the relatively cheap ammonium nitrate and aluminum makes it a replacement for pure TNT.

The mixture is affected by humidity because ammonium nitrate is highly hygroscopic. Ammonal is not easily detonated, requiring a fairly substantial shock, though it is still more sensitive than trinitrotoluene and C- 4 .

The detonation velocity of ammonal is approximately 4,400 meters per second .

2 – History

From early 1916, the British Army employed ammonal for their mines during World War I, starting with the Hawthorn Ridge mine during the Battle of the Somme. Three of the mines used at the Battle of Messines, which were exploded at the start of the Third Battle of Ypres (a.k.a. Battle of Passchendaele), contained over 13.6 metric tons of ammonal. A fourth contained over 9 metric tons . The British Army detonated 19 ammonal mines under the German lines, killing 10,000 in the deadliest non - nuclear man - made explosion in history.

Not all of the mines that had been laid at Messines were detonated. Two of the original 21 mines were not ignited because they were outside the area of the offensive. On 17 July 1955, a lightning strike set off one of the remaining mines. There were no human casualties, but one cow was killed. The 21st mine is believed to have been found , but no attempt has been made to remove it. It is possible that the one unexploded mine was dismantled, because German tunnellers were coming too close to the chamber.

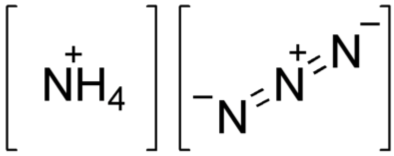
Ammonal used for military mining purposes was generally contained within metal cans or rubberized bags to prevent moisture ingress problems. The composition of ammonal used at Messines was 65 % ammonium nitrate, 17 % aluminum, 15 % tri nitro toluene (TNT), and 3 % charcoal . Ammonal remains in use as an industrial explosive. Typically, it is used for quarrying or mining purposes.

3 – Proportions

An ammonal mixture previously used in hand grenades and shells has the proportions (by mass) :

Ammonium nitrate 58.6 %
Aluminum powder 21 %
Charcoal 2.4 %
TNT 18 %

Ammonium Azide



Other names : Ammonium trinitride	
Molecular formula	NH_4N_3, $NH_3.HN_3$
Molar mass	60 g / mol
Appearance	white crystalline solid
Odor	odorless
Density	1.3459 g / cm^3
Melting point	160 °C
Boiling point	400 °C decomp.
Main hazards	Very Toxic, Explosive

Contents

1 - Introduction

Ammonium azide is the chemical compound with the formula NH_4N_3, being the salt of ammonia and hydrazoic acid. Like other inorganic azides, this colourless crystalline salt is a powerful explosive, although it has a remarkably low sensitivity. NH_4N_3 is physiologically active: inhalation of small amounts causes headaches and palpitations. It was first obtained by Theodor Curtius in 1890, along with other azides.

2 - Structure

Ammonium azide is ionic. It is scarcely soluble in water. Ammonium azide contains about 93 % nitrogen by weight as ammonium cation and azide anion. It is a structural isomer of tetrazene.

Ammonium Chlorate

IUPAC name : Ammonium chlorate	
Molecular formula	H_4ClNO_3
Molar mass	101.5 g mol^{-1}
Appearance	small colorless crystals
Density	2.42 g/cm^3
Melting point	380 °C (de comp)
Main hazards	strong oxidant, decomposes when heated

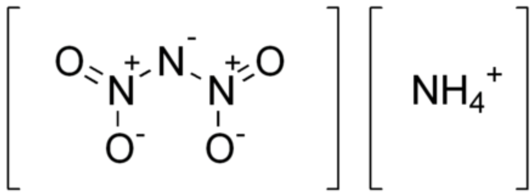
Ammonium chlorate is an inorganic compound with the formula NH_4ClO_3.

It is obtained by neutralizing chloric acid with either ammonia or ammonium carbonate, or by precipitating barium, strontium or calcium chlorates with ammonium carbonate or ammonium sulfate, producing the respective carbonate or sulfate precipitate and an ammonium chlorate solution. Ammonium chlorate crystallizes in small needles, readily soluble in water.

On heating, ammonium chlorate decomposes at about 102 °C, with liberation of nitrogen, chlorine and oxygen. It is soluble in dilute aqueous alcohol, but insoluble in strong alcohol. This compound is a strong oxidizer and should never be stored with flammable materials.

Ammonium chlorate is a very unstable oxidizer and will decompose, sometimes violently, at room temperature. This results from the mixture of the reducing ammonium cation and the oxidizing chlorate anion. It will explode when exposed to sunlight for a few minutes. Even solutions are known to be unstable. Because of the dangerous nature of this salt it should only be kept in solution when needed, and never be allowed to crystallize.

Ammonium Dinitramide

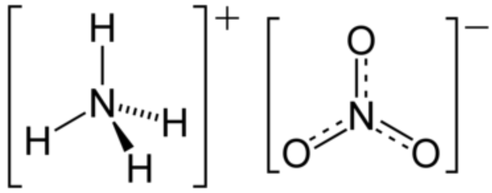


IUPAC name : Ammonium Dinitramide	
Molecular formula	$H_4N_4O_4$
Molar mass	124 g mol^{-1}
Density	1.81 g / cm^3
Melting point	93 °C
Boiling point	decompose

Ammonium Dinitramide (**ADN**) is the ammonium salt of dinitraminic acid. ADN decomposes under heat to leave only nitrogen, oxygen, and water. The ions are the ammonium ion NH_4^+ and the dinitramide $N(NO_2)_2^-$. It was originally invented in the Soviet Union, but remained classified until it was discovered independently in the United States in 1989 at SRI International. SRI obtained US and international patents for ADN in the mid-1990s at which time scientists from the former Soviet Union revealed they had discovered ADN in the 1970s.

It makes an excellent solid rocket oxidizer with a slightly higher specific impulse than ammonium perchlorate and more importantly, does not leave hydrogen chloride fumes. It decomposes into low molecular mass gases so it contributes to higher performance without creating excessive temperatures if used in gun or rocket propellants. The salt is prone to detonation under high temperatures and shock more so than the perchlorate. It can be synthesized from ammonium nitrate, nitric acid, and super concentrated sulfuric acid, to which a base other than ammonia must be added before the acid dinitramide decomposes. The final product is obtained by fractional crystallization.

Ammonium Nitrate



Contents

1 - Introduction

The chemical compound **ammonium nitrate**, the nitrate of ammonia with the chemical formula NH_4NO_3, is a white crystalline solid at room temperature and standard pressure. It is commonly used in agriculture as a high - nitrogen fertilizer, and it has also been used as an oxidizing agent in explosives, including improvised explosive devices. It is the main component of ANFO, a popular explosive, which accounts for 80% explosives used in North America. It is used in instant cold packs, as hydrating the salt is an endothermic process.

Ammonium nitrate is found as a natural mineral (ammonia niter — the ammonium analogue of saltpeter and other niter minerals like sodium nitrate) in the driest regions of the Atacama Desert in Chile, often as a crust on the ground and/or in conjunction with other nitrate, chlorate, iodate, and halide minerals. Ammonium nitrate was mined there in the past, but virtually 100 per cent of the chemical now used is synthetic.

IUPAC name : Ammonium nitrate	
Molecular formula	$(NH_4)\ (NO_3)$
Molar mass	80 g / mol
Appearance	White / grey solid
Density	1.725 g/cm^3 (20 °C)
Melting point	169.6 °C
Boiling point	*approx.* 210 °C de comp.
Solubility in water	150 g / 100 ml (20 °C) 410 g / 100 ml (60 °C) 1024 g / 100 ml (100 °C)
Crystal structure	trigonal
Explosive data	
Shock sensitivity	very low
Friction sensitivity	very low
Explosive velocity	5270 m/s
Main hazards	Explosive
LD_{50}	2085 – 5300 mg / kg (oral in rats , mice)

2 – Fertilizer

Ammonium nitrate is an important fertilizer with the NPK rating 34-0-0 (34% nitrogen). It is less concentrated than urea (46-0-0) giving ammonium nitrate a slight transportation disadvantage. Ammonium nitrate's advantage over urea is that it is more stable and does not lose nitrogen to the atmosphere. During warm weather, urea should only be applied before imminent rain in order to minimize nitrogen loss.

3 – Safety , handling and storage

Health and safety data are shown on the material safety data sheets available from suppliers and found on the internet.

Heating or any ignition source may cause violent combustion or explosion. Ammonium nitrate reacts with combustible and reducing materials as it is a strong oxidant. Although it is mainly used for fertilizer it can be used for explosives. It was sometimes used to blast away earth to make farm ponds . Ammonium nitrate is also used to modify the detonation rate of other explosives, such as ammonia-based dynamites, for example nitroglycerin .

Numerous safety guidelines are available for storing and handling ammonium nitrate.[10] It should not be stored near combustible substances or certain fertilizers, especially urea.

Ammonium nitrate has a critical relative humidity of 59.4%, above which it will absorb moisture from the atmosphere. Therefore, it is important to store ammonium nitrate in a tightly sealed container. Otherwise it can coalesce into a large, solid mass. Ammonium nitrate can absorb enough moisture to liquefy.

The potential for use of the material as an explosive has prompted regulatory measures. For example in Australia, the Dangerous Goods Regulations came into effect in August 2005 to enforce licensing in dealing with such substances.[11] Licenses are granted only to applicants (industry) with appropriate security measures in place to prevent any misuse.[12] Additional uses such as education and research purposes may also be considered but individual use will not. Employees of those with licenses to deal with the substance are still required to be supervised by authorized personnel and are required to pass a security and national police check before a license may be granted.

4 – Production

The processes involved in the production of ammonium nitrate in industry, although chemically simple, are technologically challenging. The acid - base reaction of ammonia with nitric acid gives a solution of ammonium nitrate :

$$HNO_3\,(aq) + NH_3\,(l) \rightarrow NH_4NO_3\,(aq)$$

For industrial production, this is done using anhydrous ammonia gas and concentrated nitric acid. This reaction is violent and very exothermic. After the solution is formed, typically at about 83% concentration, the excess water is evaporated to an ammonium nitrate (AN) content of 95% to 99.9 % concentration (AN melt), depending on grade. The AN melt is then made into "prills" or small beads in a spray tower, or into granules by spraying and tumbling in a rotating drum. The prills or granules may be further dried, cooled, and then coated to prevent caking. These prills or granules are the typical AN products in commerce.

The Haber process combines nitrogen and hydrogen to produce ammonia, part of which can be oxidized to nitric acid and combined with the remaining ammonia to produce the nitrate. Another production method is used in the so - called Odda process.

Ammonium nitrate can also be made via metathesis reactions :

$(NH_4)_2SO_4 + 2\ NaNO_3 \rightarrow 2\ NH_4NO_3 + Na_2SO_4$
$(NH_4)_2SO_4 + Ca(NO_3)_2 \rightarrow 2\ NH_4NO_3 + CaSO_4$

Sodium sulfate is removed by lowering the temperature of the mixture. Since sodium sulfate is much less water-soluble than ammonium nitrate, it precipitates, and may be filtered off. For the reaction with calcium nitrate, the calcium sulfate generated is quite insoluble, even at room temperature.

5 – Reactions

Ammonium nitrate reacts with metal hydroxides, releasing ammonia and forming alkali metal nitrate

$$NH_4NO_3 + Na\ OH \rightarrow NH_3 + H_2O + NaNO_3$$
$$NH_4NO_3 + KOH \rightarrow NH_3 + H_2O + KNO_3$$

Ammonium nitrate gives ammonium chloride and nitric acid upon reaction with hydrochloric acid :

$$NH_4NO_3 + H\ Cl \rightarrow NH_4Cl + HNO_3$$

Ammonium nitrate leaves no residue when heated :

$$NH_4NO_3\ \Delta \rightarrow N_2O + 2H_2O$$

Ammonium nitrate is also formed in the atmosphere from emissions of NO, SO_2 and NH_3 and is a secondary component of PM10.

6 - Crystalline phases

Transformations of the crystal states due to changing conditions (temperature, pressure) affect the physical properties of ammonium nitrate. The following crystalline states have been identified:

System	Temperature (°C)	State	Volume Change (%)
-	> 169.6	liquid	-
I	169.6 to 125.2	cubic	+2.1
II	125.2 to 84.2	tetragonal	−1.3
III	84.2 to 32.3	α - rhombic	+3.6
IV	32.3 to −16.8	β - rhombic	−2.9
V	−16.8	tetragonal	-

The type V crystal is a quasi - cubic form which is related to caesium chloride, the nitrogens of the nitrates and the ammoniums are at the sites in a cubic array where Cs and Cl would be in the CsCl lattice.

7 - Health hazards

Health and safety data are shown on the material safety data sheets which are available from suppliers and can be found on the internet.

Ammonium nitrate is not an extremely hazardous chemical and is usually used in fertilizer products . The chances of direct personal exposure to the chemical are very low, because the fertilization of the soil by use of ammonium nitrate is done at early stages of plant growth and usually does not remain detectable on the harvested plants or when the plants reach the consumer .

Ammonium nitrate has an LD_{50} of 2217 mg/kg,[6] which for comparison is about two - thirds that of table salt.

7 – 1 - Acute health effects

Short - term exposure to ammonium nitrate can cause symptoms ranging from minor irritation to nausea , vomiting , gastric irritation, headaches, dizziness and hypertension.

Area of exposure	Hazard level
Ingestion	Moderately hazardous
Skin contact	Moderately hazardous (irritant)
Eye contact	Moderately hazardous
Inhalation	Moderately hazardous

7 – 2 – Long - term health effects

The toxicity of nitrates when ingested is due to in vivo conversion to nitrites. The material safety data sheet considers chronic ingestion of more than 5 mg / kg / day unacceptable. The primary overdose effects of chronic exposure are orthostatic hypotension and methemoglobinemia. Other common effects include: faintness, fatigue , weakness , depression, mental impairment, dizziness, shortness of breath, and reflex tachycardia; headache, nausea, vomiting, and nephritis may also occur.

Types of effect	Effect level
Carcinogenic effects	Though no ammonium-nitrate-specific studies are available, nitrates can be reduced to nitrites in the body, and the formed nitrites can subsequently react with amines to form suspect carcinogens N-nitrosamine.
Mutagenic effects	In general, nitrates and nitrites are genotoxic.
Developmental toxicity	Though not specific to ammonium nitrate, some studies have shown a link between birth defects (particularly neural tube defects) and nitrate-contaminated well water.

Prolonged exposure	Causes damage to lungs and mucous membranes and may also cause damage to blood and gastrointestinal tract. Chronic ingestion may also cause nephritis.[6]

8 – Disasters

Ammonium nitrate decomposes into the gases nitrous oxide and water vapor when heated (non - explosive reaction) ; however, ammonium nitrate can be induced to decompose explosively by detonation. Large stockpiles of the material can be a major fire risk due to their supporting oxidation, and may also detonate, as happened in the Texas City disaster of 1947, which led to major changes in the regulations for storage and handling.

There are two major classes of incidents resulting in explosions:

In the first case , the explosion happens by the mechanism of shock – to - detonation transition. The initiation happens by an explosive charge going off in the mass, by the detonation of a shell thrown into the mass, or by detonation of an explosive mixture in contact with the mass..

In the second case , the explosion results from a fire that spreads into the ammonium nitrate itself (Texas City , Brest , Oakdale) , or from a mixture of ammonium nitrate with a combustible material during the fire (Repauno , Cherokee, Nadadores). The fire must be confined at least to a degree for successful transition from a fire to an explosion (a phenomenon known as "deflagration-to-detonation transition", or DDT). Pure, compact AN is stable and very difficult to ignite, and there are numerous cases when even impure AN did not explode in a fire.

Ammonium – nitrate - based explosives were used in the Oklahoma City bombing and in the 2011 Delhi bombing, 2013 Hyderabad blasts and the bombing in Oslo 2011.

Ammonium nitrate decomposes in temperatures normally well above 200 °C. However the presence of impurities (organic and/or inorganic) will often reduce the temperature point when heat is being generated. Once the AN has started to decompose, then a runaway reaction will normally occur as the heat of decomposition is very large. AN evolves so much heat that this runaway reaction is normally impossible to stop. This is a well-known hazard with some types of N-P-K Fertilizers, and it is responsible for the loss of several cargo ships.

Under normal handling conditions, ammonium nitrate is not harmful. However, inhalation of high concentrations of ammonium nitrate dust can cause respiratory tract irritation. Symptoms may include: coughing, sore throat, shortness of breath, or even suffocation. When swallowed in high concentrations, ammonium nitrate may cause headache, dizziness, abdominal pain, vomiting, bloody diarrhea, weakness, a tingling sensation, heart and circulation irregularities, convulsions, collapse, and suffocation. Ammonium nitrate forms a mild acid when mixed with water. This acid can cause irritation to the eyes, nose, and skin.

In November 2009, a ban on ammonium sulfate, ammonium nitrate, and calcium ammonium nitrate fertilizers was imposed in the former Malakand Division—comprising the Upper Dir , Lower Dir, Swat, Chitral, and Malakand districts of the North West Frontier Province (NWFP) of Pakistan—by the NWFP government, following reports that those chemicals were used by militants to make explosives. In January 2010, these substances were also banned in Afghanistan for the same reason. After several cases, AN has now been legalised due to the Pakistani forces of NWFP.

Ammonium nitrate was suspected as the explosive responsible for the fertilizer plant explosion in West, Texas on April 17, 2013. Investigators said they believe it exploded following a fire that began in the plant's office.[20]

9 - Mixture with fuel oil

ANFO is a mixture of 94% ammonium nitrate and 6% fuel oil (ANFO) widely used as a bulk industrial explosive.[21]:1 It is used in coal mining, quarrying, metal mining, and civil construction in undemanding applications where the advantages of ANFO's low cost and ease of use matter more than the benefits offered by conventional industrial explosives, such as water resistance, oxygen balance, high detonation velocity, and performance in small diameters.

Ammonium Nitrate Disasters

Contents

1 - Introduction

Ammonium nitrate decomposes into gases including oxygen when heated (non - explosive reaction) ; however, ammonium nitrate can be induced to decompose explosively by **detonation**. Large stockpiles of the material can be a major fire risk due to their supporting oxidation, and may also detonate, as happened in the Texas City disaster of 1947, which led to major changes in the regulations for storage and handling.

There are two major classes of incidents resulting in explosions:

In the first case, the explosion happens by the mechanism of shock to detonation transition. The initiation happens by an explosive charge going off in the mass, by the detonation of a shell thrown into the mass, or by detonation of an explosive mixture in contact with the mass. The examples are Kriewald, Morgan, Oppau, Tessenderlo and Traskwood.

In the second case, the explosion results from a fire that spreads into the ammonium nitrate (AN) itself (Texas City, Brest), or to a mixture of an ammonium nitrate with a combustible material during the fire. The fire must be confined at least to a degree for successful transition from a fire to an explosion (a phenomenon known as "deflagration to detonation transition", or DDT). Pure, compact AN is stable and very difficult to initiate. However, there are numerous cases when even impure AN did not explode in a fire.

Ammonium nitrate decomposes in temperatures above 210 °C. Pure AN is stable and will stop decomposing once the heat source is removed, but when catalysts are present (combustible materials, acids, metal ions, chlorides.) the reaction can become self-sustaining (known as self-sustaining decomposition, SSD). This is a well-known hazard with some types of NPK fertilizers, and is responsible for the loss of several cargo ships.

2 - Timeline of major disasters

	Notes
United Kingdom Faversham, Kent April 2, 1916 Deaths 120	**The Great Explosion**: On April 2, 1916 a factory in Uplees, Faversham, exploded after a fire spread to a store of 15 tons of TNT and 150 tons of ammonium nitrate. The blast at the Explosives Loading Company killed 120 people and shattered windows in Southend-on-Sea across the Thames Estuary while the tremor was felt in Norwich.
United States Morgan, New Jersey (now Sayreville) October 4, 1918 Deaths 0	**T. A. Gillespie Company Shell Loading Plant explosion**: On October 4, 1918, an explosion at the Morgan Depot occurred leading to many artillery shells being launched into the air, some of which landed on a neighboring warehouse where 4000 tones of ammonium nitrate were stored in barrels. One of the shells caused a large explosion, but the majority of the ammonium nitrate did not detonate.
Germany Kriewald July 26, 1921 Deaths 19	On July 26, 1921, in this railway town (now in Poland) workers tried to dislodge 30 tonnes of ammonium nitrate that had aggregated (solidified into one mass) in two wagons. When mining explosives were used on this solid mass the wagons exploded and killed nineteen people.
Germany Oppau September 21, 1921 Deaths 561	**Explosion at BASF plant Oppau**: Another attempt at disaggregation of a fertilizer mix with industrial explosives caused the death of 561 people and left more than 2000 injured. The

fertilizer was a 50:50 mixture of ammonium nitrate and ammonium sulfate and the factory had used this method of disaggregation over 20,000 times without incident. It is thought that, on this occasion, poor mixing had led to certain parts of the mass containing more ammonium nitrate than others. Only 450 tones exploded, out of 4500 tones of fertilizer stored in the warehouse.

United States Nixon, New Jersey (now Edison Township) March 1, 1924 Deaths 20	**1924 Nixon Nitration Works disaster**: On March 1, 1924, a fire and several large explosions destroyed a warehouse containing ammonium nitrate at the Nixon Nitration Works. The explosiveness of the product was perhaps enhanced, as it had been prepared using nitric acid that had previously been used for the production of TNT.
United States Muscle Shoals, Alabama 1925 Deaths 0	On April 4, 1925, and May 3, 1925, two carloads, each containing 220 barrels of ammonium nitrate, were dispatched from Muscle Shoals, Alabama and caught fire in transportation. The barrels had been stored in a warehouse with varying humidity for 6 years, so it is believed that they were ignited by friction with their nitrate-impregnated manila paper lining. Other shipments were reportedly more successful.
France Miramas August 5, 1940 Deaths 0	240 tones of ammonium nitrate in sacks exploded after being hit by a shell from a nearby fire in a munitions train.
Belgium Tessenderlo	Another attempt to disaggregate a pile of 150 tonnes of ammonium nitrate with industrial

April 29, 1942
Deaths 189

explosives ended tragically on April 29, 1942: 189 people were killed, 900 wounded.

United States
Texas City
April 16, 1947
Deaths 581

Texas City Disaster: The cargo ship *Grandcamp* was being loaded on April 16, 1947, when a fire was detected in the hold: at this point, 2600 tones of ammonium nitrate in sacks were already aboard. The captain responded by closing the hold and pumping in pressurised steam. One hour later, the ship exploded, killing several hundred people and setting fire to another vessel, the *High Flyer*, which was moored 250 meters away and which contained 1050 toes of sulfur and 960 tons of ammonium nitrate. The Grand camp explosion also created a power ful earth shock that broke windows as far as 40 miles away and knocked two small planes flying at 1,500 feet (460 m) out of the sky. The *High Flyer* exploded the next day, after having burned for sixteen hours. 500 tonnes of ammonium nitrate on the quayside also burned, but without exploding, probably because it was less tightly packed. All but one member of the Texas City fire department died.

France
Brest
July 28, 1947
Deaths 29

The cargo ship *Ocean Liberty* was loaded with 3300 toes of ammonium nitrate and various inflammable products when it caught fire at 12:30 July 28, 1947. The captain ordered the hold to be sealed and pressurized steam was pumped in. As this did not stop the fire, the vessel was towed out of the harbor at 14:00, and exploded at 17:00. The explosion caused 29 deaths and serious damage to the port of Brest.

- Red Sea 1954 Deaths 0	A fire was detected on the cargo ship *Tirrenia* on January 23, 1954, while it was carrying 4000 tones of ammonium nitrate. Attempts to extinguish the fire with steam were unsuccessful, and the ship was abandoned before it exploded later in the night.
United States Roseburg, Oregon August 7, 1959 Deaths 14	**The Roseburg Blast**: A truck carrying dynamite and ammonium nitrate caught fire early in the morning of August 7, 1959. When it exploded it killed 14 people and injured 125 more. Several blocks of downtown Roseburg were destroyed. The accident is locally referred to as "The Blast".
United States Traskwood, Arkansas December 17, 1960 Deaths 0	On December 17, 1960, a 96 freight car train suffered partial derailment, in which the last 23 cars were derailed. The derailed cars included: four fuel oil tank cars, two tank cars of gasoline, three tank cars of petroleum oil, four cars of lube oil drums, three cars of liquid fertilizer, one car of fuming nitric acid and two cars of fertilizer grade ammonium nitrate. In this particular accident, neither car of ammonium nitrate exploded . However, the nitric acid reacted with the fuel oil, essentially creating ANFO to feed the conflagration, resulting in the spread of the ammonium nitrate material around the incident site.
United States Kansas City, Missouri November 29, 1988 Deaths 6	On November 29, 1988, at 4:07 am two trailers containing approximately 23,000 kg of the explosive ANFO (ammonium nitrate with fuel oil) exploded at a construction site located near the 87 th street exit of Highway 71 in Kansas City, Missouri. The explosives were to be used in the blasting of rock while constructing

Highway 71. The result of the explosions were the deaths of six firemen from the Kansas City Fire Department's Pumper Companies 30 and 41. Both companies were dispatched after 911 calls indicated that a fire had been set to a pickup truck located near the trailers. The responding companies were warned that there were explosives on-site; however, they were unaware that the trailers were essentially magazines filled with explosives. At 4:07 am one of the "magazines" caught fire and a catastrophic explosion occurred, killing all six firemen instantly — only sparing remains were found. A second blast occurred 40 minutes later, although all fire crews had been pulled back at this time. The blasts created two craters, each approximately 100 feet (30 m) wide and 8 feet (2.4 m) deep. The explosions also shattered windows within a 10-mile (16 km) area and could be heard 40 miles (64 km) away. It was later determined that the explosions were acts of arson, set by individuals embroiled in a labor dispute with the construction company contracted to build the highway.

Papua New Guinea
Porgera Gold Mine
August 2, 1994
Deaths 11

At 9:45 am, 2 August 1994, 11 workers were killed when the sensitised AN emulsion plant they were working on exploded at the Porgera Gold Mine. The fatal explosion involved at most a few tonnes of explosive. A larger explosion of about 80 tonnes of emulsion (Ammonium Nitrate Emulsion, ANE, UN 3375) was caused by fires under storage facilities at the site at 11:02 am. There were no fatalities in the second explosion because the site had been evacuated. A mushroom cloud was seen to rise.

ANE is an emulsion of ammonium nitrate, fuel and water.

United States
Port Neal, Iowa
December 13, 1994
Deaths 4

Port Neal fertilizer plant explosion: At about 6:06 am on December 13, 1994, two explosions rocked the Port Neal, Iowa, ammonium nitrate processing plant operated by Terra Industries. Four people were killed and 18 injured. Approximately 5,700 tons of anhydrous ammonia were released and releases of ammonia continued for six days after the explosions. Groundwater under the processing plant was contaminated by chemicals released as a result of the blast. The timing of the explosion occurred prior to the start of the arrival of the 8:00 am shift personnel, or the death toll may have been larger.

China
Xingping, Shaanxi
January 6, 1998
Deaths 22

At midnight on January 6, 1998, the Xinghua Fertilizer company had a series of explosions in the plant. About 27.6 tons of Ammonium nitrate liquor was in a container there. The explosion claimed 22 lives, with a further 56 wounded. The explosion was officially announced as an accident.

France
Toulouse
September 21, 2001
Deaths 31

AZF: On September 21, 2001, at 10:15 am, in the AZF (Azote de France) fertiliser factory in Toulouse, France, an explosion occurred in a warehouse where the off-specification granular AN was stored flat, separated by partitions. About 200 – 300 tons is said to be involved in the explosion, resulting in 31 people dead and 2,442 injured, 34 of them seriously. The blast wave shattered windows up to 3 kilometers away, and the resulting crater was 10 metres deep and 50 meters wide. The exact cause remains unknown. The material damage was estimated at 2.3 billion euros. France's Environment Minister concluded the explosion "may have been a terrorist attack" as it was soon after the September 11 attacks and linked to worker with militant views.

Spain Cartagena, Murcia January 2003 Deaths 0	The fertilizer storage facility of Fertiberia held a self - sustained decomposition (SSD) fire in January 2003. The fire was controlled after most of the material was removed by mechanical means .
Spain Barracas March 9, 2004 Deaths 2	A truck carrying 25 tonnes of ammonium nitrate fertilizer exploded half an hour after a traffic accident on March 9, 2004, killing two people and injuring five others. The explosion, which could be heard at a distance of several kilometers caused a crater five metres deep.
Romania Mihăileşti, Buzău May 24, 2004 Deaths 18	**Mihăileşti explosion**: A truck carrying 20 tones of ammonium nitrate tipped over on the European road E85 near Mihăileşti at 4:57 am on May 24, 2004. Shortly afterwards, a fire started in the cabin. Two reporters got to the site of the accident and started filming while firemen were trying to stop the fire. Around 5:50 am the truck exploded, killing 18 and wounding 13 people. A crater 6.5 meters deep and 42 meters in diameter was formed by the explosion.
North Korea Ryongchŏn April 22, 2004 Deaths 162	**Ryongchon disaster**: A freight train carrying ammonium nitrate exploded in this important railway town near the Chinese border on April 22, 2004, killing 162 people and injuring over 3,000 others. The train station was destroyed, as

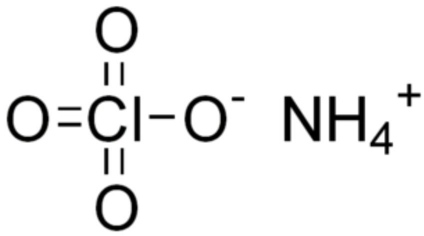
	were most buildings within 500 metres, and nearly 8,000 homes were destroyed or damaged. Two craters of about ten metres in depth were seen at the site of the explosion. The authorities blamed "human error" for the explosion, although rumors persist that it was in fact an attempt to assassinate the North Korean leader Kim Jong-Il, who was due to be passing through the station at the time.
Spain Estaca de Bares 2007 Deaths 0	The NPK fertilizer cargo of the ship *Ostedijk* sustained a self-sustained decomposition (SSD) fire for 11 days. The fire plume reached 10 m in diameter and several hundred meters in length. Special water spears were inserted inside the cargo to extinguish the fire.
Mexico Monclova, Coahuila September 10, 2007 Deaths 40	On September 10, 2007, near Monclova, Coahuila, México, a pick - up truck lost control and crashed into a trailer loaded with 22 tons of ammonium nitrate and fuel oil explosives (ANFO) leaving three occupants in the pick-up truck dead in the crash. A fire then started in the trailer's cabin and approximately 40 minutes after that, a huge explosion occurred, resulting in around 150 people injured and 37 more dead. A crater 9.1 m wide and 1.8 m deep was created due to the explosion.
United States Bryan, Texas July 30, 2009 Deaths 0	A plant in Bryan, Texas (El Dorado Chemical Company), which processes ammonium nitrate into fertilizer, caught fire at about 11:40 am on July 30, 2009. Over 80,000 residents in the Bryan/College Station area were asked to evacuate south of town due to the toxic fumes this fire generated. Texas A&M University provided shelter at Reed Arena, a local venue

on campus. Only minor injuries were reported.

United states
West, Texas
April 17, 2013
Deaths 15

West Fertilizer Company explosion: A fertilizer company in West, Texas, caught fire. Around 20 minutes later, ammonium nitrate stored there exploded, leveling roughly 80 homes and a middle school. 133 residents of a nearby nursing home were trapped in the ruins. In all, 15 were killed, and about 200 injured. There were reports that the facility had stored more ammonium nitrate than it was allowed to, without regulation by the Department of Homeland Security.

Ammonium Perchlorate



Contents

1 - Introduction

Ammonium perchlorate is an inorganic compound with the formula NH_4ClO_4. It is the salt of per chloric acid and ammonia. It is a powerful oxidizer, which is why its main use is in solid propellants. It has been implicated in a number of accidents, such as the PEPCON industrial disaster and the crash of South African Airways Flight 295.

IUPAC name : Ammonium perchlorate	
Other names : AP	
Molecular formula	$NH_4 Cl O_4$
Molar mass	117.5 g/mol
Appearance	White Crystalline
Density	1.95 g / cm^3
Melting point	Exothermic decomposition before melting at > 200 °C
Solubility in water	11.56 g/100 mL (0 °C) 20.85 g/100 mL (20 °C) 57.01 g/100 mL (100 °C)
Solubility	Soluble in Methanol partially soluble in Acetone insoluble in Ether

Crystal structure	Orthorhombic
MSDS	External MSDS
EU classification	Oxidant (**O**)
Auto ignition temperature	240 °C

2 – Production

Ammonium perchlorate (AP) is produced by reaction between ammonia and perchloric acid, and is the driver behind the industrial production of perchloric acid. It also can be prepared by treatment of ammonium salts with sodium perchlorate. This process exploits the fact that the solubility of NH_4ClO_4 is about 10% of that for sodium perchlorate.

AP crystallises into colorless rhombohedra.

3 – Decomposition

Like most ammonium salts, ammonium perchlorate decomposes before melting. Mild heating results in the evolution of chlorine, nitrogen, oxygen, and water.

$$2\ NH_4ClO_4 \rightarrow Cl_2 + N_2 + 2\ O_2 + 4\ H_2O$$

The combustion of AP is quite complex and is widely studied. AP crystals decompose before melting , even though a thin liquid layer has been observed on crystal surfaces during high - pressure combustion processes. Strong heating may lead to explosions. Complete reactions leave no residue. Pure crystals cannot sustain a flame below the pressure of 2 MPa.

AP is a Class 4 oxidizer (can undergo an explosive reaction) for particle sizes over 15 micrometers and is classified as an explosive for particle sizes less than 15 micrometers.

4 – Applications

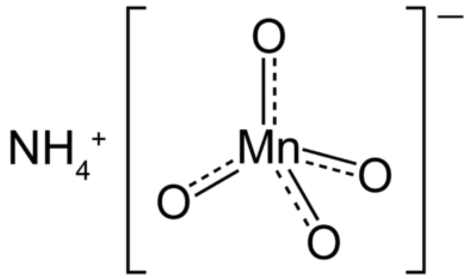
The vast majority of ammonium perchlorate is used to make solid propellants . When AP is mixed with a fuel (like a powdered aluminum and / or with an elastomeric binder) , it can generate self-sustained combustion at far under atmospheric pressure. It is an important oxidizer with a decades-long history of use in solid rocket propellants — space launch (including the Space Shuttle Solid Rocket Booster), military, amateur, and hobby high-power rockets, as well as in some fire works.

Some "breakable" epoxy adhesives contain suspensions of AP. Upon heating to 300 °C, the AP degrades the organic adhesive, breaking the cemented joint.

5 – Toxicity

Perchlorate itself confers little acute toxicity. For example, sodium perchlorate has an LD_{50} of 2-4 g/kg and is eliminated rapidly after ingestion. However, chronic exposure to perchlorates, even in low concentrations, has been shown to cause various thyroid problems, as it is taken up in place of iodine.

Ammonium Permanganate



IUPAC name . Ammonium manganite (VII)	
Other names . Ammonium permanganate	
Molecular formula	NH_4 Mn O_4
Molar mass	137 g / mol
Appearance	rhombic needle crystals or powder with rich violet - brown or dark purple metallic sheen, become steel - gray in storage; magenta – rose in solution
Density	g / cm³, solid
Melting point	°C *decomp.*
Solubility in water	8.0 g / 100 ml at 15 °C
Main hazards	Oxidant (O), Harmful (Xn), Dangerous for the environment (N)

Ammonium permanganate is the chemical compound NH_4MnO_4, or $NH_3 \cdot HMnO_4$. It is soluble in water. It is a strong oxidizer, owing to its permanganate anion, and it is a moderately strong explosive, owing to the combination of oxidizer permanganate anion and reducing ammonium cation. Dry ammonium permanganate can detonate by heat, shock, or friction, and it may explode at temperatures above 60 °C .

Ammonium permanganate decomposes explosively to manganese dioxide, nitrogen, and water :

$2\ NH_4MnO_4 \rightarrow 2\ MnO_2 + N_2 + 4\ H_2O$

Ammonium permanganate was first prepared by Eilhard Mitscherlich in 1824 by reaction of silver permanganate with equal molar amount of ammonium chloride, filtering the silver chloride and evaporating the water. It can be also prepared in a similar way from barium permanganate and ammonium sulfate.

Ammonium permanganate decomposes slowly in storage even at normal temperatures. A sample stored for 3 months was only 96% pure, after 6 months it assumed color of iodine and had strong smell of nitrogen oxides. It emits toxic fumes when decomposed by heat.[3]

Quaternary ammonium permanganate compounds can be prepared, such as tetra butyl ammonium permanganate.

Ammunition

Contents

1 - Introduction

Ammunition is gunpowder and artillery, or broadly anything that can be used in combat including bombs, missiles, warheads, landmines, naval mines, and anti-personnel mines. The word comes from the French *la munition* which is all material used for war. The collective term for all types of ammunition is munitions.

The purpose of ammunition is to project force against a selected target. However, the nature of ammunition use also includes delivery or combat supporting munitions such as pyrotechnic or incendiary compounds. Since the design of the cartridge, the meaning has been transferred to the assembly of a projectile and its propellant in a single package.

Ammunition involves the application of fire to targets, general use of weapons by personnel, explosives and propellants, cartridge systems, high explosive projectiles (HE), warheads, shaped charge forms of attack on armour and aircraft, carrier projectiles, fuzes, mortar ammunition, small arms ammunition, grenades, mines, pyrotechnics, improved conventional munitions, and terminally guided munition.

2 – Glossary

A cartridge, is a single unit of ammunition. For a modern small arms cartridge this is the combination of bullet, propellant, primer and cartridge case in a single unit.

A "round" is a term synonymous with a fully loaded cartridge containing a projectile, propellant, primer and casing.

Large caliber cannon often fire explosive-filled projectiles known as shells , non - explosive projectiles may be used for practice

Large numbers of small projectiles intended to be fired all at once in a single discharge are also called shot; hand-held guns designed for this type of ammunition are generally known as shotguns.

Duds are fully loaded ordnance that fail to function as intended. A cartridge that fails to fire in the weapon is known as a misfire. A partially functioning round is named a hang fire. Dud ammunition, unexploded ordnance (UXO), is regarded as highly dangerous, and most safety officials inform civilians to report finding of any large-bore duds to the local police or military.

Dum - dum rounds were early attempts to cause contact-initiated expansion. Many were lead nose bullets with "X" marks cut across the nose.

2 – 1 - Historical (c. World War I)

These general conditions apply to the storage of ammunition in fortresses. Here the positions for the magazine and ammunition stores are so chosen as to afford the best means of protection from an enemy's fire. Huge earth parapets cover these buildings, which are further strengthened, where possible, by traverses protecting the entrances. For the purpose of filling, emptying, and examining cannon cartridges and shell, a laboratory is generally provided at some distance from the magazine. The various stores for explosives are classified into those under magazine conditions (such as magazines, laboratories, and cartridge stores) and those with which these restrictions need not be observed (such as ammunition and shell stores). The interior walls of a magazine are lined, and the floors laid so that there may be no exposed iron or steel. At the entrance, there is a lobby or barrier, inside which persons about to enter the magazine change their clothes for a special suit, and their boots for a pair made without nails. In an ammunition or shell store these precautions need not be taken except where the shell store and the adjacent cartridge store have a common entrance; persons entering may do so in their ordinary clothes. A large work may have a main magazine and several subsidiary magazines, from which the stock of cartridges is renewed in the cartridge stores attached to each group of guns or in the expense cartridge stores and cartridge recesses. The same applies to main ammunition stores which supply the shell stores, expense stores, and recesses.

Cannon balls from the American Civil War

The supply of ammunition are either for guns forming the movable armament or for guns placed in permanent positions. The movable armament will consist of guns and howitzers of small and medium caliber, and it is necessary to arrange suitable expense cartridge stores and shell stores close to the available positions. They can generally be constructed to form part of the permanent work in the projected face of traverses or other strong formations, and should be arranged for a twenty - four hour supply of ammunition. These stores are refilled from the main magazine every night under cover of darkness. Light railways join the various positions. The guns mounted in permanent emplacements are divided into groups of two or three guns each, and usually each group will require but one calibre of ammunition. A cartridge store, shell store and a general store, all well ventilated, are arranged for the especial service of such a group of guns. In the cartridge store the cylinders containing the cartridges are so placed and labeled that the required charge, whether reduced or full, can be immediately selected.

In the shell store, the common shell are separated from the armour - piercing or shrapnel. Each nature of projectile is painted in a distinctive manner to render identification easy. The fuzes and tubes are placed in the general store with the tools and accessories belonging to the guns. The gun group is distinguished by some letter and the guns of the group by numerals; thus A/1 is number one gun of group A. The magazine and shell stores are also indicated by the group letter, and so that mistakes, even by those unaccustomed to the fort, may be avoided, the passages are pointed out by finger posts and direction boards. For the immediate service of each gun, a few cartridges and projectiles are stored in small receptacles (called cartridge and shell recesses respectively) built in the parapet as near the gun position as practicable. In some cases, a limited number of projectiles may be placed close underneath the parapet if this is conveniently situated near the breech of the gun and not exposed to hostile fire.

In order to supply the ammunition sufficiently rapidly for the efficient service of modern guns, hydraulic, electric, or hand-power, hoists are employed to raise the cartridges and shell from the cartridge store and shell store to the gun floor, whence they are transferred to a derrick or loading tray attached to the mounting for loading the gun.

Projectiles for BL guns above 152 mm caliber are stored in shell stores ready filled and fuzed standing on their bases, except shrapnel and high - explosive shell, which are fuzed only when about to be used. Smaller sizes of shells are laid on their sides in layers, each layer pointing in the opposite direction to the one below to prevent injury to the driving bands. Cartridges are stored in brass corrugated cases or in zinc cylinders. The corrugated cases are stacked in layers in the magazine with the mouth of the case towards a passage between the stacks, so that it can be opened and the cartridges removed and transferred to a leather case when required for transport to the gun. Cylinders are stacked, when possible, vertically one above the other. The charges are sent to the gun in these cylinders, and provision is made for the rapid removal of the empty cylinders.

The number and nature of rounds allotted to any fortress depends on questions of policy and location, the degrees of resistance the nature of the works and personnel could reasonably be expected to give, and finally on the nature of the armament. That is to say, for guns of large calibre three hundred to four hundred rounds per gun might be sufficient, while for light QF guns it might amount to one thousand or more rounds per gun.

2 – 2 - Modern era

Female ordnance workers inspecting cartridge cases in Los Angeles, 1943

Modern ammunition includes not only shells for tube artillery and mortars, but increasingly aircraft - delivered bombs, smart bombs, rockets and other explosive - bearing projectiles. The destructive power and lethality of these systems may be difficult to appreciate; but forces in the fight see the accuracy as just another survival tool against the enemy. A single cluster bomb, deliverable by any of the above systems, can sow softball - sized bomb lets across a 100-yard

(90-m) American football – sized field in sufficient density to kill any personnel, even penetrating sandbagged trenches and body armour.

Operation Desert Storm saw widespread usage of cluster bombs — the Iraqi forces called them "*steel rain*". There is little doubt that their usage is also seen as a psychological tool. The aforementioned bomblets are armed upon dispersal by the spinning action which is hastened by a design resembling a "softball with small wings".

3 - Design of the ammunition

The design of the ammunition is determined by its purpose; anti-personnel ammunition is often designed to break up or tumble inside the target, in order to maximize the damage done. Anti-personnel shells contain shrapnel and are designed to explode in mid-air, so its fragments will spread over a large area. Armor-piercing ammunition tends to be hard, sharp, and narrow, often with lubrication. Incendiary projectiles include a material such as white phosphorus which burns fiercely. Tracer ammunition emits light as it travels, allowing the gunner to see the path of bullets in flight while using a machine gun.

Popular types of military rifle and machine gun ammunition include the 5.45 mm, 5.56 mm, and 7.62 mm. Main battle tanks use KE-penetrators to combat other MBTs and armoured fighting vehicles, and HE - Frag (High Explosive-Fragmentation) for soft targets such as infantry.

4 - Components of ammunition

Preparing 105mm M119 howitzer ammunition: powder propellant, cartridge and shell with fuze.

The components of ammunition intended for rifles and munitions may be divided into these categories :

explosive materials and propellants
projectiles of all kinds
cartridges

4 – 1 – Fuzes

The term "fuze" is used, by English speakers, to denote detonators for explosives, differentiating it from "fuzes", which are either circuit breakers or a means of transmitting fire (e.g. the fuze on a fire cracker).

Common artillery fuzes include point detonating, delay, time, and proximity. Point detonating fuzes detonate upon contact with the target. Delay fuzes are designed to penetrate a target before detonating. Time fuzes, as the name implies, detonate a certain time after being fired in order to achieve a burst at a specific time after being fired. Proximity fuzes contain a radio transceiver activated after firing to detonate the projectile when the signal reflected from the ground reaches a certain strength, e.g. 7 meters above the ground. Fuzes are usually armed by the acceleration of the projectile imparted by firing, and usually arm several meters after clearing the bore of the weapon.

5 - Storage of ammunition

See ammunition dump and magazine for discussion of modern ammunition storage facilities.

6 - Fire arms ammunition

Various rifle cartridges compared to the height of a US $ 1 bill.

Ammunition for infantry refers to the ammunition carried by a typical foot (infantry) soldier. Someone serving in the infantry generally carries, in pouches, bandoliers, etc., one hundred rounds of small-arms ammunition (S.A.A.), and it is usual to supplement this, when an action is imminent, from the regimental reserve (see below).

Every reduction in the caliber (size) of the rifle's ammunition means an increase in the number of rounds carried. One hundred rounds of the Martini - Henry ammunition weighed 4.8 kg ; the same weight gives 155 rounds of 7.7 mm ammunition and at 6.5 mm the number of rounds is still greater. The regimental reserves were historically carried in six S.A.A. carts and on eight pack animals. The six carts are distributed, one as reserve to the machine gun, three as reserve to the battalion itself, and two as part of the brigade reserve, which consists therefore of eight carts. The brigade reserve communicates directly with the brigade ammunition columns of the artillery (see below). The eight pack animals follow the eight companies of their battalion. These, with two out of the three battalion carts , endeavour to keep close to the firing line, the remaining cart being with the reserve companies. Men also are employed as carriers, and this duty is so onerous that picked men only are detailed. Gallantry displayed in bringing up ammunition is considered indeed to justify special rewards. The amount of S.A.A. in regimental charge is 100 rounds in the possession of each soldier, 2000 to 2200 on each pack animal, and 16,000 to 17,600 in each of four carts, with, in addition, about 4000 rounds with the machine gun and 16,000 more in the fifth cart.

Currently, every army of an internationally recognized country (except those who rely on others for defense, such as Andorra) has adopted assault rifles as the main infantry weapon.

In western (NATO) forces, the 7.62 mm NATO round has been mostly replaced by the lighter 5.56 mm NATO round, which is better suited for automatic fire than the larger round and allows each soldier to carry more ammunition. The larger caliber ammunition is still retained where range and weight of shot is important, e.g. machine guns and sniper rifles.

Other nations, especially forces with former ties to the Soviet Union tend to use rifles related to or developed from the AK-47 with similar sized rounds to the NATO ones. In 7.62x39mm and 5.45x39mm for assault rifles and 7.62 x 54 mm R for sniper rifles and light machine guns.

7 - Ordnance ammunition

	
M107 Shells	*Modern 120 mm tank gun cartridges with different projectiles*

Base cap from a single piece, combust able cartridge from a 120mm tank gun.

Artillery ordnance ammunition is classified in three types: fixed, semi - fixed and separate loading. Fixed and semi - fixed ammunition (rounds) appear in the form of a projectile mated with a cartridge case which contains the propellant and they resemble small arms rounds. The difference between fixed and semi - fixed ammunition is that the latter allows the propellant charge to be adjusted.

The canister is outfitted with a primer on its base which fires upon contact from the firing pin. Gunpowder, precision machined to burn evenly, is contained inside of cloth bags that are numbered. US/NATO 105 mm howitzers use semi-fixed ammunition, containing seven powder bags referred to as increments or charges. Putting the powder in bags allows the howitzer crew to remove the increments when firing at closer targets. The unused increments are disposed of by analyzing burning in a powder pit at a safe distance from the guns.

Above a certain size, semi - fixed rounds are impracticable; the weight of the whole assembly is too much to be carried effectively. In this case separate loading ammunition is used: the projectile and propelling charge are supplied and loaded separately. The projectile is rammed home in the chamber, the powder charge(s) are loaded (usually by hand), then the breech is closed and the primer is inserted into the primer holder on the back the breech. Separate loading ammunition is typically used on 155 mm and larger howitzers. Several propellant types are available for 155 mm howitzer.

All normal projectiles arrive at the weapon with a plug in the fuze well on the nose of the projectile. Using a special fuze wrench, the plug is unscrewed and a fuze is screwed in. The decision as to which type of fuze to use is made by the fire direction center and carried out by the gun crew.

The armaments fitted to early tanks were contemporary field or naval artillery pieces and used the same ammunition. When tank versus tank combat became more important, and specific tank guns did not exist, it became common to adapt anti-aircraft guns (artillery) which fired shells of high velocity, which were needed for high altitude targets. As the armour applied to tanks increased, ammunition for tank use paralleled that of anti-tank guns. Current tank gun ammunition is a single fixed round ("shell" and charge combined in a single piece) for quick loading, the propellant is in a combustible case, thus negating empty shell casings. The primary anti - armor (anti-tank) warhead is the sabot round, a shaped charge or sensor fuzed warhead.

The tank made horse cavalry obsolete, and while an infantryman could deal with a horse - mounted enemy, new weapons were needed to defeat a tank or other armored fighting vehicle. The first anti-tank weapons given to the infantrymen were based upon small arms; for example the anti - tank rifle. As even the later designs of tanks carried more armour, the limit of a man-portable rifle that could fire a round with sufficient kinetic energy to penetrate the armour was reached.

The introduction of the shaped charge warhead gave the infantryman a weapon that used chemical energy rather than kinetic to penetrate armour in a focused manner, which made them more effective than large grenades. When propelled by a rocket, the shaped charge gained range as well. Weapons such as the US Bazooka and German Panzer Faust, although bulky, were suitable for infantry use—though they were designed to be short ranged weapons, which simplified accuracy for striking a vehicle's weak points.

After World War 2, the advent of the missile delivered both great range and accuracy and provided infantry with a weapon that could reliably destroy the heaviest tanks at long distances.

Today's infantryman can deploy sophisticated multi - man - portable surface – to - air missiles equipped with the ability to reject decoys and defeat counter - measures.

Since aircraft are relatively light in weight, and delicate in construction, this, combined with their highly flammable fuel, made aircraft more susceptible to fatal damage since their first mass usage in World War I; some times being brought down by single bullet, when striking some thing vital in the airplane. The main weaknesses of ammunition provided to infantry to deal with aircraft were limited range and small warheads; both due to the necessity of maintaining man - portable weapons.

An example of a modern surface to air missile for infantry is the FIM-92 Stinger MANPADS (Man Portable Air Defence System), provided as an all - up round in a canister it is attached to a launcher unit and is ready to expend. Numerous other missiles in this class exist from different nations of origin. Infantry machine guns and rifles may improve their ability against aircraft by utilizing tracer ammunition, to allow the aimer to better gauge the lead aim necessary to strike his target.

Weapons developed primarily for anti-tank roles can add proximity fusing to increase the probability of a kill by having the warhead detonate nearby the target without having to make contact.

8 - Naval ammunition

Battleship ammunition

The ranges at which engagements are conducted by warships are typically much greater than that at which land warfare is observed. However, many exceptions can occur. The targets are also generally machines, not men. Naval ammunition is therefore optimized for great velocity (to reach those great ranges, to hit aircraft flying at altitude and also with the benefit of reducing the lead that has to be applied to hit a distant moving target) and to disable said machines, rather than rending human flesh. Naval gun ammunition of World War II vintage came in two main varieties, armor - piercing shells to attack hardened warships or high explosive incendiary shells (with point detonating fuzes to start fires on ships, or mechanical time fuzes designed to fragment and create clouds of shrapnel to defeat aircraft). With the demise of the armored warship, contemporary naval gun ammunition is solely the high explosive variety, but new fuzes and guidance options are available to increase lethality, especially against high speed missile or aircraft threats.

9 - Supply of ammunition in the field

With every successive improvement in military arms there has necessarily been a corresponding modification in the method of supplying ammunition and in the quantity required to be supplied. When hand - to - hand weapons were the principal implements of battle , there was no such need. But in the Middle Ages, the archers and crossbowmen had to replenish the shafts and bolts expended in action, and during a siege, stone bullets of great size, as well as heavy arrows, were freely used. The missiles of those days were however interchangeable, and at the Battle of Towton (1461), part of the Wars of the Roses, the commander of the Yorkist archers induced the enemy to loose arrows in order to obtain them for future use, similarly to a story in the *Romance of the Three Kingdoms* (孔明借箭). This interchangeability of war material was even possible for many centuries after the invention of firearms. At the Battle of Liegnitz (1760) a general officer was specially commissioned by Frederick II of Prussia to pack up and send away, for Prussian use, all the muskets and ammunition left on the field of battle by the defeated Austrians.

In earlier periods of warfare, captured material was often utilized. In the First Sino-Japanese War, the Japanese went so far as to prepare before hand spare parts for the Chinese guns they expected to capture. By the end of the 19th century, it was rare to find a modern army trusting to captures for arms and ammunition; almost the only instance of the practice from that time was that of the 1891 Chilean Civil War in which the army of one belligerent was almost totally dependent upon this means of replenishing stores of arms and cartridges. What was possible with weapons of comparatively rough make is no longer to be thought of in the case of modern arms.

After World War II, the wide spread availability of mass-produced small arms have resulted in many conflicts in which both sides use the same weapons (e.g. the AK - 47) and ammunition types, making captured ammunition once again a potentially important consideration.

10 - Ammunition sabotage

As an unconventional warfare tactic, parties to an armed conflict may attempt to supply ammunition to their opponents that has been sabotaged such that some rounds explode when fired, disabling the weapon and killing or injuring its user. Apart from the direct damage so inflicted, this tactic has the advantage of undermining the enemy's confidence in their ammunition supply. Sabotaging ammunition is not without drawbacks, however: it involves the supply of some working ammunition to the enemy, and it incurs the risk that the sabotaged ammunition may find its way to friendly troops. Over time, the enemy may also become aware of the deception and find ways to identify the sabotaged rounds.

Because of its indiscriminate nature, the use of sabotaged ammunition is not widespread in warfare, and its legality under the laws of warfare is uncertain. It has, however, found use in several modern conflicts. In World War II, it was used by the British and German forces. During the Vietnam War, Project Eldest Son was a U.S. effort to leak sabotaged AK - 47 ammunition to the Vietcong. The tactic was likely also used by Soviet forces in the Afghan civil war in the 1980s. In the most recent phase of that war, U.S. forces have sabotaged mortar rounds intended for use by the insurgent Taliban. And in the ongoing Syrian civil war, the tactic has been reported to be used by government forces.

Ammunition Box

An M19A1 ammunition box for 7.62×51mm NATO cartridges

An ammunition box is a container designed for safe transport and storage of ammunition. It is typically made of metal and labelled with caliber, quantity, and manufacturing date or lot number. A rubber gasket is commonly found in the hinged lid to protect the ammunition from moisture damage.

Due to their durable construction, used metal ammunition boxes are popularly re-used for general storage and other purposes[1][2] Players in the sport of geocaching commonly use ammunition boxes as the containers to hide logbooks and treasures.[3][4] Used boxes are often sold at military surplus stores.

The resealing ammunition box is largely a NATO tradition. Warsaw Pact nations typically stored and transported ammunition in single-use "spam cans". They had crates that had lead lining the inside, but it was basically a bigger "spam can". In World War II, Duct tape was used to seal ammo boxes .

Not all ammunition boxes are metal, however. Wood and paper have also historically been used as a method of packaging and selling ammunition. Some enthusiasts and investors collect historical ammunition boxes.

Note

Ammunition boxes have lead and propellant residue inside, so they should not be used to store food or drink. Commercially made new or fully reconditioned used cans do not have this problem.

Ammunition Technical Officer

A British Army Ammunition Technical Officer approaches a suspect device in Northern Ireland.

Contents

1 - Introduction

An Ammunition Technical Officer (ATO) is an officer involved in all aspects of the army's use of ammunition. This includes; bomb disposal, explosives accident investigation, procurement, in service management, storage, and inspection and repair.

2 - British Army

ATOs are generally selected as Captains, exclusively from within the Royal Logistic Corps; however when an Ammunition Technician (AT) Warrant Officer (WO) or Senior Non - Commissioned Officer (SNCO) is selected for commission, their AT qualification transfers to that of an ATO. One such example is Major P Norton GC.

Training as an ATO lasts 17 months and requires attendance at the Royal Military College of Science and the Defence EOD Munitions Search School Kineton formerly known as the Army School of Ammunition. At its conclusion the new ATO may take command of an EOD Troop within 11 EOD Regiment, or be employed within an Ammunition Squadron or ammunition depot.

In 11 EOD Regiment, in addition to the Troop Commander's role, the ATO performs Counter-Terrorist bomb disposal activities and IEDD within the UK and Northern Ireland, leading an EOD team. WO and SNCO ATs may also lead EOD teams, and when doing so are often referred to as the ATO.

ATs and ATOs can undergo further EOD training at the Felix Centre within the Defence EOD Munitions Search School Kineton. ATOs are the UK's Ammunition experts, with many years of experience in Palestine, Aden, Cyprus, Northern Ireland, the Balkans, Iraq, Afghanistan, and anywhere where the British Army have forces deployed and require EOD expertise and advice.

Armed Forces of other nations also have ATOs, some of which are trained by the British Army. These countries include Canada, New Zealand and Singapore.

2 – 1 - Operational Honours

George Cross

Lieutenant WM Eastman GC. Royal Army Ordnance Corps. 24 December 1940.

Captain RL Jephson - Jones GC. Royal Army Ordnance Corps. 24 December 1940.

Major Stephen Styles GC. Royal Army Ordnance Corps. 11 January 1972.

Captain Peter Norton GC. Royal Logistic Corps. 24 July 2005.

George Medal

Capt Daniel Marc Shepherd GM Royal Logistic Corps, 19 March 2010. Killed in Afghanistan whilst clearing Improvised Explosive Devices (IEDs) in Helmand Province, Afghanistan.

Military Cross

Captain SD Bratcher MC Royal Logistic Corps, 24 March 2006.

Major ID Scattergood MBE MC Royal Logistic Corps, 25 July 2008.

Queen's Gallantry Medal

Captain Vincent Michael Strafford QGM, Royal Logistic Corps. 19 July 2007

Captain Wayne Edward James Owers QGM, Royal Logistic Corps, 19 March 2010

Queen's Gallantry Medal with Bar

Captain Eamon Conrad Heakin QGM*, Royal Logistic Corps. 7 March 2008

Captain Vincent Michael Strafford QGM*, Royal Logistic Corps. 7 March 2008

3 - Australian Army

The Australian Army also employs ATOs, who are members of the Royal Australian Army Ordnance Corps (RAAOC). RAAOC ATOs are trained in Australia, and this training has also been made available to members of other regional (Asia/South Pacific) Defence Forces.

4 - Pakistan Army

The Pakistan Army has ATOs who are trained at the Pakistan Army Ordnance College. They are selected from the officers of the Pakistan Army Ordnance Corps in almost the same manner as that of the British Army ATOs. They are specialists in the ammunition field, and have many years of experience within Pakistan and other countries, such as Liberia, Congo, Ivory Coast, Sudan and Darfur, and any where the Pakistan Army deploys as part of the UN. Pakistan ATOs have the unique honour of handling IEDs and completing EOD Operations during War On Terror in Swat, North and South Waziristan Agencies and even in the settled areas of the countries. Most of the ATOs have specialized from CIED and EOD Trg programmes covered by British and US EOD institutes to assist the Engineers Corps as a technical expert to handle all IEDs and supervise their EOD activities. It is imperative to note and mention here, that, every field formation of Pakistan Army has a specified ATO appointment amongst its Staff Appointments to work as Advisor on Ammunition Matters to the Formation Commander directly.

5 - South African Army

The role and function of the South African Ammunition Corps is to ensure that only safe and effective ammunition is supplied to the Department of Defence and other users. Their functions includes participation in research and development, quality assurance, unit inspection, maintenance and disposal of ammunition. Candidates must have a sound psychological profile exhibiting a high degree of intelligence, steadiness and an aptitude or innovative technical thinking. Learners must be in possession of a National Senior Certificate (Grade 12) or Level 4 (N3) certificate and must have passed Mathematics and Physical Science.

References[edit]

Ammunition Technician

The AT Badge.

Contents

1 - Introduction

An Ammunition Technician (AT) is a British Army soldier, formerly of the Royal Army Ordnance Corps but since 1993 the Royal Logistic Corps trained to inspect, repair, test and store, and modify all ammunition, guided missiles and explosives used by the British Army. These technicians are also trained to safely dispose by demolition, individual items of ammunition and explosives (EOD) or to conduct logisitc disposal of bulk stocks of multi items. After gaining sufficient experience, those who show the appropriate qualities are given extra training to render safe Improvised Explosive Devices (IED) by a process called Improvised Explosive Device Disposal. Experienced ATs may be called to give evidence in criminal or coroners courts in relation to ammunition or explosives, or EOD and IEDD duties where they are regarded by the judicial system as expert witnesses.

2 – History

Within the Royal Army Ordnance Corps, the receipt into service, storage, examination and issue of ammunition was possibly the oldest and most important function of the Corps. War could not be waged without ammunition, and to be waged successfully the ammunition had to be in every respect serviceable and dependable. The trade were previously called Ammunition Examiners (AE) and it was in the safeguarding of ammunition stockpiles during the wars that the Ammunition Examiner proved his worth. Promotion however was limited up to Warrant Officer Class 2 and at this stage the AE had to re-muster in the trade of RAOC Clerk in order to obtain higher rank. In 1948, the increased responsibility of the ammunition organization in Ordnance Services and in order to utilise the experience of these highly skilled tradesmen both as Warrant Officers and as Officers, the RAOC decided that promotion to WO1 would be introduced. RAOC Instruction No 466 introduced a new type of Quartermaster commission into the Royal Army Ordnance Corps to permit the Warrant Officer Ammunition Examiner being commissioned within the sphere of his normal employment on ammunition duties. These commissioned WOs would be called Assistant Inspecting Ordnance Officers (AIOOs).

3 – Training

Training was initially undertaken at Bramley in Hampshire at the School of Ammunition. However the school moved to Kineton in 1974. To qualify to attend the Ammunition Technician Class 2 course , a soldier must first pass a pre-select course, during which time they will be assessed for suitability for role. The pre-selection includes psychometric testing, leadership skills, problem solving, resource planning and numeracy tests.

The basic AT course is 7 months in duration, the first part of which is spent at The Royal Military College of Science. The instruction within the Defence College of Management and Technology forms the first phase of the 7 month course. The aim of the first part is to provide the scientific and technical basis for further training in ammunition and explosives. The syllabus is an integrated study of mathematics, ballistics, explosives and general chemistry, physics, metallurgy, electronics and the design of armoured vehicles, artillery and infantry weapons. Time is also spent on nuclear, biological and chemical weapons design and the related protection systems. The remainder of the course covers conventional land munitions, explosive demolitions, conventional munitions disposal, guided weapons and explosive theory and safety. The majority of the course takes place at the Defence EOD Munitions Search Training Regiment (DEMS Trg Regt). Training previously took place at the Defence EOD Munitions Search School Kineton, DEMSS Kineton, and before that the Army School of Ammunition.

After 3 years gaining experience in trade, these technicians will be selected to return to Kineton to attend their Class 2 to Class 1 Upgrading Course, a 3 month course to broaden their technical knowledge and ability in munitions incident investigations, large scale demolitions and the disposal of chemical and biological munitions.

The Royal Logistic Corps Ammunition Technicians trained at Kineton are regarded throughout the world as the subject matter experts in the management of munitions and in Improvised Explosive Device (IED) disposal as a result of their combined experience in Palestine, Cyprus, Hong Kong, Northern Ireland, Iraq, Afghanistan, Aden, Malaya and other conflicts.

Commissioned officers are known as Ammunition Technical Officers and for the Sandhurst entrant, they complete a 17 month technical course in the rank of Captain. ATs that become commissioned later in their service are also referred to as ATOs and will be granted the ato qualification by a testing board based on their experience, knowledge and competence.

4 - Scope of Work

ATs are employed within the Royal Logistic Corps of the British Army and are the technical experts in storing and processing ammunition in base depots or field storage sites at home or on operations where safety in storage is paramount to overall force protection. Being an Ammunition Technician calls for intelligence, clear thinking and analytical skills, a calm outlook coupled with excellent attention to detail, discipline and courage. ATs develop specialist skills to look after the MoDs global stockpiles of ammunition by carrying out surveillance tasks, testing, inspecting, maintaining and disposing of all sorts of ammunition, from bullet clips, anti-aircraft guided weapon systems, mines, mortars, tank rounds and aircraft bombs. The Ammunition Technician profession is not exclusive to the UK MoD but similar technical personnel also exist in the Canadian, Australian RAAOC,[2] and New Zealand armed forces. Ammunition Technicians trained at the Defence EOD Munitions Search School, Kineton also work on loan service engagements in a number of African, Far Eastern and Middle Eastern armed forces.

In the United Kingdom, bomb disposal is carried out in all three services (Royal Navy, Royal Air Force, and the Royal Logistic Corps and Royal Engineers of the British Army). The majority of counter terrorist bomb disposal and conventional munitions disposal activity is carried out by the Ammunition Technicians of the Royal Logistic Corps, the Royal Navy Clearance Divers deal with shoreline and underwater tasks, the Royal Air Force deal with conventional tasks on their own property and from UK aircraft, and the Royal Engineers deal with minefields, conventional, biological and chemical munitions and enemy aircraft bombs that occasionally turn up.

5 - Operational Honours

The trade of Ammunition Technician is one of the most highly decorated professions in the British Army. The trade has been awarded 231 British gallantry awards as follows :

George Cross - 9
George Medal - 80
Conspicuous Gallantry Cross - 1
Military Cross - 3
Queen's Gallantry Medal - 100
MBE for Gallantry - 14
BEM for Gallantry - 23

In addition, Ammunition Technicians and Ammunition Technical Officers have also received almost 200 Mention in Dispatches, King's or Queen's Commendations for Bravery.

A further 100 awards of the MBE and BEM have been made to Ammunition Technicians for distinguished service within their trade.

These decorations have been awarded since 1940 and in places such as Aden, Afghanistan, Burma, Cyprus, Egypt, France, Germany, Gibraltar, Great Britain, Greece, Hong Kong, Iraq, Italy, Malaya, Malta, Northern Ireland, Pacific, Sicily and Yugoslavia.

George Cross

Staff Sergeant Sydney Rogerson GC. Royal Army Ordnance Corps. 11 October 1946.

Warrant Officer Class 1 Barry Johnson GC Royal Army Ordnance Corps. 6 November 1990

Staff Sergeant Olaf Sean Schmid GC Royal Logistic Corps 19 March 2010

George Medal

Sergeant FW Pearce GM Royal Army Ordnance Corps 1944.

Sergeant AT Taylor GM Royal Army Ordnance Corps 8 March 1957.

Warrant Officer Class 2 BJC Reid GM Royal Army Ordnance Corps 1966.

Sergeant AE Dedman GM Royal Army Ordnance Corps 1972.

Warrant Officer Class 1 PES Gurney GM Royal Army Ordnance Corps 1973. Peter Gurney was later awarded a bar to his GM as a civilian.

Sergeant JA Anderson GM Royal Army Ordnance Corps 1980.

Warrant Officer Class 1 JRT Balding GM Royal Logistic Corps 1993, first GM awarded to member of the newly formed Royal Logistic Corps.

Warrant Officer Class 1 NB Thomsen GM Royal Logistic Corps 1995.

Warrant Officer Class 2 A Islam GM QGM Royal Logistic Corps 1997.

Warrant Officer Class 2 G O'Donnell Royal Logistic Corps 2006 and 2009. Posthumously awarded a second GM in March 2009 for "repeated and sustained acts of immense bravery" in Afghanistan.

Warrant Officer Class 2 K Ley GM Royal Logistic Corps 24 September 2010

Conspicuous Gallantry Cross

Staff Sergeant James Anthony Wadsworth CGC Royal Logictic Corps. 7 March 2008

Military Cross

Staff Sergeant Gareth Wood MC Royal Logistic Corps 24 September 2010

Queen's Gallantry Medal

Warrant Officer Class 1 Richard Gill QGM Royal Army Ordnance Corps 7 October 1974

Staff Sergeant Arthur Burns QGM Royal Army Ordnance Corps 6 January 1975

Warrant Officer Class 2 Kevin Callaghan GM QGM Royal Army Ordnance Corps 20 October 1980

Warrant Officer Class 2 Ernest Leonard Bienkowski QGM Royal Army Ordnance Corps 14 April 1987

Warrant Officer Class 1 Robert John McLelland QGM, Royal Logistic Corps. 21 November 1994

WO1 Eamon Conrad Heakin QGM, Royal Logistic Corps. 7 September 2004

Warrant Officer Class 2 Colin Robert George Grant QGM, Royal Logistic Corps 11 September 2009 [3]

MBE for Gallantry

WO2 Henry Albert Vaughan MBE RAOC 16 February 1968.

WO1 Stanley Gordon Woods MBE RAOC 10 May 1968.

WO1 Frederick William Wood MBE RAOC 12 November 1968.

BEM for Gallantry

Sergeant Gordon Epps BEM RAOC 31 December 1946

WO2 Donald Frederick Tildesley BEM RAOC 4 November 1949.

Sergeant Donald Lawrence Birch BEM RAOC 10 May 1968.

Staff Sergenat David Greenaway BEM RAOC 18 Mar 1974.

6 – RAOC / RLC EOD Memorial

RAOC and RLC EOD Memorial

Although a highly decorated trade, the price of recognition for Ammunition Technicians and Ammunition Technical Officers has been high. The Ammunition Technician trade has lost a number of their colleagues killed in action whilst undertaking operational Explosive Ordnance Disposal tasks worldwide. Ammunition Technicians proudly have their own memorial at Marlborough Barracks, Temple Herdewyke in Warwickshire, the home of the trade.

The idea of a memorial was initiated by the senior Warrant Officers of the trade and supported by the Director of Land Service Ammunition and his staff. A RAOC EOD Memorial Working Party was set up and reported progress to the Director General of Ordnance Services. The memorial was funded by RAOC central funds, donations from industry and from private donations from individual technicians within the trade. The memorial was designed by the Fine Arts Department of Coventry Polytechnic and sculpted from local sandstone. The memorial represents a single bomb disposal operator, dressed in the bomb suit and holding his protective helmet. This scene is one that every EOD operator will recognize as being the last few moments before donning the helmet and becoming totally shut off from the team and ready to make the longest walk into danger towards an explosive device. The memorial is enclosed behind double wrought iron gates bearing the trade badges of the ATO and AT. The gates lead into a walled garden with 2 stone benches. The walls bear grey slate tablets, each engraved with the name of those killed, the date and location of the incident. A small brass plaque records the award of posthumous gallantry medals or decorations.

The memorial was formally opened during a dedication service on 23rd June 1991. The service of dedication was led by the Chaplain General to the Forces, The Reverend James Harkness OBE QHC MA with readings by WO1 (Staff Sergeant Major) B Johnson GC and Major General PWE Istead CB OBE GM, Representative Colonel Commandant, RAOC. Amongst the guests at the service where the widows and families of many of those whose names appear on the memorial. A parade and the annual service of remembrance by members of the units based at Kineton is held at the EOD Memorial on Remembrance Sunday in November each year.

The EOD memorial is dedicated to the fallen ATO's and AT's of The Royal Army Ordnance Corps and The Royal Logistic Corps who through their selfless commitment, have singularly taken the "Longest Walk" in the service of their country but sadly, have not returned. Members of the ammunition trade have been killed in Cyprus, Hong Kong, Northern Ireland, England, Iraq and Afghanistan, "Sua Tela Tonanti / We Sustain"

Amnesty International

Contents

1 - Introduction

Amnesty International (commonly known as Amnesty and AI) is a non - governmental organization focused on human rights with over 3 million members and supporters around the world. The objective of the organization is "to conduct research and generate action to prevent and end grave abuses of human rights, and to demand justice for those whose rights have been violated."

Amnesty International was founded in London in 1961, following the publication of the article "The Forgotten Prisoners" in *The Observer* 28 May 1961,[4] by the lawyer Peter Benenson. Amnesty draws attention to human rights abuses and campaigns for compliance with international laws and standards. It works to mobilize public opinion to put pressure on governments that let abuse take place . The organization was awarded the 1977 Nobel Peace Prize for its "campaign against torture,"[5] and the United Nations Prize in the Field of Human Rights in 1978.[6]

In the field of international human rights organizations Amnesty has the longest history and broadest name recognition, and is believed by many to set standards for the movement as a whole.

2 - 1960s

Amnesty International was founded in London in July 1961 by English labour lawyer Peter Benenson . According to his own account, he was travelling in the London Underground on 19 November 1960, when he read that two Portuguese students from Coimbra had been sentenced to seven years of imprisonment in Portugal for allegedly "having drunk a toast to liberty".[a][9] Researchers have never traced the alleged newspaper article in question.[a] In 1960, Portugal was ruled by the Estado Novo government of António de Oliveira Salazar . The government was authoritarian in nature and strongly anti - communist, suppressing enemies of the state as anti-Portuguese. In his significant newspaper article "The Forgotten Prisoners", Benenson later described his reaction as follows: "Open your newspaper any day of the week and you will find a story from somewhere of someone being imprisoned, tortured or executed because his opinions or religion are unacceptable to his government [...] The news paper reader feels a sickening sense of impotence. Yet if these feelings of disgust could be united into common action, something effective could be done."

Benenson worked with friend Eric Baker. Baker was a member of the Religious Society of Friends who had been involved in funding the British Campaign for Nuclear Disarmament as well as becoming head of Quaker Peace and Social Witness, and in his memoirs

Benenson described him as "a partner in the launching of the project". In consultation with other writers, academics and lawyers and, in particular, Alec Digges, they wrote via Louis Blom-Cooper to David Astor, editor of *The Observer* newspaper, who, on 28 May 1961, published Benenson's article "The Forgotten Prisoners". The article brought the reader's attention to those "imprisoned, tortured or executed because his opinions or religion are unacceptable to his government"[11] or, put another way, to violations, by governments, of articles 18 and 19 of the Universal Declaration of Human Rights (UDHR). The article described these violations occurring, on a global scale, in the context of restrictions to press freedom, to political oppositions, to timely public trial before impartial courts, and to asylum. It marked the launch of "Appeal for Amnesty, 1961", the aim of which was to mobilize public opinion, quickly and widely, in defence of these individuals, whom Benenson named "Prisoners of Conscience". The "Appeal for Amnesty" was reprinted by a large number of international newspapers. In the same year Benenson had a book published, *Persecution 1961*, which detailed the cases of nine prisoners of conscience investigated and compiled by Benenson and Baker (Maurice Adin, Ashton Jones, Agostinho Neto, Patrick Duncan, Olga Ivinskaya, Luis Taruc, Constantin Noica, Antonio Amat and Hu Feng) . In July 1961 the leadership had decided that the appeal would form the basis of a permanent organization, Amnesty, with the first meeting taking place in London. Benenson ensured that all three major political parties were represented, enlisting members of parliament from the Labour Party, the Conservative Party, and the Liberal Party.[14] On 30 September 1962, it was officially named 'Amnesty International'. Between the 'Appeal for Amnesty, 1961' and September 1962 the organization had been known simply as 'Amnesty'.

What started as a short appeal soon became a permanent international movement working to protect those imprisoned for non-violent expression of their views and to secure worldwide recognition of Articles 18 and 19 of the UDHR. From the very beginning, research and campaigning were present in Amnesty International's work. A library was established for information about prisoners of conscience and a network of local groups, called 'THREES' groups, was started. Each group worked on behalf of three prisoners, one from each of the then three main ideological regions of the world: communist, capitalist and developing.

By the mid-1960s Amnesty International's global presence was growing and an International Secretariat and International Executive Committee were established to manage Amnesty International's national organizations, called 'Sections', which had appeared in several countries. The international movement was starting to agree on its core principles and techniques. For example, the issue of whether or not to adopt prisoners who had advocated violence, like Nelson Mandela, brought unanimous agreement that it could not give the name of 'Prisoner of Conscience' to such prisoners. Aside from the work of the library and groups, Amnesty International's activities were expanding to helping prisoners' families, sending observers to trials, making representations to governments, and finding asylum or overseas employment for prisoners. Its activity and influence were also increasing within intergovernmental organizations; it would be awarded consultative status by the United Nations, the Council of Europe and UNESCO before the decade ended.

In 1967 founder of Amnesty International resigned after independent inquiry has not supported his claims that AI is infiltrated by British agents "Peter Benenson".. Later he claimed that Central Intelligence Agency has become involved in Amnesty.

3 - 1970s

Leading Amnesty International in the 1970s were key figures Seán MacBride and Martin Ennals. While continuing to work for prisoners of conscience, Amnesty International's purview widened to include "fair trial" and opposition to long detention without trial (UDHR Article 9), and especially to the torture of prisoners (UDHR Article 5). Amnesty International believed that the reasons underlying torture of prisoners by governments, were either to acquire and obtain information or to quell opposition by the use of terror, or both. Also of concern was the export of more sophisticated torture methods, equipment and teaching by the superpowers to "client states", for example by the United States through some activities of the CIA.

Amnesty International drew together reports from countries where torture allegations seemed most persistent and organised an international conference on torture. It sought to influence public opinion to put pressure on national governments by organising a campaign for the 'Abolition of Torture' which ran for several years.

Amnesty International's membership increased from 15,000 in 1969 to 200,000 by 1979 . This growth in resources enabled an expansion of its program, 'outside of the prison walls', to include work on "disappearances", the death penalty and the rights of refugees. A new technique, the 'Urgent Action', aimed at mobilising the membership into action rapidly was pioneered. The first was issued on 19 March 1973, on behalf of Luiz Basilio Rossi, a Brazilian academic, arrested for political reasons.

At the intergovernmental level Amnesty International pressed for application of the UN's Standard Minimum Rules for the Treatment of Prisoners and of existing humanitarian conventions; to secure ratifications of the two UN Covenants on Human Rights in 1976); and was instrumental in obtaining additional instruments and provisions forbidding its practice. Consultative status was granted at the Inter - American Commission on Human Rights in 1972.

In 1976 Amnesty's British Section started a series of fund-raising events that came to be known as The Secret Policeman's Balls series. They were staged in London initially as comedy galas featuring what the Daily Telegraph called "the crème de la crème of the British comedy world" including members of comedy troupe Monty Python, and later expanded to also include performances by leading rock musicians. The series was created and developed by Monty Python alumnus John Cleese and entertainment industry executive Martin Lewis working closely with Amnesty staff members Peter Luff (Assistant Director of Amnesty 1974 – 1978) and subsequently with Peter Walker (Amnesty Fund - Raising Officer

1978 – 1982 Cleese, Lewis and Luff worked together on the first two shows (1976 and 1977) . Cleese, Lewis and Walker worked together on the 1979 and 1981 shows, the first to carry what the Daily Telegraph described as the "rather brilliantly re-christened" *Secret Policeman's Ball* title.

The organization was awarded the 1977 Nobel Peace Prize for its "campaign against torture" and the United Nations Prize in the Field of Human Rights in 1978.[6]

4 - 1980s

By 1980 Amnesty International was drawing more criticism from governments. The USSR alleged that Amnesty International conducted espionage, the Moroccan government denounced it as a defender of lawbreakers, and the Argentine government banned Amnesty International's 1983 annual report.

Throughout the 1980s, Amnesty International continued to campaign against torture, and on behalf of prisoners of conscience. New issues emerged, including extrajudicial killings, military, security and police transfers, political killings; and disappearances.

Towards the end of the decade, the growing number of refugees worldwide was a very visible area of Amnesty International's concern. While many of the world's refugees of the time had been displaced by war and famine, in adherence to its mandate, Amnesty International concentrated on those forced to flee because of the human rights violations it was seeking to prevent. It argued that rather than focusing on new restrictions on entry for asylum-seekers, governments were to address the human rights violations which were forcing people into exile.

Apart from a second campaign on torture during the first half of the decade, two major musical events occurred, designed to increase awareness of Amnesty and of human rights (particularly among younger generations) during the mid- to late - 1980s. The 1986 Conspiracy of Hope tour, which played five concerts in the US, and culminated in a daylong show, featuring some thirty-odd acts at

Giants Stadium, and the 1988 Human Rights Now! world tour. Human Rights Now!, which was timed to coincide with the 40th anniversary of the United Nations' Universal Declaration of Human Rights (UDHR), played a series of concerts on five continents over six weeks. Both tours featured some of the most famous musicians and bands of the day.

5 - 1990s

Throughout the 1990s, Amnesty International continued to grow, to a member ship of over 3 million in over 150 countries and territories , led by Senegalese Secretary General Pierre Sané. Amnesty continued to work on a wide range of issues and world events. For example, South African groups joined in 1992 and hosted a visit by Pierre Sané to meet with the apartheid government to press for an investigation into allegations of police abuse, an end to arms sales to the African Great Lakes region and the abolition of the death penalty. In particular, Amnesty International brought attention to violations committed on specific groups, including refugees, racial/ethnic/religious minorities, women and those executed or on Death Row. The death penalty report *When the state kills* (ISBN 978 – 0 – 691 – 10261 - 0) and the 'Human Rights are Women's Rights' campaign were key actions for the latter two issues. During the 1990s, Amnesty International was forced to react to human rights violations occurring in the context of a proliferation of armed conflict in Angola, East Timor, the Persian Gulf, Rwanda, and the former Yugoslavia. Amnesty International took no position on whether to support or oppose external military interventions in these armed conflicts. It did not (and does not) reject the use of force, even lethal force, or ask those engaged to lay down their arms. Instead, it questioned the motives behind external intervention and selectivity of international action in relation to the strategic interests of those sending troops. It argued that action should be taken to prevent human rights problems becoming human rights catastrophes, and that both intervention and inaction represented a failure of the international community.

In 1995, when AI wanted to promote how Shell Oil Company was involved with the execution of an environmental and human rights activist Ken Saro - Wiwa in Nigeria, it was stopped. Newspapers and advertising companies refuzed to run AI's ads because Shell Oil was a customer of theirs as well. Shell's main argument was that it was drilling oil in a country that already violated human rights and had no way to enforce human rights policies. To combat the buzz that AI was trying to create, it immediately publicised how Shell was helping to improve overall life in Nigeria. Salil Shetty, the director of Amnesty, said, "Social media re-energises the idea of the global citizen".[14] James M. Russell notes how the drive for profit from private media sources conflicts with the stories that AI wants to be heard.

Amnesty International was proactive in pushing for recognition of the universality of human rights. The campaign 'Get Up, Sign Up' marked 50 years of the UDHR. Thirteen million pledges were collected in support, and the Decl music concert was held in Paris on 10 December 1998 (Human Rights Day). At the intergovernmental level, Amnesty International argued in favour of creating an United Nations High Commissioner for Human Rights (established 1993) and an International Criminal Court (established 2002) .

After his arrest in London in 1998 by the Metropolitan Police, Amnesty International became involved in the legal battle of Senator Pinochet, a former Chilean President, who sought to avoid extradition to Spain to face charges. Lord Hoffman had an indirect connection with Amnesty International, and this led to an important test for the appearance of bias in legal proceedings in UK law. There was a suit[21] against the decision to release Senator Pinochet, taken by the then British Home Secretary Mr Jack Straw, before that decision had actually been taken, in an attempt to prevent the release of Senator Pinochet. The English High Court refuzed[22] the application and Senator Pinochet was released and returned to Chile. This legal challenge was a novel attempt to use legal process to challenge a decision before it was taken and could be seen as hard to reconcile with the rule of law, as it was predicated on a presumption that the Home Secretary had erred in law whatever the reasons were for the decision .

6 - 2000s

After 2000, Amnesty International's agenda turned to the challenges arising from globalization and the reaction to the 11 September 2001 attacks in the United States. The issue of globalization provoked a major shift in Amnesty International policy, as the scope of its work was widened to include economic, social and cultural rights, an area that it had declined to work on in the past. Amnesty International felt this shift was important, not just to give credence to its principle of the indivisibility of rights, but because of what it saw as the growing power of companies and the undermining of many nation states as a result of globalization.

In the aftermath of 11 September attacks, the new Amnesty International Secretary General, Irene Khan, reported that a senior government official had said to Amnesty International delegates: "Your role collapsed with the collapse of the Twin Towers in New York". In the years following the attacks, some believe that the gains made by human rights organizations over previous decades had possibly been eroded. Amnesty International argued that human rights were the basis for the security of all, not a barrier to it. Criticism came directly from the Bush administration and *The Washington Post*, when Khan, in 2005, likened the US government's detention facility at Guantanamo Bay, Cuba, to a Soviet Gulag.

During the first half of the new decade, Amnesty International turned its attention to violence against women, controls on the world arms trade, concerns surrounding the effectiveness of the UN, and ending torture. With its membership close to two million by 2005, Amnesty continued to work for prisoners of conscience.

In 2007, AI's executive committee decided to support access to abortion "within reasonable gestational limits...for women in cases of rape, incest or violence, or where the pregnancy jeopardizes a mother's life or health".

Amnesty International reported, concerning the Iraq War, on 17 March 2008, that despite claims the security situation in Iraq has improved in recent months, the human rights situation is disastrous, after the start of the war five years ago in 2003.

In 2008 Amnesty International launched a mobile donating campaign in the United States, which allows supporters to make $5 micro - donations by sending a text message to the short code 90999 with the keyword RIGHTS. Amnesty International's mobile fund raising campaign was created in partnership with Mgive and the Mobile Giving Foundation.

In 2009 Amnesty International accused Israel and the Palestinian Hamas movement of committing war crimes during Israel's January offensive in Gaza, called Operation Cast Lead, that resulted in the deaths of more than 1,400 Palestinians and 13 Israelis. The 117- page Amnesty report charged Israeli forces with killing hundreds of civilians and wanton destruction of thousands of homes. Amnesty found evidence of Palestinian militants using human shields to stop Israeli attacks. A subsequent United Nations Fact Finding Mission on the Gaza Conflict was carried out; Amnesty stated that its findings were consistent with those of Amnesty's own field investigation, and called on the UN to act promptly to implement the mission's recommendations.

7 - 2010s

In February 2010, Amnesty suspended Gita Sahgal, its gender unit head, after she criticized Amnesty for its links with Moazzam Begg, Director of a campaign group called Cage prisoners. She had called the links "a gross error of judgment" that risked Amnesty's reputation on human rights, and said it was wrong to ally with "Britain's most famous supporter of the Taliban". Amnesty responded that Sahgal was not suspended "for raising these issues internally... [Begg] speaks about his own views ..., not Amnesty International's " . Among those who spoke up for Saghal were Salman Rushdie ("Amnesty ... has done its reputation incalculable damage.... It looks very much as if Amnesty's leader ship is suffering from a kind of moral bankruptcy, and has lost the ability to distinguish right from wrong") , Member of Parliament Denis Mac Shane, Joan Smith, Christopher Hitchens, Martin Bright, Melanie Phillips, and Nick Cohen.

In February 2011, Amnesty requested that Swiss authorities start a criminal investigation of former US President George W. Bush and arrest him.

In July 2011, Amnesty International celebrated its 50 years with an animated short film directed by Carlos Lascano, produced by Eallin Motion Art and Dreamlife Studio, with music by Academy Award winner Hans Zimmer and nominee Lorne Balfe. The film shows that the fight for humanity is not yet over.[49]

8 – Principles

The core principle of Amnesty International is a focus on prisoners of conscience, those persons imprisoned or prevented from expressing any opinion other than violence. Along with this commitment to opposing repression of freedom of expression, Amnesty International's founding principles included non - intervention on political questions and a robust commitment to gathering facts about the various cases.

One key issue in the principles is in regards to those individuals who may advocate or tacitly support resort to violence in struggles against repression. AI does not judge whether recourse to violence is justified or not. However, AI does not oppose the political use of violence in itself since The Universal Declaration of Human Rights, in its preamble, foresees situations in which people could "be compelled to have recourse, as a last resort, to rebellion against tyranny and oppression". If a prisoner is serving a sentence imposed, after a fair trial, for activities involving violence, AI will not ask the government to release the prisoner.

AI neither supports nor condemns the resort to violence by political opposition groups in itself, just as AI neither supports nor condemns a government policy of using military force in fighting against armed opposition movements. However, AI supports minimum humane standards that should be respected by governments and armed opposition groups alike. When an opposition group tortures or kills its captives, takes hostages, or commits deliberate and arbitrary killings, AI condemns these abuses.

Amnesty International opposes capital punishment in all cases, regardless of the crime committed, the circumstances surrounding the individual or the method of execution.

9 – Work

“ Amnesty International's vision is of a world in which every person enjoys all of the human rights enshrined in the Universal Declaration of Human Rights and other international human rights standards.

In pursuit of this vision, Amnesty International's mission is to undertake research and action focused on preventing and ending grave abuses of the rights to physical and mental integrity, freedom of conscience and expression, and freedom from discrimination, within the context of its work to promote all human rights. ”

—Statute of Amnesty International , 27th International Council meeting, 2005

Amnesty International primarily targets governments, but also reports on non - governmental bodies and private individuals ("non - state actors") .

There are six key areas which Amnesty deals with :

1 Women's, children's , minorities' and indigenous rights
2 Ending torture
3 Abolition of the death penalty
4 Rights of refugees
5 Rights of prisoners of conscience
6 Protection of human dignity.

Some specific aims are to: abolish the death penalty, end extra judicial executions and "disappearances," ensure prison conditions meet international human rights standards, ensure prompt and fair trial for all political prisoners, ensure free education to all children worldwide, decriminalize abortion , fight impunity from systems of justice, end the recruitment and use of child soldiers, free all prisoners of conscience, promote economic, social and cultural rights for marginalized communities, protect human rights defenders, promote religious tolerance, protect LGBT rights , stop torture and ill-treatment, stop unlawful killings in armed conflict, uphold the rights of refugees, migrants, and asylum seekers, and protect human dignity.

To further these aims, Amnesty International has developed several techniques to publicise information and mobilise public opinion. The organization considers as one of its strengths the publication of impartial and accurate reports. Reports are researched by: interviewing victims and officials, observing trials, working with local human rights activists, and monitoring the media. It aims to issue timely press releases and publishes information in newsletters and on web sites. It also sends official missions to countries to make courteous but insistent inquiries.

Campaigns to mobilize public opinion can take the form of individual, country, or thematic campaigns. Many techniques are deployed, such as direct appeals (for example, letter writing), media and publicity work, and public demonstrations. Often, fund-raising is integrated with campaigning.

In situations which require immediate attention, Amnesty International calls on existing urgent action networks or crisis response networks; for all other matters, it calls on its membership. It considers the large size of its human resources to be another of its key strengths.

The role of Amnesty International has an immense impact on getting citizens onboard (sic) with focusing on human rights issues. These groups influence countries and governments to give their people justice with pressure and in man power. An example of Amnesty International's work, which began in the 1960s, is writing letters to free imprisoned people that were put there for non-violent expressions. The group now has power, attends sessions, and became a source of information for the U.N. The increase in participation of non-governmental organizations changes how we live today. Felix Dodds states in a recent document that, "In 1972 there were 39 democratic countries in the world; by 2002, there were 139 " . This shows that non-governmental organizations make enormous leaps within a short period of time for human rights.

9 – 1 - Country focus

Amnesty reports disproportionately on relatively more democratic and open countries, arguing that its intention is not to produce a range of reports which statistically represents the world's human rights abuses, but rather to apply the pressure of public opinion to encourage improvements. The demonstration effect of the behaviour of both key Western governments and major non-Western states is an important factor: as one former Amnesty Secretary-General pointed out, "for many countries and a large number of people, the United States is a model," and according to one Amnesty manager, "large countries influence small countries."[7] In addition, with the end of the Cold War, Amnesty felt that a greater emphasis on human rights in the North was needed to improve its credibility with its Southern critics by demonstrating its willingness to report on human rights issues in a truly global manner.

According to one academic study, as a result of these considerations the frequency of Amnesty's reports is influenced by a number of factors, besides the frequency and severity of human rights abuses. For example, Amnesty reports significantly more (than predicted by human rights abuses) on more economically powerful states; and on countries which receive US military aid, on the basis that this Western complicity in abuses increases the likelihood of public pressure being able to make a difference . In addition, around 1993 – 94, Amnesty consciously developed its media relations, producing fewer background reports and more press releases, to increase the impact of its reports. Press releases are partly driven by news coverage, to use existing news coverage as leverage to discuss Amnesty's human rights concerns. This increases Amnesty's focus on the countries the media is more interested in.

In 2012, Kristyan Benedict, Amnesty UK's campaign manager, listed several countries as "regimes who abuse peoples' basic universal rights": Burma, Iran, Israel, North Korea and Sudan.

Amnesty's country focus is similar to that of some other comparable NGOs, notably Human Rights Watch: between 1991 and 2000, Amnesty and HRW shared eight of ten countries in their "top ten" (by Amnesty press releases; 7 for Amnesty reports) . In addition, six of the 10 countries most reported on by Human Rights Watch in the 1990s also made *The Economist's* and *Newsweek's* "most covered" lists during that time.

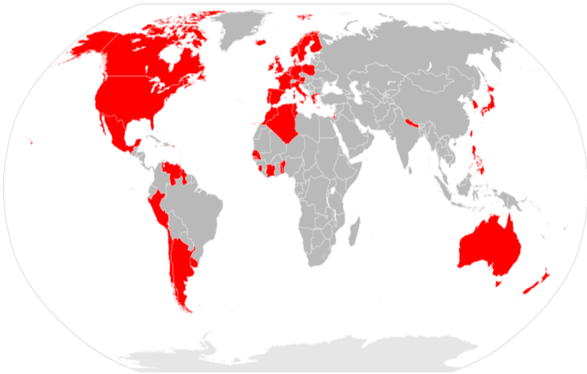
In August 2012 Amnesty International' chief executive in India, sought an impartial investigation, led by the United Nations, to render justice to those affected by war crimes in Sri Lanka.

9 – 2 - Artists For Amnesty

Amnesty International, through its "Artists For Amnesty" program has also endorsed various cultural media works for what its leadership often consider accurate or educational treatments of real-world topics which fall within the range of Amnesty's concern :

A is for Auschwitz
At the Death House Door
Blood Diamond[58]
Bordertown
Catch a Fire
In Prison My Whole Life
Invictus
Lord of War
Rendition
The Constant Gardener
Tibet: Beyond Fear
Trouble the Water

10 – Organization

	
The Amnesty Canadian head quarters in Ottawa.	*Amnesty International Sections, 2005*

Amnesty International is largely made up of voluntary members, but retains a small number of paid professionals. In countries in which Amnesty International has a strong presence, members are organised as 'sections'. Sections co-ordinate basic Amnesty International activities normally with a significant number of members, some of whom will form into 'groups', and a professional staff. Each have a board of directors. In 2005 there were 52 sections worldwide. 'Structures' are aspiring sections. They also co-ordinate basic activities but have a smaller membership and a limited staff. In countries where no section or structure exists, people can become 'international members'. Two other organizational models exist: 'international networks', which promote specific themes or have a specific identity, and 'affiliated groups', which do the same work as section groups, but in isolation.

The organizations outlined above are represented by the International Council (IC) which is led by the IC Chairperson. Members of sections and structures have the right to appoint one or more representatives to the Council according to the size of their membership. The IC may invite representatives from International Networks and other individuals to meetings, but only representatives from sections and structures have voting rights. The function of the IC is to appoint and hold accountable internal governing bodies and to determine the direction of the movement. The IC convenes every two years.

The International Executive Committee (IEC), led by the IEC Chairperson, consists of eight members and the IEC Treasurer. It is elected by, and represents, the IC and meets biannually. The role of the IEC is to take decisions on behalf of Amnesty International, implement the strategy laid out by the IC, and ensure compliance with the organization's statutes.

The International Secretariat (IS) is responsible for the conduct and daily affairs of Amnesty International under direction from the IEC and IC. It is run by approximately 500 professional staff members and is headed by a Secretary General. The IS operates several work programmes; International Law and Organisations; Research; Campaigns; Mobilisation; and Communications. Its offices have been located in London since its establishment in the mid-1960s.

Amnesty International Sections, 2005

Algeria; Argentina; Australia; Austria; Belgium (Dutch speaking); Belgium (French speaking) ; Benin; Bermuda; Canada (English speaking); Canada (French speaking); Chile; Côte d'Ivoire; Denmark; Faroe Islands; Finland; France; Germany; Greece; Guyana; Hong Kong; Iceland; Ireland; Israel; Italy; Japan; Korea (Republic of); Luxembourg; Mauritius; Mexico; Morocco; Nepal; Netherlands; New Zealand; Norway; Peru; Philippines; Poland; Portugal; Puerto Rico; Senegal; Sierra Leone; Slovenia; Spain; Sweden; Switzerland; Taiwan; Togo; Tunisia; United Kingdom; United States of America; Uruguay; Venezuela

Amnesty International Structures, 2005

Belarus; Bolivia; Burkina Faso; Croatia; Curaçao; Czech Republic; Gambia; Hungary; Malaysia; Mali; Moldova; Mongolia; Pakistan; Paraguay; Slovakia; South Africa; Thailand; Turkey; Ukraine; Zambia; Zimbabwe

IEC Chairpersons

Seán MacBride, 1965 – 1974; Dirk Börner, 1974 – 1977; Thomas Hammarberg, 1977 – 1979; José Zalaquett, 1979 – 1982; Suriya Wickremasinghe, 1982 – 1985; Wolfgang Heinz, 1985 – 1996; Franca Sciuto, 1986 – 1989; Peter Duffy, 1989 – 1991; Annette Fischer, 1991 – ; Ross Daniels, 1993 – 1997 ; Susan Waltz, 1996– 1998; Mahmoud Ben Romdhane, 1999 – 2000; Colm O Cuanachain, 2001 – 2002; Paul Hoffman, 2003–2004; Jaap Jacobson, 2005; Hanna Roberts, 2005 – 2006; Lilian Gonçalves - Ho Kang You, 2006–2007; Peter Pack , 2007 – 2011 and Pietro Antonioli,2011 – present.

Secretaries General

Secretary General	Office	Origin
Peter Benenson	1961 – 1966	Britain
Eric Baker	1966 – 1968	Britain
Martin Ennals	1968 – 1980	Britain
Thomas Hammarberg	1980 – 1986	Sweden
Ian Martin	1986 – 1992	Britain
Pierre Sané	1992 – 2001	Senegal
Irene Khan	2001 – 2010	Bangladesh
Salil Shetty	2010 – present	India

10 – 1 – Funding

Amnesty International is financed largely by fees and donations from its worldwide membership. It says that it does not accept donations from governments or governmental organisations. According to the AI website, "these personal and unaffiliated donations allow AI to maintain full independence from any and all governments, political ideologies, economic interests or religions. We neither seek nor accept any funds for human rights research from governments or political parties and we accept support only from businesses that have been carefully vetted. By way of ethical fundraising leading to donations from individuals, we are able to stand firm and unwavering in our defence of universal and indivisible human rights " .

However, AI did receive grants from the UK Department for International Development , the European Commission , the United States State Department. and other governments

10 – 2 - Charitable Status

In the UK Amnesty International has two principal arms, Amnesty International UK and Amnesty International Charity Ltd. Both are UK - based organizations but only the latter is a charity.

11 – Criticism

Criticism of Amnesty International includes claims of excessive pay for management, under protection of overseas staff, associating with organizations with a dubious record on human rights protection, selection bias, ideological policy bias against either non-Western countries or Western - supported countries, and criticism of Amnesty's policies relating to abortion . Governments and their supporters have criticised Amnesty's criticism of their policies, including those of Canada , China , Democratic Republic of the Congo , Iran, Israel , Saudi Arabia, Vietnam , Russia and the United States, for what they assert is one-sided reporting or a failure to treat threats to security as a mitigating factor. The actions of these governments — and of other governments critical of Amnesty International — have been the subject of human rights concerns voiced by Amnesty. As of February 2011, Amnesty is engaged in a dispute with the British union Unite over Amnesty allegedly attempting to de - recognize some of its foreign-based workers' rights.

11 – 1 - Pay controversy

In February 2011, newspaper stories in the UK revealed that Irene Khan had received a payment of UK£533,103 from Amnesty International following her resignation from the organization on 31 December 2009 , a fact pointed to from Amnesty's records for the 2009 –2010 financial year. The sum paid to her was in excess of four times her annual salary of £ 132 , 490 . The deputy secretary general, Kate Gilmore – who also resigned in December 2009 – received an ex

- gratia payment of £ 320,000 . Peter Pack, the chairman of Amnesty's international executive committee, initially stated on 19 February 2011, "The payments to outgoing secretary general Irene Khan shown in the accounts of AI (Amnesty International) Ltd for the year ending 31 March 2010 include payments made as part of a confidential agreement between AI Ltd and Irene Khan." and that "It is a term of this agreement that no further comment on it will be made by either party."

The payment and AI's initial response to its leakage to the press led to considerable outcry. Philip Davies, the Conservative MP for Shipley, decried the payment, telling the *Daily Express*, "I am sure people making donations to Amnesty, in the belief they are alleviating poverty, never dreamed they were subsidising a fat cat payout. This will disillusion many benefactors."[81] On 21 February Peter Pack issued a further statement, in which he said that the payment was a "unique situation" that was "in the best interest of Amnesty's work" and that there would be no repetition of it. He stated that "the new secretary general, with the full support of the IEC, has initiated a process to review our employment policies and procedures to ensure that such a situation does not happen again."[80] Pack also stated that Amnesty was "fully committed to applying all the resources that we receive from our millions of supporters to the fight for human rights". On 25 February, Pack issued a more complete statement intended for internal circulation among Amnesty members and staff. In summary, it states that Amnesty's International Executive Committee (IEC) in 2008 had decided not to prolong Khan's contract for a third term. In the following months, IEC discovered that due to British employment law, it had to choose between the three options of either offering Khan a third term, discontinuing her post and potentially risking legal consequences, or signing a confidential agreement and issuing a pay compensation.

12 - Local groups

Local Group	Local Website
Amnesty International Algeria	www.amnestyalgerie.org
Amnesty International Argentina	www.amnistia.org.ar
Amnesty International Australia	www.amnesty.org.au
Amnesty International Austria	www.amnesty.at
Amnesty International Belgium	www.amnesty.be
Amnesty International Benin	www.aibenin.org
Amnesty International Bermuda	www.amnestybermuda.org
Amnesty International Brazil	www.anistia.org.br
Amnesty International Burkina Faso	www.amnesty-bf.org
Amnesty International Canada	www.amnesty.ca
Amnesty International Chile	www.amnistia.cl
Amnesty International Czech Republic	www.amnesty.cz
Amnesty International Denmark	www.amnesty.dk
Amnesty International Faroe Islands	www.amnesty.fo
Amnesty International Finland	www.amnesty.fi
Amnesty International France	www.amnesty.fr
Amnesty International Germany	www.amnesty.de
Amnesty International Greece	www.amnesty.org.gr
Amnesty International Hong Kong	www.amnesty.org.hk
Amnesty International Hungary	www.amnesty.hu
Amnesty International Iceland	www.amnesty.is
Amnesty International India	www.act.amnesty.org.in
Amnesty International Ireland	www.amnesty.ie
Amnesty International Israel	www.amnesty.org.il
Amnesty International Italy	www.amnesty.it
Amnesty International Japan	www.amnesty.or.jp
Amnesty International Jersey	www.amnesty.org.je
Amnesty International Luxembourg	www.amnesty.lu
Amnesty International Malaysia	www.aimalaysia.org

Amnesty International Mauritius	www.amnestymauritius.org
Amnesty International Mexico	www.amnistia.org.mx
Amnesty International Moldova	www.amnesty.md
Amnesty International Mongolia	www.amnesty.mn
Amnesty International Morocco	www.amnestymaroc.org
Amnesty International Nepal	www.amnestynepal.org
Amnesty International Netherlands	www.amnesty.nl
Amnesty International New Zealand	www.amnesty.org.nz
Amnesty International Norway	www.amnesty.no
Amnesty International Paraguay	www.amnistia.org.py
Amnesty International Peru	www.amnistia.org.pe
Amnesty International Philippines	www.amnesty.org.ph
Amnesty International Poland	www.amnesty.org.pl
Amnesty International Portugal	www.amnistia-internacional.pt
Amnesty International Puerto Rico	www.amnistiapr.org
Amnesty International Russia	www.amnesty.org.ru
Amnesty International Senegal	www.amnesty.sn
Amnesty International Slovak Republic	www.amnesty.sk
Amnesty International Slovenia	www.amnesty.si
Amnesty International South Africa	www.es.amnesty.org
Amnesty International South Korea	www.amnesty.or.kr
Amnesty International Spain	www.es.amnesty.org
Amnesty International Sweden	www.amnesty.se
Amnesty International Switzerland	www.amnesty.ch
Amnesty International Taiwan	www.amnesty.tw
Amnesty International Togo	www.amnesty.tg
Amnesty International Turkey	www.amnesty.org.tr
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Amphibious Aircraft

Canadair CL-415 seaplane with retractable wheels, Ontario, c. 2007

Contents

1 - Introduction

An amphibious aircraft or amphibian is an aircraft that can take off and land on both land and water. Fixed - wing amphibious aircraft are seaplanes (flying boats and float planes) that are equipped with retractable wheels, at the expense of extra weight and complexity, plus diminished range and fuel economy compared to planes designed for land or water only. Some amphibians are fitted with reinforced keels which act as skiis , allowing them to land on snow or ice with their wheels up and are dubbed tri - phibians.

2 – Design

Float planes often have floats that are interchangeable with wheeled landing gear (thereby producing a conventional land-based aircraft) however in cases where this is not practical amphibious floatplanes, such as the amphibious version of the DHC Otter, incorporate retractable wheels within their floats.

Many amphibian aircraft are the flying boat type. These aircraft, and those designed as floatplanes with a single main float under the fuzelage centerline (such as the Loening OL) , require outrigger floats to provide lateral stability so as to avoid dipping a wingtip, which can destroy an aircraft if it happens at speed, or can cause the wingtip to fill with water and sink if stationary. While these impose weight and drag, amphibious aircraft also face the possibility of these getting hit when operating from a runway. A common solution is to make them retractable as those found on the Consolidated Catalina however these are even heavier than fixed floats. Some aircraft may have the tip floats removed for extended use from land. Other amphibians, such as the Dornier Seastar use stub wings called sponsons, mounted with their own lower surfaces nearly even with the ventral "boat - hull" shaped fuzelage surface to provide the needed stability, while floatplane amphibians usually avoid the problem by dividing their buoyancy requirements between two floats, much like a catamaran.

Some non - amphibious seaplanes may be mistaken for amphibians (such as the Shin Meiwa PS-1) which carry their own beaching gear - usually this is a wheeled dolly or temporary set of wheels used to move a flying boat or floatplane from the water and allow it to be moved around on land but can also appear as a conventional undercarriage. These are not built to take the impact of the aircraft landing on them. An amphibian can leave the water without anyone getting in the water to attach beaching wheels (or even having to have any handy), yet a fully functional undercarriage is heavy and impacts the aircraft's performance, and isn't required in all cases, so an aircraft may be designed to carry its own.

3 – Hazards

An occasional problem with amphibians is with ensuring the wheels are in the correct position for landing. In normal operation, the pilot uses a checklist, verifying each item. Since amphibians can land with them up or down though, the pilot must take extra care to ensure they are correct for the chosen landing place. Landing wheels up on land may damage the keel (unless done on wet grass, a technique occasionally used by pilots of pure flying boats), while landing wheels down on water will almost always flip the aircraft upside down, causing substantial damage.

Vicker Viking - an early amphibian.

4 – Usage

Amphibious aircraft are heavier and slower, more complex and more expensive to purchase and operate than comparable landplanes but are also more versatile. Even if they cannot hover or land vertically, for some jobs they compete favorably with helicopters and do so at a significantly lower cost. Amphibious aircraft can be much faster and have longer range than comparable helicopters, and can achieve nearly the range of land based aircraft,[1] as an airplane's wing is more efficient than a helicopter's lifting rotor. This makes an amphibious aircraft, such as the Grumman Albatross and the Shin Meiwa US-1A, useful for long-range air-sea rescue tasks. In addition, amphibious aircraft are particularly useful as "Bushplanes" engaging in light transport in remote areas, where they are required to operate not only from airstrips, but also from lakes and rivers.

5 – History

In the United Kingdom, traditionally a maritime nation, a large number of amphibians were built between the wars, starting from 1918 with the Vickers Viking and the early 1920s Super marine Seagull and were used for exploration and military duties including search and rescue, artillery spotting and anti-submarine patrol. These evolved throughout the interwar period to ultimately culminate in the post World War 2 Super marine Seagull, which was to have replaced the wartime Walrus and the Sea Otter but was overtaken by advances in helicopters.

replica of Osa's Ark - a Sikorsky S-38 used to explore Africa in the 30s.

Starting in the mid-1920s and running into the late 30s in the United States , Sikorsky produced an extensive family of amphibians (the S - 34 , S - 36 , S - 38 , S - 39 , S - 41, S - 43) that were widely used for exploration and as airliners around the globe, helping pioneer many overseas air routes where the larger flying boats could not go, and helping to popularize amphibians in the US. The Grumman Corporation, late-comers to the game, introduced a pair of light utility amphibious aircraft - the Goose and the Widgeon during the late 1930s for the civilian market. However, their military potential could not be ignored, and many were ordered by the US Armed forces and their allies during World War II. Not coincidentally, the Consolidated Catalina (named for an Catalina island whose resort was partially popularized by the use of amphibians in the 1930s, including Sikorskys, and Douglas Dolphins) was redeveloped from being a pure flying boat into an amphibian during the war. After the war, the United States military ordered hundreds of the Grumman Albatross and its variants for a variety of roles, though, like the pure flying boat was made obsolete by helicopters which could operate in sea conditions far beyond what the best seaplane could manage.

Italian Air Force Piaggio P.136 during takeoff retracting the wheels that make it an amphibian.

Development of amphibians was not limited to the United Kingdom and the United States but few designs saw more than limited service - there being a widespread preference for pure flying boats and floatplanes due to the weight penalty the undercarriage imposed, yet Russia also developed a number of important flying boats, including the widely used pre-war Shavrov Sh-2 utility flying boat, and postwar the Beriev Be-12 anti - submarine and maritime patrol amphibian. Development of amphibians continues in Russia with the jet engined Beriev Be-200. Italy, bordering the Mediterranean and Adriatic has had a long history of waterborne aircraft going back to the first Italian aircraft to fly. While most were not amphibians, quite a few were, including the Savoia-Marchetti S.56A and the Piaggio P.136.

Amphibious aircraft were particularly useful in the unforgiving terrain of Alaska and northern Canada, where many remain in civilian service, providing remote communities with vital links to the outside world. The Canadian Vickers Vedette was developed for forestry patrol in remote areas, previously a job that was done by canoe and took weeks could be accomplished in hours, revolutionizing forestry conservation. Although successful, flying boat amphibians like it ultimately proved less versatile than floatplane amphibians and are no longer as common as they once were. Amphibious floats that could be attached to any aircraft were developed, turning any aircraft into an amphibian, and these continue to be essential for getting into the more remote locations during the summer months when the only open areas are the waterways.

Despite the gains of amphibious floats, small flying boat amphibians continued to be developed into the 1960s, with the Republic Seabee and Lake LA - 4 series proving popular, though neither was a commercial success due to factors beyond their makers control. Many today are home builts , by necessity as the demand is too small to justify the costs of development, with the Volmer Sportsman being a popular choice amongst the many offerings. With the increased availability of airstrips in remote communities, fewer amphibious aircraft are manufactured today than in the past,

Amphibious Warfare

Two USMC AAVS emerge from the surf at Freshwater Bay, Australia.

Contents

1 - Introduction

Amphibious warfare is a type of offensive military operation that uses naval ships to project ground and air military power onto a hostile or potentially hostile shore . Through history the operations were conducted using ship's boats as the primary method of delivering troops to shore. Since the Gallipoli Campaign specialised watercraft were increasingly designed for landing troops, materiel and vehicles, including by landing craft and for insertion of commandos, by fast patrol boats, zodiacs (rigid inflatable boats) and from mini-submersibles.

The term *amphibious* first emerged in the USA during the 1930s after design of the Landing Vehicle Tracked where the first prototypes were named *Alligator* and *Crocodile*, though neither species are amphibian. Amphibious warfare includes operations defined by their type, purpose, scale and means of execution. In the British Empire at the time these were called combined operations which were defined as "...operations where naval, military or air forces in any combination are co-operating with each other, working independently under their respective commanders, but with a common strategic object "[Ç] . All armed forces that employ troops with special training and equipment for conducting landings from naval vessels to shore agree to this definition.

Since the 20th century an amphibious landing of troops on a beachhead is acknowledged as the most complex of all military manoeuvres. The undertaking requires an intricate coordination of numerous military specialties, including air power, naval gunfire, naval transport, logistical planning, specialized equipment, land warfare, tactics, and extensive training in the nuances of this man oeuvre for all personnel involved.

2 - Amphibious operation

An amphibious operation is both similar and different in many ways to both land, naval and air operations. At its basic such operations include phases of strategic planning and preparation, operational transit to the intended theatre of operations, pre-landing rehearsal and disembarkation, troop landings, beachhead consolidation and conducting inland ground and air operations. Historically, within these scope of these phases a vital part is of success was often based on the military logistics, naval gunfire and close air support. Another factor is the variety and quantity of specialized vehicles and equipment used by the landing force that are designed for the specific needs of this type of operation.

Amphibious operations can be classified as tactical or operational raids such as the Dieppe Raid, operational landings in support of a larger land strategy such as the Kerch–Eltigen Operation, and a strategic opening of a new Theatre of Operations, for example the *Operation Avalanche*.

The purpose of amphibious operations is always offensive, but limited by the plan and terrain.

Landings on islands less than 5,000 km^2 (1,900 sq mi) in size are tactical, usually with the limited objectives of neutralising enemy defenders and obtaining a new base of operation. Such an operation may be prepared and planned in days or weeks, and would employ a naval Task force to land less than a division of troops. The intent of operational landings is usually to exploit the shore as a vulnerability in the enemy's overall position, forcing redeployment of forces, premature use of reserves, and aiding a larger allied offensive effort elsewhere. Such an operation requiring weeks to months of preparation and planning, would use multiple task forces, or even a naval fleet to land corps - size forces, including on large islands,

A strategic landing operation requires a major commitment of forces to invade a national territory in the archipelagic, e.g. the Battle of Leyte, or continental, e.g. *Operation Neptune* invasion. Such an operation may require multiple naval and air fleets to support the landings, and extensive intelligence gathering and planning of over a year.

Although most amphibious operations are thought of primarily as beach landings, they can take exploit available shore infrastructure to land troops directly into an urban environment if unopposed. In this case non - specialized ships can offload troops, vehicles and cargo using organic or facility wharf - side equipment. Tactical landings in the past have utilized small boats, small craft, small ships and civilian vessels converted for the mission to deliver troops to the water's edge.

2 – 1 - Preparation and planning

Preparation and planning the naval landing operation requires the assembly of vessels with sufficient capacity to lift necessary troops employing combat loading. The military intelligence services produce a briefing on the expected opponent which guides the organization and equipping of the embarked force. First specially designed landing craft were used for the Gallipoli landings, and armoured tracked vehicles were also available for the Guadalcanal Campaign. Helicopters were first used to support beach landings during *Operation Musketeer*. Hovercraft have been in use for naval landings by military forces since the 1960s.

3 – History

Recorded amphibious warfare predates the 18th century by a couple of millennia: the Sea Peoples that menaced the Egyptians from the reign of Akhenaten as captured on the reliefs at Medinet Habu and Karnak; the Hellenic city states who routinely resorted to opposed assaults upon each other's shores, which they reflected upon in their plays and other expressions of art; the landing at Marathon by the ancient Persians on 9 September 490 BC, which history records as the largest amphibious operation for 2,400 years until eclipsed by Gallipoli.

More current amphibious landings have been conducted by small commando forces of various states and non-state actors. There exists debate over mainland China (PRC)'s potential to conduct amphibious operations against Taiwan (ROC). With the bulk of the world's population concentrated near the sea, chances are high that future conflict may entail the use of amphibious assets.

3 – 1 - 16th century

In 1565, the island of Malta was invaded by the Turks during the Siege of Malta. A strategic choke point in the Mediterranean Sea, the loss was so menacing for the Western Europe kingdoms that forces were urgently raised in order to recover the island. But it took four months to train, arm, and move a 5,500 man amphibious force to retake the island.

Then, Philip II, King of Spain, decided to train and assign amphibious - assault skilled units to the Royal Armada. These units were trained specifically for the fighting on ships and from ships. The Spanish Marines were born. The idea was to set up a permanent assignation of land troops to the Royal Spanish Navy, available for the Crown.

Thus, countries adopted the idea and subsequently raised their early marine corps too.

The first "professional" Marine units were already task-trained amphibious troops, but instead of being disbanded, were kept for the Crown's needs. First actions took place all along the Mediterranean Sea where the Turks and pirate settlements were a risk for the commerce and navigation: Algiers, Malta, Gelves.

Landings at the "Terceras Landing" in the Azores Islands 25 May 1583, was a military feat as the planners decided to make a fake landing to distract the defending forces (5,000 Portuguese, English and French soldiers); also special seagoing barges were arranged in order to unload cavalry horses and 700 artillery pieces on the beach; special rowing boats were equipped with small cannons to support the landing boats; special supplies were readied to be unloaded and support the 11,000 men landing force strength. The total strength of the amphibious force, was 15,000 men, including an armada of 90 ships.

After an initial reconnaissance action where the most suitable beaches for the landing assets were chosen, a 4,000 – man first assault wave was unloaded while two "Galeras" made a distractive fake landing away from the main beach. The main defensive body ran to defend against the feinted action, but the first wave had set up a firm defensive perimeter, and the second wave was already landing with the heavy artillery.

In this operation we can find documented reports about the detailed planning, the previous reconnaissance of the beaches, the special equipment and training, ship - to - shore movement, naval fire support. This would be one of the first examples of a complex amphibious assault that would characterize modern amphibious warfare.

3 – 2 - 17th century

This was a century of "expansion". European countries were expanding and creating colonies. Amphibious operations were mostly oriented to settle colonies and strong points along the navigational routes. Fights among countries to keep or destroy opposing power's capabilities were continuous.

Amphibious forces were fully organized and devoted to this mission, although the troops not only fought ashore, but on board ships.

3 – 3 - 18th century

Amphibious landings were performed by Spanish Marines allowing them to conquer Sardinia (1717) and Sicily (1732).

By their nature amphibious assaults are highly complex operations involving the coordination of disparate elements and are therefore prone to disastrous results if not properly planned. One of the most spectacular instances of such a failure occurred in 1741 at the Battle of Cartagena de Indias, when a large British empire amphibious assault force with a compromised command was defeated by a much smaller but well organized and led Spanish empire defence.

In 1759, during the siege of Quebec, the British troops attempted on a number of occasions to cross the Saint Lawrence River in force. An attempt to land some 4,000 troops in the face of resistance failed. Ultimately a landing was managed at a relatively undefended site, and British troops gained a foothold allowing 5,000 to take part in the Battle of the Plains of Abraham which led to the surrender of the city.

In 1762 Royal Navy troops & marines succeed in taking the capitals of the Spanish West & East Indies Havana in Cuba & Manila by sea respectively.

In 1776, Samuel Nicholas and the Continental Marines, the "progenitor" of the United States Marine Corps, made a first successful landing in the Battle of Nassau.

In 1781, the Spanish field marshal Bernardo de Gálvez, successfully captured British controlled Fort George by amphibious assault in the Battle of Pensacola. In 1782, he captured the British naval base at New Providence in the Bahamas. In 1782, a long Franco-Spanish attempt to seize Gibraltar by water borne forces was abandoned. In 1783, a Franco - Spanish force invaded the island of Minorca.

In 1793, Minorca experienced yet another of its many changes of sovereignty, when captured by a British landing.

3 – 4 - 19th century

During the American Civil War, the United States made several amphibious assaults all along the Confederate states coastline. Hatteras Inlet and Port Royal, South Carolina were the first of many attacks. Along with others on Roanoke Island, NC; Galveston, TX; Fort Sumter, Morris Island and James Island, SC; and several others. The largest was at the Fort Fisher, which was the largest and most powerful fort in the world at the time, protecting the entrance of Wilmington, North Carolina. The assaulting force of over 15,000 men and 70 warships with over 600 guns, was the most powerful amphibious assault in world history .

An early form of amphibious warfare was employed during the War of the Pacific in 1879, and saw coordination of army, navy and specialized units.

The first amphibious assault of this war took place as 2,100 Chilean troops successfully took Pisagua from 1,200 Peruvian and Bolivian defenders on 2 November 1879. Chilean Navy ships bombarded beach defenses for several hours at dawn, followed by open, oared boats landing Army infantry and sapper units into waist-deep water, under enemy fire. An outnumbered first landing wave fought at the beach; the second and third waves in the following hours were able to overcome resistance and move inland. By the end of the day, an expeditionary army of 10,000 had disembarked at the captured port.

In 1881 Chilean ships transported approximately 30,000 men, along with their mounts and equipment, 500 miles (800 km) in order to attack Lima . Chilean commanders were using purpose-built, flat-bottomed landing craft that would deliver troops in shallow water closer to the beach, possibly the first purpose-built amphibious landing craft in history :

Landing tactics and operations were closely observed by neutral parties during the war: two Royal Navy ships monitored the Battle of Pisagua; United States Navy observer Lt. Theodorus B. M. Mason included an account on his report *The War on the Pacific Coast of South America*. The USS Wachusett with Alfred Thayer Mahan in command, was stationed at Callao, Peru, protecting American interests during the final stages of the War of the Pacific. He formulated his concept of sea power while reading a history book in an English gentleman’s club in Lima, Peru. This concept became the foundation for his celebrated The Influence of Sea Power upon History.

3 – 5 - World War I era

An amphibious assault took place at the beaches of Veracruz, Mexico in 1914, when the United States Navy attacked and occupied the city as result of the Tampico Affair.

During World War I, amphibious warfare was still in its infancy: tactics and equipment were rudimentary and required much improvisation.

During this period, British Royal Marine Light Infantry (merged with the Royal Marine Artillery in the 1920s to form the Royal Marines) were used primarily as naval parties onboard Royal Navy warships to maintain discipline and man ships' guns. The RMLI joined a new Royal Navy division — the Royal Naval Division— formed in 1914 to fight on land; however, throughout the conflict, army units were depended upon to provide the bulk — if not all—of troops used in amphibious landings.

The first amphibious assault of the war ended in disaster in 1914. A large British Indian Army force was directed to launch an amphibious assault on Tanga, German East Africa. British actions prior to the assault, however, alerted the Germans to prepare to repel an invasion. The Indian forces suffered heavy casualties when they advanced on the city, forcing them to withdraw back to their boats, leaving much of their equipment behind.

The Allied invasion against the Ottoman Empire at the Battle of Gallipoli in 1915 proved even more disastrous than Tanga, in part due to incompetence at the high command strata.

Soldiers were landed via open, oared whaleboats and tugs at Anzac Cove and Helles. At V Beach, Helles, the landing troops— inexperienced at amphibious landings — were effectively slaughtered by the Ottoman defenders, most not even making it out of their landing craft. The Royal Dublin Fusiliers, for example, lost almost all their officers, including their commander, and suffered over 500 casualties.

In a second landing at Suvla in August, the forerunner of modern landing craft — the armoured 'Beetle' — was first used by the British.

On the 11th of October 1917 German land and naval forces launched an amphibious assault, code named Operation Albion, on the islands of Saaremaa (Ösel), Hiiumaa (Dagö) and Muhu (Moon), that controlled the entrance to the Gulf of Riga. By the end of the month German forces had successfully overrun the islands forcing the Russians to abandon them with the loss of some 20,000 troops, 100 guns and the Pre - dreadnought battle ship Slava. The capture of the islands opened a route for German naval forces into the Gulf of Finland threatening the city of Petrograd, a fact that contributed to the cessation of hostilities on the Eastern front

3 – 6 - Interwar period

The Alhucemas Landing on 8 September 1925, performed by a Spanish - French coalition against rebel Kabilas in the north of Morocco, was a landing where tanks were used for the first time; air naval gunfire support were employed by the landing forces, directed by spotting personnel with communication devices.

Floating depots were organized with medical, water, ammunition and food supplies, to be dispatched ashore when needed. The barges used in this landing were the surviving "K" boats from Gallipoli. But in this case, the landings were performed against a prepared, defended in force positions.

In 1938, Japanese forces attacked Chinese defenders over the Yangtze River at the Battle of Wuhan.

3 – 6 - 1 - U.S. Marines devise an amphibious mission

The U.S. Marine Corps was searching for an expanded mission after World War I. It had been used in France as a junior version of the Army infantry, and Marine leaders realized that was a dead end. It found

a new mission: it would be a fast - reacting, light infantry fighting force carried rapidly to far off locations by the Navy. Its special role was amphibious landings on enemy-held islands, but it took years to figure out how to do that. The Mahanian notion of a decisive fleet battle required forward bases for the Navy close to the enemy. After the Spanish - American War the Marines gained the mission of occupying and defending those forward bases, and they began a training program on Culebro Island, Puerto Rico. The emphasis at first was on defending the forward base against enemy attack; they would be like the Turks who in 1915 inflicted 250,000 casualties on the British, Australian and New Zealand invaders of Gallipoli, forcing their withdrawal.

As early as 1900 the Navy's General Board considered building advance bases for naval operations in the Pacific and the Caribbean. The Marine Corps was given this mission in 1920, but the challenge was to avoid another disaster like Gallipoli. The conceptual breakthrough came in 1921 when Major "Pete" Ellis wrote "Advanced Base Operations in Micronesia" a secret 30,000 - word manifesto that proved inspirational to Marine strategists and highly prophetic . To win a war in the Pacific, the Navy would have to fight its way through thousands of miles of ocean controlled by the Japanese — including the Marshall, Caroline, Marianas and Ryukus island chains. If the Navy could land Marines to seize selected islands, they could become forward bases. Ellis argued that with an enemy prepared to defend the beaches, success depended on high-speed movement of waves of assault craft, covered by heavy naval gunfire and attack from the air. He predicted the decision would take place on the beach itself, so the assault teams would need not just infantry but also machine gun units, light artillery, light tanks, and combat engineers to defeat beach obstacles and defenses. Assuming the enemy had its own artillery, the landing craft would have to be specially built to protect the landing force. The failure at Gallipoli came because the Turks could easily reinforce the specific landing sites. The Japanese would be unable to land new forces on the islands under attack.

Not knowing which of the many islands would be the American target, the Japanese would have to disperse their strength by garrisoning many islands that would never be attacked. An island like Eniwetok in the Marshall Islands, would, Ellis estimated, require two regiments, or 4,000 Marines. (Indeed, in February 1944 the Marines seized Eniwetok with 4,000 men in three battalions.) Guided by Marine observer airplanes, and supplemented by Marine light bombers, warships would provide enough firepower so that Marines would not need any heavy artillery (in contrast to the Army, which relied heavily on its artillery.) Shelling defended islands was a new mission for warships. The Ellis model was officially endorsed in 1927 by the Joint Board of the Army and Navy .

Actual implementation of the new mission took another decade because the Corps was preoccupied in Central America, the Navy was slow to start training in how to support the landings, and a new kind of ship had to be invented to hit the beaches without massive casualties. In 1941 British and American ship architects invented a new class of "landing ship" to solve the problem. In World War II, the Navy built 1,150 LSTs. They were large (2400 tons) and slow (10 knots); officially known as "Landing Ship Tank," the passengers called them "Large Stationary Targets." Lightly armored, they could steam cross the ocean with a full load on their own power, carrying infantry, tanks and supplies directly onto the beaches. Together with 2,000 other landing craft, the LSTs gave the Marines (and Army soldiers) a protected, quick way to make combat landings, beginning in summer 1943.

In 1933, a "Fleet Marine Force" was established with the primary mission of amphibious landings. The Force was a brigade with attached Marine aviation units that were trained in observation and ground support. By paying special attention to communications between ground and air, and between shore and sea, they developed an integrated three-dimensional assault force. By 1940, having adding enough men, the appropriate equipment, and a rigorous training program, the Marine Corps had worked out, in theory, its doctrine of amphibious assaults. Under the combat leadership of Holland "Howlin Mad" Smith, the general most responsible for training, the Marines were ready to hit the beaches.

7 - World War II

By the Second World War tactics and equipment had moved on. Purpose built landing craft were among the vessels used at the evacuation from Dunkirk (Operation Dynamo) and an amphibious operation was tried out at Dieppe in 1942. The operation proved a costly failure, but the lessons, hard learned, were used later. Many small - scale operations were conducted by the Allies on the Axis -

held coast of Europe, including raids on the Lofoten Islands, St Nazaire and Bruneval.

Arguably the most famous amphibious assault was the Normandy landings on 6 June 1944, in which British, Canadian, and US forces were landed at Utah, Omaha, Gold, Juno and Sword beaches. The organizational planning of the landing itself (Operation Neptune) was in the hands of Admiral Bertram Ramsay. It covered the landing of the troops and their re-supply.

Other large amphibious operations in the European Theatre in WWII include :

Location	Operation Name	Date	Notes
Norway	Operation 'Weser -Exercise' (German: Unternehmen Weserübung)	9 April 1940	
Great Britain	Operation Sea Lion (German: Unternehmen Seelöwe)	17 September 1940	Not carried out
Crete	Operation Mercury (German: Unternehmen Merkur)	20 May 1941	Primarily an airborne assault
North Africa	Operation Torch	8 November 1942	Three task forces covering the coasts of Morocco and Algeria
Sicily	Operation Husky	began on the night of 9 – 10 July 1943	
Salerno	Operation Avalanche	9 September 1943	Also involved two supporting operations: in Calabria (Operation Baytown, 3rd Sept) and Taranto (Operation Slapstick, 9 September).
Anzio	Operation Shingle	22 January 1944	
Southern France	Operation Dragoon	15 August 1944	

In the Pacific Theatre, almost every campaign involved "island hopping" assaults from the sea. Some of the famous ones include :

Malaya
The Philippines 1941- 42 and 1944 - 45
Guadalcanal Campaign
Battle of Tarawa
Battle of Makin
Battle of Saipan
Battle of Peleliu
Battle of Iwo Jima
Battle of Okinawa

The war finished before the large Indian Ocean amphibious assault Operation Zipper was launched, however, small amphibious operations took place along the Arakan coast during the Burma Campaign.

In late 2001, USS Peleliu (LHA-5) amphibious group sent ashore 15th MEU into Northern Pakistan and Afghanistan.

3 - 8 –After World War II

3 - 8 – 1 - Korean War

During the Korean War the U.S. X Corps, consisting of the 1st Marine Division and 7th Infantry Division landed at Inchon. Conceived of and commanded by U.S. General Douglas MacArthur, this landing is considered by many military historians to have been a tactical jewel, one of the most brilliant amphibious maneuvers in history . The success of this battle eventually resulted in link up with U.S. Army forces that broke out of the Pusan perimeter, and led by the 1st Cavalry Division and its Task Force Lynch , cleared much of

South Korea. A second landing by the Tenth Corps on the east coast approached the Chosin Reservoir and hydroelectric plants that powered much of Communist China's heavy industry, and led to intervention by Chinese forces on behalf of North Korea. Amphibious landings also took place during the First Indochina War, notably during Operation Camargue, one of the largest of the conflict .

3 - 8 – 2 - Suez Crisis

The British Royal Marines made their first post - World War II amphibious assault during the Suez Crisis of 1956 when they successfully landed at Suez on 6 November as part of a joint seaborne/airborne operation code - named MUSKETEER. It was the first amphibious operation that employed helicopters in the assault. Nearly 30 years later in the Falklands War, the Argentine 1st Marine Brigade of the Argentine Navy along with Naval Special Forces, landed at Mullet Creek near Stanley on 2 April 1982, while later the Royal Marines' 3 Commando Brigade, (augmented by the British Army's Parachute Regiment) landed at Port San Carlos on 21 May 1982.

3 - 8 – 3 - Sri Lankan Civil War

In the Sri Lankan Civil War, the Sri Lanka armed forces carried out several successful amphibious assault against the Liberation Tigers of Tamil Eelam, that included the landing code named Operation Balavegaya.

3 - 8 – 4 - Landing at Cyprus

The Turkish Armed Forces launched an amphibious assault in 20 July 1974, on Kyrenia, following the event of 1974 Cypriot coup d'état. The Turkish naval force provided naval gun support during the landing operation and transported the amphibious forces from port of Mersin to the island. The Turkish landing forces consisted of around 3,000 troops, tanks, armored personnel carriers and artillery pieces.[16]

3 - 8 – 5 - Persian Gulf War

During the Persian Gulf War, Assault Craft Unit 5 was able to position U.S. Marine and naval support off the coast of Kuwait and

Saudi Arabia. This force was composed of 40 amphibious assault ships, the largest such force to be assembled since the Battle of Inchon . The objective was to fix the six Iraqi divisions deployed along the Kuwaiti coast. The purpose behind this amphibious maneuver (known as an amphibious demonstration) was to prevent 6 Iraqi divisions poised for the defense of the littorals from being able to actively engage in combat at the real front. The operation was extremely successful in keeping more than 41,000 Iraqi forces from repositioning to the main battlefield. As a result, the Marines maneuvered through the Iraq defense of southern Kuwait and outflanked the Iraqi coastal defense forces.

3 - 8 – 6 - Iraq War

An amphibious assault was carried out by Royal Marines, U.S. Marines and units of the Polish special forces when they landed at the Al - Faw Peninsula on 20 March 2003 during the Iraq War.

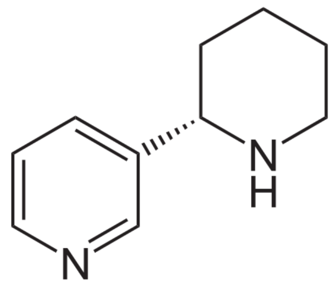
3 - 8 – 7 - Invasion of Anjouan

On March 25, 2008, Operation Democracy in Comoros was launched in the Comoros by government and African Union troops. The amphibious assault led to the ousting of Colonel Bacar's government: which had taken over the autonomous state of Adjouan.

3 - 8 – 8 - Battle of Kismayo (2012)

From September 28 to October 1, 2012, the Somali National Army led an assault in conjuncture with allied militia and Kenyan troops to liberate the city of Kismayo from insurgent control. The operation, known as Operation Sledge Hammer, started with the landing of Somali and Kenyan troops outside the city of Kismayo. By October 1, the coalition forces were able to push Al-Shabaab out of the city.

Anabasine



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3 - (2-piperidyl) pyridine	
Formula	$C_{10}H_{14}N_2$
Mol. mass	162 g / mol

Contents

1 - Introductıon

Anabasine is a pyridine and piperidine alkaloid found in the Tree Tobacco (*Nicotiana glauca*) plant, a close relative of the common tobacco plant (*Nicotiana tabacum*). It is a structural isomer of, and chemically similar to, nicotine. Its principal (historical) industrial use is as an insecticide.

Anabasine is present in trace amounts in tobacco smoke, and can be used as an indicator of a person's exposure to tobacco smoke.[1]

2 – Pharmacology

Anabasine is a nicotinic acetylcholine receptor agonist. In high doses, it produces a depolarizing block of nerve transmission, which can cause symptoms similar to those of nicotine poisoning and, ultimately, death by asystole. In larger amounts it is thought to be teratogenic in swine.

The intravenous LD_{50} of anabasine ranges from 11 mg / kg to 16 mg / kg in mice, depending on the enantiomer.

Anabolism

Anabolism (from Greek : "upward" and "to throw") is the set of metabolic pathways that construct molecules from smaller units. These reactions require energy. One way of categorizing metabolic processes, whether at the cellular, organ or organism level is as "anabolic" or as "catabolic", which is the opposite. Anabolism is powered by catabolism, where large molecules are broken down into smaller parts and then used up in respiration. Many anabolic processes are powered by the hydrolysis of adenosine triphosphate (ATP).

Anabolic processes tend toward "building up" organs and tissues. These processes produce growth and differentiation of cells and increase in body size, a process that involves synthesis of complex molecules. Examples of anabolic processes include the growth and mineralization of bone and increases in muscle mass. Endocrinologists have traditionally classified hormones as anabolic or catabolic, depending on which part of metabolism they stimulate. The classic anabolic hormones are the anabolic steroids, which stimulate protein synthesis and muscle growth, and insulin. The balance between anabolism and catabolism is also regulated by circadian rhythms, with processes such as glucose metabolism fluctuating to match an animal's normal periods of activity throughout the day.[3]

Anaerobic Respiration

Contents

1 - Introductıon

Anaerobic respiration is a form of respiration using electron acceptors other than oxygen. Although oxygen is not used as the final electron acceptor, the process still uses a respiratory electron transport chain; it is respiration without oxygen. In order for the electron transport chain to function, an exogenous final electron acceptor must be present to allow electrons to pass through the system. In aerobic organisms, this final electron acceptor is oxygen. Molecular oxygen is a highly oxidizing agent and, therefore, is an excellent acceptor. In anaerobes, other less - oxidizing substances such as sulfate (SO_4^{2-}), nitrate (NO_3^-), sulfur (S), or fumarate are used. These terminal electron acceptors have smaller reduction potentials than O_2, meaning that less energy is released per oxidized molecule. Anaerobic respiration is, therefore, in general energetically less efficient than aerobic respiration.

Anaerobic respiration is used mainly by prokaryotes that live in environments devoid of oxygen. Many anaerobic organisms are obligate anaerobes, meaning that they can respire only using anaerobic compounds and will die in the presence of oxygen.

2 - Anaerobic respiration as compared to fermentation

Cellular respiration (both aerobic and anaerobic) utilizes highly reduced species such as NADH and FADH2 (for example produced during glycolysis and the citric acid cycle) to establish an electrochemical gradient (often a proton gradient) across a membrane, resulting in an electrical potential or ion concentration difference across the membrane. The reduced species are oxidized by a series of respiratory integral membrane proteins with sequentially increasing reduction potentials with the final electron acceptor being oxygen (in aerobic respiration) or another species (in anaerobic respiration) . The membrane in question is the inner mitochondrial membrane in eukaryotes and the cell membrane in prokaryotes. A proton motive force or p mf drives protons down the gradient (across the membrane) through the proton channel of ATP synthase. The resulting current drives ATP synthesis from ADP and inorganic phosphate.

Fermentation in contrast, does not utilize an electrochemical gradient. Fermentation instead only uses substrate - level phosphorylation to produce ATP. The electron acceptor NAD+ is regenerated from NADH formed in oxidative steps of the fermentation pathway by the reduction of oxidized compounds. These oxidized compounds are often formed during the fermentation pathway itself, but may also be external. For example, in homo fermentative lactic acid bacteria, NADH formed during the oxidation of glyceraldehyde - 3 - phosphate is oxidized back to NAD+ by the reduction of pyruvate to lactic acid at a later stage in the pathway. In yeast, acetaldehyde is reduced to ethanol.

3 - Ecological importance

Anaerobic respiration plays a major role in the global nitrogen, sulfur, and carbon cycles through the reduction of the oxyanions of nitrogen, sulfur, and carbon to more - reduced compounds. Dissimilatory denitrification is the main route by which biologically fixed nitrogen is returned to the atmosphere as molecular nitrogen gas. Hydrogen sulfide, a product of sulfate respiration, is a potent neurotoxin and responsible for the characteristic 'rotten egg' smell of brackish swamps. Along with volcanic hydrogen sulfide, biogenic sulfide has the capacity to precipitate heavy metal ions from solution, leading to the deposition of sulfidic metal ores. Many terrestrial environments become temporarily flooded, and the resulting decrease in oxygen availability results in transient anoxia. Sequential changes in redox conditions and associated adapted microorganisms will follow a flooding event (such as initially aerobic conditions becoming nitrate - reducing followed by iron - reducing, sulfate reducing and eventually methanogenic). Redox gradients such as these may occur in either time (called sequential reduction) or space (the redox regime becomes increasingly negative with distance from and oxygen source). Environmental redox cycling often has strong effects on natural biogeochemical cycling as well as biodegradation of anthropogenic organic pollutants.

4 - Economic relevance

Dissimiltory denitrification is widely used in the removal of nitrate and nitrite from municipal waste water. An excess of nitrate can lead to eutrophication of waterways into which treated water is released. Elevated nitrite levels in drinking water can lead to problems due to its toxicity. Denitrification converts both compounds into harmless nitrogen gas.

Methanogenesis is a form of carbonate respiration that is exploited to produce methane gas by anaerobic digestion. Biogenic methane is used as a sustainable alternative to fossil fuels. On the negative side, uncontrolled methanogenesis in landfill sites releases large volumes of methane into the atmosphere, where it acts as a powerful greenhouse gas.

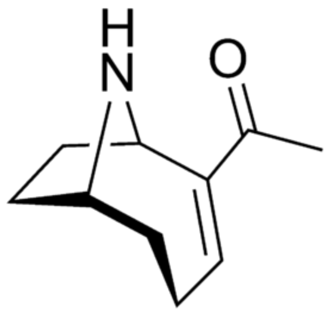
Specific types of anaerobic respiration are also used to convert toxic chemicals into less - harmful molecules. For example, toxic arsenate or selenate can be reduced to less toxic compounds by various bacteria.

5 - Examples of respiration

Type	Lifestyle	Electron acceptor	Products	Example organisms
aerobic respiration	obligate aerobes and facultative anaerobes	oxygen O_2	$H_2O + CO_2$	eukaryotes and aerobic prokaryotes
iron reduction	facultative anaerobes and obligate anaerobes	ferric iron Fe (III)	Fe (II)	*Geobacter*, *Geothermobacter*, *Geopsychrobacter*, *Pelobacter carbinolicus*, *P. acetylenicus*, *P. venetianus*, *Desulfuromonadale*

				s, Desulfovibrio
manganese	facultative anaerobes and obligate anaerobes	Mn (IV)	Mn (II)	*Desulfuromonadales, Desulfovibrio*
cobalt reduction	facultative anaerobes and obligate anaerobes	Co (III)	Co (II)	*Geobacter sulfurreducens*
uranium reduction	facultative anaerobes and obligate anaerobes	U(VI)	U(IV)	*Geobacter metallireducens, Shewanella putrefaciens,* (*Desulfovibrio*)
nitrate reduction (denitrification)	facultative anaerobes	nitrate NO_3^-	nitrite NO_2^-	*Paracoccus denitrificans, E. coli*
fumarate respiration	facultative anaerobes	fumarate	succinate	*Escherichia coli*
sulfate respiration	obligate anaerobes	sulfate SO_4^{2-}	sulfide HS^-	*Desulfobacter latus, Desulfovibrio' oxygen*
methanogenesis (carbonate reduction)	methanogens	carbon dioxide CO_2	methane CH_4	*Methanothrix thermophila*
sulfur respiration (sulfur reduction)	facultative anaerobes and obligate anaerobes	sulfur S^0	sulfide HS^-	*Desulfuromonadales*
acetogenesis (carbonate reduction)	acetogens	carbon dioxide CO_2	acetate	*Acetobacterium woodii*
dehalorespiration	facultative anaerobes and obligate anaerobes	halogenated organic compoundss R-X	Halide ions and dehalogenated compound X^- + R-H	*Trichlorobacter* (*Geobacteraceae*)

Anatoxin – a



Contents

1 - Introduction

Anatoxin-a , also known as Very Fast Death Factor, is a secondary, bicyclic amine alkaloid and cyanotoxin with acute neurotoxicity. It was first discovered in the early 1960s in Canada, and was isolated in 1972. The toxin is produced by seven different genera of cyanobacteria and has been reported in North America, Europe, Africa, Asia, and New Zealand. Symptoms of anatoxin exposure include loss of coordination, muscular fasciculations, convulsions and death by respiratory paralysis. Its mode of action is through the nicotinic acetyl choline receptor (nAchR) where it acts as an agonist of acetyl choline. As such, anatoxin-a has been used for medicinal purposes to investigate diseases characterized by low acetylcholine levels. Due to its high toxicity and potential presence in drinking water, anatoxin-a poses a threat to humans and animals. While methods for detection and water treatment exist, scientists have called for more research to improve reliability and efficacy. Anatoxin-a is not to be confuzed with anatoxin-a(S), another potent cyanotoxin that has a similar mechanism of action to that of anatoxin-a and is produced by many of the same cyanobacteria genera, but is structurally unrelated.

IUPAC name : 1-{9-aza bi cyclo [4.2.1]non-2-en-2-yl}ethan-1-one	
Other names : Anatoxin A	
Molecular formula	$C_{10}H_{15}NO$
Molar mass	165

2 – History

Anatoxin-a was first discovered by P.R Gorham in the early 1960s, after several herds of cattle died as a result of drinking water from Saskatchewan Lake in Canada, which contained toxic algal blooms. It was later isolated (1972) by J.P. Devlin from the cyanobacteria *Anabaena flos aquae*.

In 1977, Carmichael, Gorham, and Biggs experimented with anatoxin-a. They introduced toxic cultures of *Anabaena flos aquae* into the stomachs of two young male calves, and observed that muscular fasciculations and loss of coordination occurred in a matter of minutes, while death due to respiratory failure occurred anywhere between several minutes and a few hours. They also established that extensive periods of artificial respiration did not allow for detoxification to occur and natural neuromuscular functioning to resume. From these experiments, they calculated that the oral minimum lethal dose (MLD) for calves is roughly 420 mg / kg body weight.

Flamingos at Lake Bogoria

In the same year JP Devlin and colleagues discovered the bicyclic secondary amine structure of anatoxin-a. They also performed experiments similar to those of Carmichael et al. on mice. They found that anatoxin-a kills mice 2 – 5 min after intraperitoneal injection preceded by twitching, muscle spasms, paralysis and respiratory arrest. They determined the LD50 for mice to be 25 mg/kg body weight.

Electrophysiological experiments done by Spivak et al. (1980) on frogs showed that anatoxin-a is a potent agonist of the muscle - type α12βγδ nAChR. Anatoxin-a induced depolarizing neuromuscular blockade, contracture of the frog's rectus abdominis muscle, depolarization of the frog Sartorius muscle, desensitization, and alteration of the action potential. Later, Thomas et al., (1993) through his work with chicken α4β2 nAChR subunits expressed on mouse M 10 cells and chicken α7 nAChR expressed in oocytes from Xenopus laevis, showed that anatoxin-a is also a potent agonist of neuronal nAChR.

Many cases of wildlife and livestock deaths due to anatoxin-a have been reported since its discovery. Domestic dog deaths due to the cyanotoxin, as determined by analysis of stomach contents, have been observed at the lower North Island in New Zealand in 2005,[4] in eastern France in 2003 , in California of the United States in 2002 and 2006,[6] in Scotland in 1992, and in Ireland in 1997 and 2005. In each case the dogs began showing muscle convulsions within minutes, and were dead within a matter of hours. Numerous cattle fatalities arising from the consumption of water contaminated with cyanobacteria that produce anatoxin-a have been reported in the United States, Canada, and Finland between 1980 and the present.[2] A particularly interesting case of anatoxin-a poisoning is that of the Lesser Flamingos at Lake Bogoria in Kenya. The cyanotoxin, which was identified in the stomachs and fecal pellets of the birds, killed roughly 30,000 flamingos in the second half of 1999, and continues to cause mass fatalities annually, devastating the flamingo population. The toxin is introduced into the birds via water contaminated with cyanobacterial mat communities that arise from the hot springs in the lake bed.

3 - Mechanism of toxicity

Anatoxin-a is an agonist of both neuronal α4β2 and α4 nicotinic acetylcholine receptors present in the CNS as well as the α12βγδ muscle - type nAchRs that are present at the neuromuscular junction.[1] Anatoxin-a has an affinity for these receptors that is about 20 times greater than that of acetylcholine.[2] However, the cyanotoxin has little effect on muscarinic acetylcholine receptors; it has a 100 fold lesser selectivity for these types of receptors than it has for nAchRs.[8] Anatoxin-a also shows much less potency in the CNS than in neuromuscular junctions. In hippocampal and brain stem neurons, a 5 to 10 times greater concentration of anatoxin-a was necessary to activate nAchRs than what was required in the PNS.

In normal circumstances, acetylcholine binds to nAchRs in the post-synaptic neuronal membrane, causing a conformational change in the extracellular domain of the receptor which in turn opens the channel pore. This allows Na^+ and Ca^{2+} ions to move into the neuron, causing cell depolarization and inducing the generation of action potentials, which allows for muscle contraction. The acetylcholine neurotransmitter then dissociates from the nAchR , where it is rapidly cleaved into acetate and choline by acetyl cholinesterase.

Anatoxin-a binding to these nAchRs cause the same effects in neurons. However, anatoxin-a binding is irreversible, and the anatoxin-a nAchR complex cannot be broken down by acetyl cholinesterase. Thus, the nAchR is temporarily locked open and after a period of time becomes desensitized. In this desensitized state the nAchRs no longer let cations pass through, which ultimately leads to a blockage of neuromuscular transmission.

Of the two enantiomers of anatoxin-a, the positive enantiomer, (+)anatoxin-a, is 150 fold more potent than the synthetic negative enantiomer, (−) anatoxin-a. This is thought to be the case because (+)anatoxin-a, the s-*cis* enone conformation, has a distance a 6.0 A^{o} between its nitrogen and carbonyl group, which corresponds well to the 5.9 A^{o} distance that separate the nitrogen and oxygen in acetylcholine.

Respiratory arrest, which results in a lack of an oxygen supply to the brain, is the most evident and lethal effect of anatoxin-a.[8] Injections of mice, rats, birds, dogs, and calves with lethal doses of anatoxin-a have demonstrated that death is preceded by a sequence of muscle fasciculations, decreased movement, collapse, exaggerated abdominal breathing, cyanosis and convulsions. In mice, anatoxin-a seriously also seriously impacted blood pressure and heart rate, and caused severe acidosis.

4 - Stability and Degradation

Anatoxin-a is unstable in water and other natural conditions, and in the presence of UV light undergoes photo degradation, being converted to the non toxic products dihydro anatoxin-a and epoxy anatoxin-a. The photo degradation of anatoxin-a is dependent on pH and sunlight intensity but independent of oxygen, indicating that the degradation by light is not achieved through the process of photo-oxidation.

Studies have shown that some microorganisms are capable of degrading anatoxin-a. A study done by Kiviranta and colleagues in 1991 showed that the bacterial genus Pseudomonas was capable of degrading anatoxin-a at a rate of 2 – 10 μg / ml per day. Later experiments done by Rapala and colleagues (1994) supported these results. They compared the effects of sterilized and non - sterilized sediments on anatoxin-a degradation over the course of 22 days, and found that after that time vials with the sterilized sediments showed similar levels of anatoxin-a as at the commencement of the experiment, while vials with non-sterilized sediment showed a 25-48% decrease.

5 - Public Health

Despite the relatively low frequency of anatoxin-a relative to other cyano toxins, its high toxicity (the lethal dose is not known for humans, but is estimated to be less than 5 mg for an adult male) means that it is still considered a serious threat to terrestrial and aquatic organisms, most significantly to livestock and to humans. Anatoxin-a is suspected to have been involved in the death of at least one person.[11] The threat posed by anatoxin-a and other cyanotoxins is increasing as both fertilizer runoff, leading to eutrophication in lakes and rivers, and higher global temperatures contribute to a greater frequency and prevalence of cyanobacterial blooms.

5 – 1 – Detection

There are two categories of anatoxin-a detection methods. Biological methods have involved administration of samples to mice and other organisms more commonly used in ecotoxicological testing, such as brine shrimp (*Artemia salina*), larvae of the freshwater crustacean *Thamnocephalus platyurus*, and various insect larvae. Problems with this methodology include an inability to determine whether it is anatoxin-a or another neurotoxin that causes the resulting deaths. Large amounts of sample material are also needed for such testing. In addition to the biological methods, scientists have used chromatography to detect anatoxin-a. This is complicated by the rapid degradation of the toxin and the lack of commercially available standards for anatoxin-a.

5 – 2 - Water Treatment

As of now, there is no official guideline level for anatoxin-a, although scientists estimate that a level of 1 μg L −1 would be sufficiently low, the safety for drinking water being approximately 3 orders of magnitude . Likewise, there are no official guidelines regarding testing for anatoxin-a. Among methods of reducing the risk for cyano toxins, including anatoxin-a, scientists look favorably on biological treatment methods because they do not require complicated technology, are low maintenance, and have low running costs. Few biological treatment options have been tested for anatoxin-a specifically, although a species of *Pseudomonas*, capable of biodegrading anatoxin-a at a rate of 2–10 μg mL−1 d−1, has been identified. Granular activated carbon (GAC) filters have also been tested as a method of biodegradation, but it is inconclusive that they were not simply absorbing the toxin. Others have called for additional studies to determine more about how to use activated carbon effectively.

More common methods of treating water, including UV disinfection[14] and chlorination are not effective for targeting anatoxin-a. Other oxidants such as potassium permanganate, ozone, and the hydroxyl radical have worked in lowering levels of anatoxin-a. Optimizing the treatment process would involve the ability to remove complete cyanobacterial cells, since most of the anatoxin-a is found within the cells when the bloom is growing. Additional research needs to be done to find more reliable and efficient methods of both detection and treatment.

6 – Biosynthesis

Anatoxin-a is synthesized in vivo in the species *Anabaena flos aquae*,[2] as well as several other genera of cyanobacteria. Anatoxin-a and related chemical structures are produced using acetate and glutamate. Further enzymatic reduction of these precursors results in the formation of anatoxin-a. Homo anatoxin, a similar chemical, is produced by Oscillatoria formosa and utilizes the same precursor. However, homo anatoxin undergoes a methyl addition by S-adenosyl-L_ methionine instead of an addition of electrons, resulting in a similar analogue.

7 - Laboratory Uses

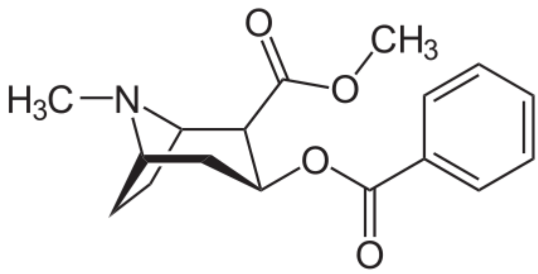
Anatoxin-a is a very powerful nicotinic acetylcholine receptor agonist and as such has been extensively studied for medicinal purposes. It is mainly used as a pharmacological probe in order to investigate diseases characterized by low acetylcholine levels, such as muscular dystrophy, Myastenia gravis, Alzheimer's disease, and

Parkinson's disease. Further research on anatoxin-a and other less potent analogues are being tested as possible replacements for acetylcholine.

8 - Laboratory Synthesis

8 – 1 - Cyclic Expansion of Tropanes

The first biologically occurring initial substance for tropane expansion into anatoxin-a was cocaine, which has similar stereo chemistry to anatoxin-a. Cocaine is first converted into the endo isomer of cyclo propane, which is then photo lytically cleaved to obtain an alpha, beta unsaturated ketone. Through the use of diethyl azo di carboxylate, the ketone is de methylated and anatoxin-a is formed. A similar, more recent synthesis pathway involves producing 2-tropinone from cocaine and treating the product with ethyl chloroformate producing a bicyclic ketone. This product is combined with trimethylsilyldiazylmethane, an organo aluminum Lewis acid and trimethylsinyl enol ether to produce tropinone. This method undergoes several more steps, producing useful intermediates as well as anatoxin-a as a final product.



Cocaine, a precursor for anatoxin-a synthesis.

8 – 2 - Cyclization of Cyclo octenes

The first and most extensively explored approach used to synthesize anatoxin-a in vitro, cyclo octene cyclization involves 1,5-cyclo ocadiene as its initial source. This starting substance is reacted to form methyl amine and combined with hypo bromous acid to form anatoxin-a. Another method developed in the same laboratory uses amino alcohol in conjunction with mercuric (II) acetate and sodium boro hydride. The product of this reaction was transformed into an alpha, beta ketone and oxidized by ethyl azo di carboxylate to form anatoxin-a.

8 – 3 - Enantioselective Enolization Strategy

This method for anatoxin-a production was one of the first used that does not utilize a chimerically analogous starting substance for anatoxin formation. Instead, a racemic mixture of 3-tropinone is used with a chiral lithium amide base and additional ring expansion reactions in order to produce a ketone intermediate. Addition of an organo cuprate to the ketone produces an enol triflate derivative, which is then lysed hydrogenously and treated with a deprotecting agent in order to produce anatoxin-a. Similar strategies have also been developed and utilized by other laboratories.

8 – 4 - Intramolecular Cyclization of Iminium Ions

Iminium ion cyclization utilizes several different pathways to create anatoxin-a, but each of these produces and progresses with a pyrrolidine iminium ion. The major differences in each pathway relate to the precursors used to produce the imium ion and the total yield of anatoxin-a at the end of the process. These separate pathways include production of alkyl iminium salts, acyl iminium salts and tosyl iminium salts.

8 – 5 - Enyne Metathesis

Enyne metathesis of anatoxin-a involves the use of a ring closing mechanism and is one of the more recent advances in anatoxin-a synthesis. In all methods involving this pathway, pyro glutamic acid is used as a starting material in conjunction with a Grubb's catalyst. Similar to iminium cyclization, the first attempted synthesis of anatoxin-a using this pathway used a 2,5-cis-pyrrolidine as an intermediate.

9 - Genera of cyanobacteria that produce anatoxin-a

Anabaena
Aphanizomenon
Cylindrospermum
Microcystis
Oscillatoria
Planktothrix
Raphidiopsis

ANFO
(Ammonium Nitrate / Fuel Oil)

	
25 - kilogram sacks containing ANFO	*Ammonium nitrate prills used in ANFO at a potash mine*

Contents

1 - Introduction

ANFO (or AN / FO, for ammonium nitrate / fuel oil) is a widely used bulk industrial explosive mixture.

It consists of 94 percent porous prilled ammonium nitrate (NH_4NO_3), (AN) that acts as the oxidizing agent and absorbent for the fuel – six percent number 2 fuel oil (FO).

ANFO has found wide use in coal mining, quarrying, metal mining, and civil construction in undemanding applications where the advantages of ANFO's low cost and ease of use matter more than the benefits offered by conventional industrial explosives, such as water resistance, oxygen balance, high detonation velocity, and performance in small diameters.

It accounts for an estimated 80 of the 2.7×10^9 kg of explosives used annually in North America .

The press and other media have used the term ANFO loosely and imprecisely in describing IEDs, in cases of fertilizer bombs.

The use of ANFO originates in the 1950s.

2 – Chemistry

ANFO under most conditions is cap - , and so it is classified as a blasting agent and not a high explosive;[7] it decomposes through detonation rather than deflagration with a moderate velocity of about 3,200 meters per second in 5-inch diameter, unconfined, at ambient temperature. It is a tertiary explosive consisting of distinct fuel and oxidizer phases and requires confinement for efficient detonation and brisance. Because it is cap - insensitive, it generally requires a primer, also known as a booster (.g., one or two sticks of dynamite, as historically used, or in more recent times, Tovex or cast boosters of pentolite (TNT) / PETN or similar compositions) to ensure continuation of the detonation wave - train.

The chemistry of ANFO detonation is the reaction of ammonium nitrate (NH_4NO_3) with a long chain alkane (C_nH_{2n+2}) to form nitrogen, carbon dioxide and water. In an ideal stoichiometric ally balanced reaction, ANFO is composed of approximately 94.3% AN and 5.7 % FO by weight. The normal ratio recommended is 2 U.S. quarts of fuel oil per 50 pounds of ammonium nitrate (80 ml / kg) . In practice, a slight excess of fuel oil is added, i.e., 2.5 to 3 quarts of fuel oil per 50 pounds of ammonium nitrate, as under dosing results in reduced performance while overdosing merely results in more post - blast fumes . When detonation conditions are optimal, the aforementioned gases are the only products. In practical use, such conditions are impossible to attain, and blasts produce moderate amounts of toxic gases such as carbon monoxide and nitrogen oxides (NO_x).

Variants of ANFO using diesel fuel, kerosene, coal dust, racing fuel, or even molasses in place of the red diesel (Nº 2 fuel oil) have been used, and finely powdered aluminium in the mixture will sensitize it to detonate more readily .

3 - Industrial use

Charging a hole with ANFO for rock blasting

Ammonium nitrate is widely used as a fertilizer in the agricultural industry. In many countries its purchase and use is restricted to buyers who have obtained the proper license. This restriction is primarily because it is an attractive and simple component used in the production of fertilizer bombs.

In the mining industry, the term ANFO specifically describes a mixture of solid ammonium nitrate prills and heating oil. In this form, it has a bulk density of approximately 840 kg/m^3. The density of individual prills is about 1300 kg / m^3, while the density of pure crystalline ammonium nitrate is 1700 kg / m^3. AN prills used for explosive applications are physically different from fertilizer prills; the former contain approximately 20 % air. These versions of ANFO that use prills are generally called explosives grade, low density, or industrial grade ammonium nitrate. These voids are necessary to sensitize ANFO: they create so-called "hot spots". Finely powdered aluminium can be added to ANFO to increase both sensitivity and energy; however, this has fallen out of favor due to cost. Other additions include perlite, chemical gassing agents, or glass air bubbles to create these voids.

AN is highly hygroscopic, readily absorbing water from air. It is dangerous when stored in humid environments, as any absorbed water interferes with its explosive function . AN is also water soluble. When used in wet mining conditions, considerable effort must be taken to dewater boreholes.

Other explosives based on the ANFO chemistry exist; the most commonly used are emulsions. They differ from ANFO in the physical form the reactants take. The most notable properties of emulsions are water resistance and higher bulk density.

The popularity of ANFO is largely attributable to its low cost and high stability. In most jurisdictions, ammonium nitrate need not be classified as an explosive for transport purposes; it is merely an oxidizer. Many mines prepare ANFO on-site using the same diesel fuel that powers their vehicles, although heating oil, which is nearly identical, may cost less than diesel fuel due to lower fuel tax. Many fuels can theoretically be used; the low volatility and cost of fuel oil makes it ideal.

4 – Disasters

Unmixed ammonium nitrate can decompose explosively and has been responsible for several industrial disasters. Notable industrial disasters include the 1947 Texas City disaster in Texas City, Texas, the 2004 Ryongchon disaster in North Korea, and the 2013 West Fertilizer Co. Plant Explosion in West, Texas. Environmental hazards include eutrophication in confined waters and nitrate/gas oil contamination of ground or surface water.

5 - Malicious use

ANFO was first used in 1970 by student protesters at the University of Wisconsin – Madison, who learned how to make and use ANFO from a Wisconsin Conservation Department booklet entitled *Pothole Blasting for Wildlife,* resulting in the Sterling Hall bombing.

The ANFO car bomb was adopted by the Provisional IRA in 1972 and, by 1973, the Troubles were consuming 47,000lbs of ammonium nitrate being used for the majority of bombs The IRA detonated an ANFO truck bomb on Bishops gate in London in 1993 killing one and causing £ 350 million in damage. It has also seen use by groups such as the Revolutionary Armed Forces of Colombia (FARC), and ETA.

Ramzi Yousef who was closely associated with Al Qaeda used ANFO to try to destroy the World Trade Center in 1993. A more sophisticated variant of ANFO (ammonium nitrate with nitromethane as the fuel called ANNM) was used in the 1995 Oklahoma City bombing.

In 2001 The Shijiazhuang bombings were a series of bomb blasts that rocked the city of Shijiazhuang, China on March 16, 2001. A total of 108 people were killed, and 38 others injured when within a short period of time several ANFO bombs exploded near four apartment buildings, and were characterized by China scholar Andrew Scobell as perhaps the worst terrorist act in the history of the People's Republic of China.

Improvised bombs made with agricultural-grade AN are less sensitive and less efficient than the explosive - grade variety. In November 2009, a ban on ammonium sulfate, ammonium nitrate and calcium ammonium nitrate fertilizers was imposed in the former Malakand Division – comprising the Upper Dir, Lower Dir, Swat, Chitral and Malakand districts of the North West Frontier Province (NWFP) of Pakistan, by the NWFP government, following reports that those chemicals were used by militants to make explosives.

In April 2010, police in Greece confiscated 180 kilograms of ANFO and other related material stashed in a hideaway in the Athens suburb of Kareas. The material was believed to be linked to attacks previously carried out by the "Revolutionary Struggle" terrorist group.

January 2010, President Hamid Karzai of Afghanistan also issued a decree banning the use, production, storage, purchase or sale of ammonium nitrate, after an investigation showed that militants in the Taliban insurgency had used the substance in bomb attacks.

On 22 July 2011, an aluminium - powder enriched ANNM explosive, with total size of 950 kg (150 kg of aluminum powder), increasing demolition power by 10 - 30 percent over plain ANFO, was used in the Oslo bombing.

A formula developed by Sandia National Laboratories which combines iron sulfate with ammonium nitrate results in an effective and cheap fertilizer which is useless as a component in an ANFO explosive; "the iron ion “grabs” the nitrate and the ammonium ion takes the sulfate ion. Iron sulfate becomes iron nitrate and ammonium nitrate becomes ammonium sulfate. This metathesis reaction occurs if someone tries to alter the fertilizer to make it detonable when mixed with a fuel." The formula was not patented, but, as of 2013, had not been marketed widely in regions such as Afghanistan where ammonium fertilizer is both needed and abused, where the formula could provide considerable mitigation against fertilizer misuse. Both iron and sulfate ions are effective fertilizers in themselves, especially in alkali soils.

6 – ANNM

ANNM, or ammonium nitrate and nitro methane, is one of the most powerful improvised types of AN-based explosives. The relative effectiveness factor of ANNM varies depending on the mix but does not exceed 1 (annmal = RE 1-1.1). ANNM usually contains a 60:40 (kinepak) mix of AN and NM (60 % ammonium nitrate, 40 % nitro methane by mass), though this results in a wet slurry. Sometimes more AN is added to reduce liquidity and make it easier to store and handle, as well as providing an oxygen - balanced mix. ANNM is also more sensitive to shock than standard ANFO and is therefore easier to detonate. When ANNM detonates, the primary byproducts produced are H_2O, CO_2 and N_2, but NO_x and other toxic gases are inevitably formed because of a negative oxygen balance. The balanced equation is as follows:

$$3NH_4NO_3 + 2CH_3NO_2 \rightarrow 4N_2 + 2CO_2 + 9H_2O$$

Depending on the detonation impetus (for example a #6 versus a #10 detonator), the products of the detonation can be decidedly unstoichiometric.

Animal - Bomb Attacks

Contents

1 - Introduction

Animal - borne bomb attacks are the use of animals as delivery systems for explosives. The explosives are strapped to a pack animal such as a horse, mule or donkey. The pack animal may be set off in a crowd.

Projects of bat bomb and pigeon bomb have also been studied. Dolphins have also been trained to destroy submarines and warships.

2 – Incidents

2 – 1 – Afghanistan

In 2009, the Taliban strapped an improvised explosive device to a donkey. The gate guard noticed something suspicious when a group of men let the donkey go a short way from the camp and then hurried off. The donkey was stopped with a rifle shot. One soldier set fire to the hay with a flare provoking a "considerable explosion".

In April of 2013, in Kabul, a bomb attached to a donkey blew up in front of a police security post, killing a policeman and wounding three civilians. A government spokesman claimed insurgents were challenging the competence of the Afghan government prior to the 2014 withdrawal of the U.S. military.

2 – 2 – Iraq

On 21 November 2003, eight rockets were fired from donkey carts at the Iraqi oil ministry and two hotels in downtown Baghdad, injuring one man and causing some damage. In 2004 a donkey in Ramadi was loaded with explosives and set off towards a US-run checkpoint. It exploded before it was able to injure or kill anyone. The incident, along with a number of similar incidents involving dogs, fueled fears of terrorist practices of using living animals as weapons, a change from an older practice of using the bodies of dead animals to hold explosives . The use of improvised explosive devices concealed in animal's carcasses was also a common practice among the Iraqi Insurgency.

2 – 3 – Lebanon

Malia Sufangi, a young Lebanese woman, was caught in the Security Zone in November 1985 with an explosive device mounted on a donkey with which she had failed to carry out an attack.[7] She claimed that she had been recruited and dispatched by Syrian Brigadier - General Ghazi Kanaan who supplied the explosives and instructions on how the attack was to be carried out from his headquarters in the town of Anjer in the Bekaa Valley.

2 – 4 - United States

In 1862, during the New Mexico Campaign of the American Civil War a Confederate force approached the ford at Valverde, six miles north of Fort Craig, hoping to cut Union communications between the fort and their headquarters in Santa Fe. About midnight, Union Captain James Craydon tried to blow up a few rebel picket posts by sending mules loaded with barrels of fuzed gunpowder into the Confederate lines, but the faithful old army mules insisted on wandering back toward the Union camp before blowing to bits. Although the only casualties were two mules, the explosions stampeded a herd of Confederate beef cattle and horses into the Union's lines, so depriving the Confederate troops of some much-needed provisions and horses.

In the Wall Street bombing of 1920, an incident thought to be related to the 1919 United States anarchist bombings, anarchists used a bomb carried by horse - drawn cart.

2 – 5 - West Bank and Gaza Strip

June 25, 1995 – At approximately 11 a.m., a Palestinian rode a booby-trapped donkey cart to an Israeli army base west of Khan Yunis in the Gaza Strip and detonated it. The Palestinian and the donkey were killed, but no soldiers were wounded. Hamas claimed responsibility for the attack. Three soldiers were treated for minor shock.

June 17, 2001 – A Palestinian man rode a bomb-laden donkey cart up to an Israeli position in the southern Gaza Strip and set off a small explosion. Israeli soldiers destroyed the cart, and no soldiers were wounded. The Palestinian man was captured by the soldiers.

January 26, 2003 – Palestinian fighters strapped a bomb to a donkey and then exploded it remotely on the road between Jerusalem and Gush Etzion. No humans were injured in the attack. PETA director Ingrid Newkirk wrote to PLO Chairman Yasser Arafat asking him to keep animals out of the conflict. PETA was criticized for not objecting to killing of humans in the context.

June 8, 2009 – Palestinian gunmen approached the Karni crossing between the Gaza Strip and Israel with several trucks and at least five horses loaded with explosive devices and mines. The gunmen fired on IDF troops who observed them, and at least four gunmen were killed in the ensuing battle. A previously unknown organization called "the army of Allah's supporters" claimed responsibility for the foiled attack. The IDF estimated that the gunmen had planned to kidnap an Israeli soldier.

May 25, 2010 – A small Syrian-backed militant group in the Gaza Strip blew up a donkey cart laden with explosives close to the border with Israel. According to a spokesman for the group, more than 200 kilograms of dynamite were heaped on the animal-drawn cart. The explosives were detonated several dozen meters from the border fence with Israel. The animal was killed in the blast but no human injuries or damage were reported.

3 – Military

During World War II the U.S. investigated the use of "bat bombs", or bats carrying small incendiary bombs . During the same war, Project Pigeon (later Project Orcon, for "organic control") was American behaviorist B. F. Skinner's attempt to develop a pigeon-guided missile . At the same time the Soviet Union developed the "anti-tank dog" for use against German tanks. Other attempts have included the attempt by Iran to develop *kamikaze dolphins*, intended to seek out and destroy submarines and enemy warships.

Anniston Army Depot

Mechanics at Anniston Army Depot line up an M1 Abrams turret with its hull.

Anniston Army Depot (ANAD) is a major United States Army facility fulfilling various depot operations. Primary missions are the repair of tracked vehicles overhaul of Small Arms Weapon Systems and the storage of chemical weapons (Anniston Chemical Activity The depot is located in Bynum, Alabama.

The depot employs over 5,000 people and covers 65 km^2 of land. Tanks and other equipment are repaired and tested there, but historically Anniston's main role has been as a major munitions storage site, since WWII. Anniston is one of seven depots in the United States where chemical weapons are stored (7.2 % of nation's chemical weapons stockpile) . The stockpile included rockets, bombs, projectiles, and land mines armed with Sarin, VX nerve agent, or mustard gas. The last chemical munitions were destroyed in

ANAD is the only depot capable of performing maintenance on heavy-tracked combat vehicles and their components and houses a state of the art 250,000 square foot Small Arms Overhaul facility that opened in January 2012 replacing a previous facility that was outdated. The depot is designated as the Center of Technical Excellence for the M1 Abrams Tank and is the designated candidate depot for the repair of the M60 Patton tank, AVLB, M728, M88 Recovery Vehicle and M551 combat vehicles . During the Iraq War, over 1,000 M1 tanks, howitzers and other armored vehicles were stored awaiting re - engineering.

The depot also houses and operates a facility for the repair, restoration, and/or upgrade of infantry weapons such as the Beretta M9 pistol, M16 rifle, and M2 machine gun. Any firearm deemed unusable or obsolete is destroyed on the premises, the materials are reduced to unusable pieces and then sold for scrap to be melted down.

Antagonist

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An antagonist (from Greek - *antagonistēs* , "opponent, competitor, enemy, rival", from anti - "against" + agonizes thai "to contend for a prize ") is a character, group of characters, or institution that represents the opposition against which the protagonist or protagonists must contend. In other words, an antagonist is a person or a group of people who oppose the main character (s) .

In the classic style of stories wherein the action consists of a hero fighting a villain/enemy, the two can be regarded as protagonist and antagonist, respectively. Of course, some narratives cast the villain the protagonist role, with the opposing hero as the antagonist.

The antagonist may also represent a major threat or obstacle to the main character by their very existence, without necessarily deliberately targeting him or her.

Examples in both film and theatre include Sauron, the main antagonist in *The Lord of the Rings*, who constantly battles the series' protagonists, and Tybalt, an antagonist in *Romeo and Juliet*, who slays Mercutio and whose later death results in the exiling of the play's protagonist, Romeo. A convention of the antagonist in a story is that their moral choices are less savouy than those of the protagonist. This is often used by an author to create conflict within a story. However, this is merely a convention and the reversal of this can be seen in the character Macduff from *Macbeth*, who is arguably morally correct in his desire to fight the tyrant Macbeth.

Anthrax

Contents

1 - Introduction

Anthrax is an acute disease caused by the bacterium *Bacillus anthracis*. Most forms of the disease are lethal, and it affects both humans and animals. There are effective vaccines against anthrax, and some forms of the disease respond well to antibiotic treatment.

Like many other members of the genus *Bacillus*, *Bacillus anthracis* can form dormant endospores (often referred to as "spores" for short, but not to be confuzed with fungal spores) that are able to survive in harsh conditions for decades or even centuries . Such spores can be found on all continents, even Antarctica . When spores are inhaled, ingested, or come into contact with a skin lesion on a host, they may become reactivated and multiply rapidly.

Anthrax commonly infects wild and domesticated herbivorous mammals that ingest or inhale the spores while grazing. Ingestion is thought to be the most common route by which herbivores contract anthrax. Carnivores living in the same environment may become infected by consuming infected animals. Diseased animals can spread anthrax to humans, either by direct contact (e.g., inoculation of infected blood to broken skin) or by consumption of a diseased animal's flesh.

Anthrax spores can be produced *in vitro* and used as a biological weapon. Anthrax does not spread directly from one infected animal or person to another; it is spread by spores. These spores can be transported by clothing or shoes. The body of an animal that had active anthrax at the time of death can also be a source of anthrax spores.

Until the twentieth century, anthrax infections killed hundreds of thousands of animals and people worldwide each year. French scientist Louis Pasteur developed the first effective vaccine for anthrax in 1881. Thanks to over a century of animal vaccination programs, sterilization of raw animal waste materials, and anthrax eradication programs in North America, Australia, New Zealand, Russia, Europe, and parts of Africa and Asia, anthrax infection is now relatively rare in domestic animals (with only a few dozen cases reported each year) . Anthrax is especially rare in dogs and cats, as is evidenced by a single reported case in the USA in 2001.

Anthrax typically does not cause disease in carnivores and scavengers, even when these animals consume anthrax-infected carcasses. Anthrax outbreaks do occur in some wild animal populations with some regularity . The disease is more common in countries without widespread veterinary or human public health programs. In the 21st century, anthrax is still a problem in less developed countries. An outbreak of anthrax in humans who had eaten meat from a dead carabao was reported in Cagayan province in the Philippines in early 2010, with over 400 cases of illness and at least two fatalities.

Bacillus anthracis bacterial spores are soil-borne. Because of their long lifespan, spores are present globally and remain at the burial sites of animals killed by anthrax for many decades. Disturbed grave sites of infected animals have caused reinfection over 70 years after the animal's interment .

2 - Signs and symptoms

2 – 1 – Pulmonary

Respiratory infection in humans initially presents with cold or flu-like symptoms for several days, followed by pneumonia and severe (and often fatal) respiratory collapse. Historical mortality was 92%, but, when treated early (seen in the 2001 anthrax attacks), observed mortality was 45 % . Distinguishing pulmonary anthrax from more common causes of respiratory illness is essential to avoiding delays in diagnosis and thereby improving outcomes. An algorithm for this purpose has been developed. Illness progressing to the fulminant phase has a 97 % mortality regardless of treatment.

A lethal infection is reported to result from inhalation of about 10,000–20,000 spores, though this dose varies among host species.[13] As with all diseases, it is presumed that there is a wide variation to susceptibility with evidence that some people may die from much lower exposures; there is little documented evidence to verify the exact or average number of spores needed for infection. Inhalational anthrax is also known as Wool sorters' or Rag pickers' disease. These professions were more susceptible to the disease due to their exposure to infected animal products. Other practices associated with exposure include the slicing up of animal horns for the manufacture of buttons, the handling of hair bristles used for the manufacturing of brushes, and the handling of animal skins. Whether these animal skins came from animals that died of the disease or from animals that had simply lain on ground with spores on it is unknown. This mode of infection is used as a bioweapon..

2 – 2 – Gastrointestinal

Gastrointestinal infection in humans is most often caused by consuming anthrax - infected meat and is characterized by serious gastrointestinal difficulty, vomiting of blood, severe diarrhea, acute inflammation of the intestinal tract, and loss of appetite. Lesions have been found in the intestines and in the mouth and throat. After the bacterium invades the bowel system, it spreads through the bloodstream throughout the body, while also continuing to make toxins. Gastrointestinal infections can be treated but usually result in fatality rates of 25 % to 60 %, depending upon how soon treatment commences. This form of anthrax is the rarest form. In the United States, there have only been two official cases, the first reported in 1942 by the CDC and the second reported in 2010 that was treated at the Massachusetts General Hospital. It is the only known case of survival from GI anthrax in the U.S.A. An outbreak of anthrax among humans who had eaten meat from a dead carabao was reported in Cagayan province in the Philippines in early 2010, with over 400 cases of illness and at least two fatalities.

2 – 3 – Cutaneous

	
A skin lesion caused by anthrax	*Skin reaction to anthrax*

Cutaneous (on the skin) anthrax infection in humans presents as a boil - like skin lesion that eventually forms an ulcer with a black center (eschar). The black eschar often shows up as a large, painless necrotic ulcer (beginning as an irritating and itchy skin lesion or blister that is dark and usually concentrated as a black dot, somewhat resembling bread mold) at the site of infection. In general, cutaneous infections form within the site of spore penetration between 2 and 5 days after exposure. Unlike bruises or most other lesions, cutaneous anthrax infections normally do not cause pain.

Cutaneous anthrax is typically caused when *Bacillus anthracis* spores enter through cuts on the skin. This form of Anthrax is found most commonly when humans handle infected animals and/or animal products (e.g., the hide of an animal used to make drums).

Cutaneous anthrax is rarely fatal if treated , because the infection area is limited to the skin, preventing the Lethal Factor, Edema Factor, and Protective Antigen from entering and destroying a vital organ. Without treatment, about 20 % of cutaneous skin infection cases progress to toxemia and death.

3 – Cause

3 – 1 – Bacteria

Bacillus anthracis is a rod - shaped, Gram - positive, aerobic bacterium about 1 by 9 micrometers in size. It was shown to cause disease by Robert Koch in 1876 when he took a blood sample from an infected cow, isolated the bacteria and put it into a mouse.[18] The bacterium normally rests in endospore form in the soil, and can survive for decades in this state. Herbivores are often infected whilst grazing or browsing, especially when eating rough, irritant, or spiky vegetation: the vegetation has been hypothesized to cause wounds within the gastrointestinal tract permitting entry of the bacterial endo-spores into the tissues, though this has not been proven. Once ingested or placed in an open wound, the bacterium begins multiplying inside the animal or human and typically kills the host within a few days or weeks. The endo-spores germinate at the site of entry into the tissues and then spread via the circulation to the lymphatics, where the bacteria multiply.

It is the production of two powerful exo-toxins and *lethal toxin* by the bacteria that causes death. Veterinarians can often tell a possible anthrax-induced death by its sudden occurrence, and by the dark, non - clotting blood that oozes from the body orifices. Most anthrax bacteria inside the body after death are out - competed and destroyed by anaerobic bacteria within minutes to hours postmortem.

However, anthrax vegetative bacteria that escape the body via oozing blood or through the opening of the carcass may form hardy spores. One spore forms per one vegetative bacterium. The triggers for spore formation are not yet known, though oxygen tension and lack of nutrients may play roles. Once formed, these spores are very hard to eradicate.

The infection of herbivores (and occasionally humans) via the inhalational route normally proceeds as follows: Once the spores are inhaled, they are transported through the air passages into the tiny air particle sacs (alveoli) in the lungs. The spores are then picked up by scavenger cells (macrophages) in the lungs and are transported through small vessels (lymphatics) to the lymph nodes in the central chest cavity (mediastinum). Damage caused by the anthrax spores and bacilli to the central chest cavity can cause chest pain and difficulty breathing. Once in the lymph nodes, the spores germinate into active bacilli that multiply and eventually burst the macrophages, releasing many more bacilli into the bloodstream to be transferred to the entire body. Once in the blood stream, these bacilli release three proteins named *lethal factor*, *edema factor*, and *protective antigen*. All three are non - toxic by themselves, but the combination is incredibly lethal to humans . Protective antigen combines with these other two factors to form lethal toxin and edema toxin, respectively. These toxins are the primary agents of tissue destruction, bleeding, and death of the host. If antibiotics are administered too late, even if the antibiotics eradicate the bacteria, some hosts will still die of toxemia. This is because the toxins produced by the bacilli remain in their system at lethal dose levels.

The lethality of the anthrax disease owes itself to the bacterium's two principal virulence factors

(i) the poly - D - glutamic acid capsule, which protects the bacterium from phagocytosis by host neutrophils,

and (ii) the tripartite protein toxin, called anthrax toxin. Anthrax toxin is a mixture of three protein components: (i) protective antigen (PA), (ii) edema factor (EF), and (iii) lethal factor (LF). PA plus LF produces lethal toxin, and PA plus EF produces edema toxin. These toxins cause death and tissue swelling (edema), respectively.

In order to enter the cells, the edema and lethal factors use another protein produced by *B. anthracis* called *protective antigen*. Protective antigen binds to two surface receptors on the host cell. A cell protease then cleaves PA into two fragments: PA_{20} and PA_{63}. PA_{20} dissociates into the extracellular medium, playing no further role in the toxic cycle. PA_{63} then oligomerizes with six other PA_{63} fragments forming a heptameric ring-shaped structure named a prepore. Once in this shape, the complex can competitively bind up to three EF or LF forming a resistant complex.[19] Receptor-mediated endocytosis occurs next, providing the newly formed toxic complex access to the interior of the host cell. The acidified environment within the endosome triggers the heptamer to release the LF and/or EF into the cytosol.[20] It is unknown how exactly the complex results in the death of the cell.

Edema factor is a calmodulin - dependent adenylate cyclase. Adenylate cyclase catalyzes the conversion of ATP into cyclic AMP (cAMP) and pyro phosphate. The complexation of adenylate cyclase with calmodulin removes calmodulin from stimulating calcium-triggered signaling, thus inhibiting the immune response.[19] To be specific, LF inactivates neutrophils (a type of phagocytic cell) by the process just described so that they cannot phagocytose bacteria. Throughout history, it was believed that lethal factor caused macrophages to make TNF-alpha and interleukin 1, beta (IL1B). TNF-alpha is a cytokine whose primary role is to regulate immune cells as well as to induce inflammation and apoptosis or programmed cell death. Interleukin 1, beta is another cytokine that also regulates inflammation and apoptosis. The over-production of TNF-alpha and IL1B ultimately leads to septic shock and death. However, recent evidence indicates that anthrax also targets endothelial cells (cells that line serous cavities such as the pericardial cavity, pleural cavity, and the peritoneal cavity, lymph vessels, and blood vessels), causing vascular leakage of fluid and cells, and ultimately hypovolemic shock (low blood volume), and septic shock.

3 – 2 – Exposure

Occupational exposure to infected animals or their products (such as skin, wool, and meat) is the usual pathway of exposure for humans. Workers who are exposed to dead animals and animal products are at the highest risk, especially in countries where anthrax is more common. Anthrax in livestock grazing on open range where they mix with wild animals still occasionally occurs in the United States and elsewhere. Many workers who deal with wool and animal hides are routinely exposed to low levels of anthrax spores but most exposures are not sufficient to develop anthrax infections. It is presumed that the body's natural defenses can destroy low levels of exposure. These people usually contract cutaneous anthrax if they catch anything. Throughout history, the most dangerous form of inhalational anthrax was called Woolsorters' disease because it was an occupational hazard for people who sorted wool. Today this form of infection is extremely rare, as almost no infected animals remain. The last fatal case of natural inhalational anthrax in the United States occurred in California in 1976, when a home weaver died after working with infected wool imported from Pakistan. The autopsy was done at UCLA hospital. To minimize the chance of spreading the disease, the deceased was transported to UCLA in a sealed plastic body bag within a sealed metal container.

In November 2008, a drum maker in the United Kingdom who worked with untreated animal skins died from anthrax.[22] Gastrointestinal anthrax is exceedingly rare in the United States, with only one case on record, reported in 1942, according to the Centers for Disease Control and Prevention . In December 2009 an outbreak of anthrax occurred amongst heroin addicts in Glasgow, Scotland, resulting in fourteen deaths . The source of the anthrax is believed to be dilution of the heroin with bone meal in Afghanistan.

Also during December 2009, The New Hampshire Department of Health and Human Services confirmed a case of gastrointestinal anthrax in an adult female. The CDC investigated the source and the possibility that it was contracted from an African drum recently used by the woman taking part in a drumming circle . The woman apparently inhaled anthrax [in spore form] from the hide of the drum. She became critically ill, but with gastrointestinal anthrax rather than inhaled anthrax, which made her unique in American medical history. The building where the infection took place was cleaned and reopened to the public and the woman recovered. Jodie Dionne-Odom, New Hampshire state epidemiologist, states, "It is a mystery. We really don't know why it happened " .[26]

3 – 3 - Mode of infection

Anthrax can enter the human body through the intestines (ingestion), lungs (inhalation), or skin (cutaneous) and causes distinct clinical symptoms based on its site of entry. In general, an infected human will be quarantined. However, anthrax does not usually spread from an infected human to a noninfected human. But, if the disease is fatal to the person's body, its mass of anthrax bacilli becomes a potential source of infection to others and special precautions should be used to prevent further contamination. Inhalational anthrax, if left untreated until obvious symptoms occur, may be fatal.

Anthrax can be contracted in laboratory accidents or by handling infected animals or their wool or hides. It has also been used in biological warfare agents and by terrorists to intentionally infect as exemplified by the 2001 anthrax attacks.

4 – Diagnosis

There are various techniques for the direct identification of *Bacillus anthracis* in clinical material. Firstly, specimens may be Gram stained. *Bacillus* spp. are quite large in size (3 to 4 µ m long) , they grow in long chains, and they stain Gram-positive. To confirm that the organism is *B. anthracis*, rapid diagnostic techniques such as polymerase chain reaction (PCR) - based assays and immunofluorescence microscopy may be used.

All *Bacillus* species grow well on 5 % sheep blood agar and other routine culture media. PLET (poly myxin-lysozyme-EDTA-thallous acetate) can be used to isolate *B. anthracis* from contaminated specimens, and bicarbonate agar is used as an identification method to induce capsule formation. *Bacillus* spp. will usually grow within 24 hours of incubation at 35 °C, in ambient air (room temperature) or in 5 % CO_2. If bicarbonate agar is used for identification then the media must be incubated in 5 % CO_2. *B. anthracis* colonies are medium-large, gray, flat, and irregular with swirling projections, often referred to as having a "medusa head" appearance, and are non-hemolytic on 5 % sheep blood agar. The bacteria are non-motile, susceptible to penicillin, and produce a wide zone of lecithinase on egg yolk agar. Confirmatory testing to identify *B. anthracis* includes gamma bacteriophage testing, indirect hemagglutination and enzyme linked immunosorbent assay to detect antibodies.

5 – Prevention

5 – 1 – Vaccines

Vaccines against anthrax for use in livestock and humans have had a prominent place in the history of medicine, from Pasteur's pioneering 19th century work with cattle (the second effective vaccine ever) to the controversial 20th century use of a modern product (*BioThrax*) to protect American troops against the use of anthrax in biological warfare. Human anthrax vaccines were developed by the Soviet Union in the late 1930s and in the US and UK in the 1950s. The current FDA- approved US vaccine was formulated in the 1960s.

Currently administered human anthrax vaccines include acellular (USA) and live spore (Russia) varieties. All currently used anthrax vaccines show considerable local and general reactogenicity (erythema, induration, soreness, fever) and serious adverse reactions occur in about 1% of recipients. The American product, *BioThrax*, is licensed by the FDA and was formerly administered in a six-dose primary series at 0, 2, 4 weeks and 6, 12, 18 months, with annual boosters to maintain immunity. In 2008, the FDA approved omitting the week 2 dose, resulting in the currently recommended five - dose series . New second - generation vaccines currently being researched include recombinant live vaccines and recombinant sub - unit vaccines.

5 – 2 – Prophylaxis

If a person is suspected as having died from anthrax, every precaution should be taken to avoid skin contact with the potentially contaminated body and fluids exuded through natural body openings. The body should be put in strict quarantine and then burnt. A blood sample taken in a sealed container and analyzed in an approved laboratory should be used to ascertain if anthrax is the cause of death. Microscopic visualization of the encapsulated bacilli, usually in very large numbers, in a blood smear stained with polychrome methylene blue (Mc Fadyean stain) is fully diagnostic, though culture of the organism is still the gold standard for diagnosis. Full isolation of the body is important to prevent possible contamination of others. Protective, impermeable clothing and equipment such as rubber gloves, rubber apron, and rubber boots with no perforations should be used when handling the body. No skin, especially if it has any wounds or scratches, should be exposed. Disposable personal protective equipment is preferable, but if not available, decontamination can be achieved by autoclaving. Disposable personal protective equipment and filters should be autoclaved, and/or burned and buried. Bacillus anthracis bacillii range from 0.5 – 5.0 μ m in size. Anyone working with anthrax in a suspected or confirmed victim should wear respiratory equipment capable of filtering this size of particle or smaller. The US National Institute for Occupational Safety and Health (NIOSH) and Mine Safety and Health Administration (MSHA) approved high efficiency - respirator, such as a half-face disposable respirator with a high - efficiency particulate air (HEPA) filter, is recommended . All possibly contaminated bedding or clothing should be isolated in double plastic bags and treated as possible bio - hazard waste. The victim should be sealed in an airtight body bag. Dead victims that are opened and not burned provide an ideal source of anthrax spores. Cremating victims is the preferred way of handling body disposal. No embalming or autopsy should be attempted without a fully equipped biohazard laboratory and trained and knowledgeable personnel.

Delays of only a few days may make the disease untreatable and treatment should be started even without symptoms if possible contamination or exposure is suspected. Animals with anthrax often just die without any apparent symptoms. Initial symptoms may resemble a common cold — sore throat, mild fever, muscle aches and malaise. After a few days, the symptoms may progress to severe breathing problems and shock and ultimately death. Death can occur from about two days to a month after exposure with deaths apparently peaking at about 8 days after exposure. Antibiotic - resistant strains of anthrax are known.

Early detection of sources of anthrax infection can allow preventive measures to be taken. In response to the anthrax attacks of October 2001 the United States Postal Service (USPS) installed Bio Detection Systems (BDS) in their large scale mail cancellation facilities. BDS response plans were formulated by the USPS in conjunction with local responders including fire, police, hospitals and public health. Employees of these facilities have been educated about anthrax, response actions and prophylactic medication. Because of the time delay inherent in getting final verification that anthrax has been used, prophylactic antibiotic treatment of possibly exposed personnel must be started as soon as possible.

6 – Treatment

Anthrax cannot be spread directly from person to person, but a person's clothing and body may be contaminated with anthrax spores. Effective decontamination of people can be accomplished by a thorough wash-down with antimicrobial effective soap and water. Waste water should be treated with bleach or other anti - microbial agent. Effective decontamination of articles can be accomplished by boiling contaminated articles in water for 30 minutes or longer. Chlorine bleach is ineffective in destroying spores and vegetative cells on surfaces, though formaldehyde is effective. Burning clothing is very effective in destroying spores. After decontamination, there is no need to immunize, treat, or isolate contacts of persons ill with anthrax unless they were also exposed to the same source of infection.

6 – 1 – Antibiotics

Early antibiotic treatment of anthrax is essential — delay significantly lessens chances for survival.

Treatment for anthrax infection and other bacterial infections includes large doses of intravenous and oral antibiotics, such as fluoro quinolones (like ciprofloxacin) , doxycycline, erythromycin, vancomycin, or penicillin. FDA - approved agents include ciprofloxacin, doxycycline, and penicillin.

In possible cases of inhalation anthrax, early antibiotic prophylaxis treatment is crucial to prevent possible death.

In May 2009, Human Genome Sciences submitted a Biologic License Application (BLA, permission to market) for its new drug, raxibacumab (brand name Abthrax) intended for emergency treatment of inhaled anthrax . If death occurs from anthrax the body should be isolated to prevent possible spread of anthrax germs. Burial does not kill anthrax spores.

In recent years there have been many attempts to develop new drugs against anthrax, but existing drugs are effective if treatment is started soon enough.

6 – 2 - Monoclonal antibodies

On December 14, 2012, the U.S. Food and Drug Administration approved raxibacumab injection to treat inhalational anthrax. Raxibacumab is a monoclonal antibody that neutralizes toxins produced by B. anthracis that can cause massive and irreversible tissue injury and death. A monoclonal antibody is a protein that closely resembles a human antibody that identifies and neutralizes foreign material like bacteria and viruses.

7 – History

7 – 1 – Etymology

The name comes from *anthrax* , the Greek word for 'coal', because of the black skin lesions developed by victims with a cutaneous anthrax infection. It was discovered and analyzed by Robert Koch (1876) .

Alternative names: siberian plague, charbon, splenic fever, malignant edema, wool sorter's disease

7 – 2 – Discovery

Robert Koch, a German physician and scientist, first identified the bacterium that caused the anthrax disease in 1875 in Wolsztyn . His pioneering work in the late nineteenth century was one of the first demonstrations that diseases could be caused by microbes. In a groundbreaking series of experiments, he uncovered the life cycle and means of transmission of anthrax. His experiments not only helped create an understanding of anthrax, but also helped elucidate the role of microbes in causing illness at a time when debates still took place over spontaneous generation versus cell theory. Koch went on to study the mechanisms of other diseases and won the 1905 Nobel Prize in Physiology or Medicine for his discovery of the bacterium causing tuberculosis.

7 – 3 - First vaccination

In May 1881 Louis Pasteur performed a public experiment to demonstrate his concept of vaccination. He prepared two groups of 25 sheep, one goat and several cows. The animals of one group were injected with an anthrax vaccine prepared by Pasteur twice, at an interval of 15 days; the control group was left unvaccinated. Thirty days after the first injection, both groups were injected with a culture of live anthrax bacteria. All the animals in the non-vaccinated group died, while all of the animals in the vaccinated group survived.[37] The human vaccine for anthrax became available in 1954. This was a cell-free vaccine instead of the live - cell Pasteur-style vaccine used for veterinary purposes. An improved cell - free vaccine became available in 1970.

8 - Society and culture

The virulent Ames strain, which was used in the 2001 anthrax attacks in the United States, has received the most news coverage of any anthrax outbreak. The Ames strain contains two virulence plasmids, which separately encode for a three-protein toxin, called anthrax toxin, and a poly - glutamic acid capsule. Nonetheless, the Vollum strain, developed but never used as a biological weapon during the Second World War, is much more dangerous. The *Vollum* (also incorrectly referred to as *Vellum*) strain was isolated in 1935 from a cow in Oxfordshire, UK. This is the same strain that was used during the Gruinard bioweapons trials. A variation of Vollum known as "Vollum 1B" was used during the 1960s in the US and UK bioweapon programs . Vollum 1B is widely believed[39] to have been isolated from William A. Boyles, a 46 – year - old scientist at the U.S. Army Biological Warfare Laboratories at Camp (later Fort) Detrick, Maryland, USA (precursor to USAMRIID) who died in 1951 after being accidentally infected with the Vollum strain. The *Sterne* strain, named after the Trieste - born immunologist Max Sterne, is an attenuated strain used as a vaccine, which contains only the anthrax toxin virulence plasmid and not the poly - glutamic acid capsule expressing plasmid.

8 – 1 - Site cleanup and decontamination

Anthrax spores can survive for very long periods of time in the environment after release. Chemical methods for cleaning anthrax-contaminated sites or materials may use oxidizing agents such as peroxides, ethylene oxide, Sandia Foam,[40] chlorine dioxide (used in the Hart Senate Office Building), peracetic acid, ozone gas, hypochlorous acid, and liquid bleach products containing sodium hypochlorite. Non oxidizing agents effective for anthrax decontamination include methyl bromide. These agents destroy bacterial spores. Many of the aforementioned anthrax decontamination technologies have been demonstrated to be effective in laboratory tests . A bleach solution for treating hard surfaces has been approved by the EPA.

Chlorine dioxide has emerged as the preferred biocide against anthrax-contaminated sites, having been employed in the treatment of numerous government buildings over the past decade. Its chief drawback is the need for *in situ* processes to have the reactant on demand.

To speed the process, trace amounts of a non-toxic catalyst composed of iron and tetro-amido macrocyclic ligands are combined with sodium carbonate and bicarbonate and converted into a spray. The spray formula is applied to an infested area and is followed by another spray containing tert-Butyl hydro peroxide.

Using the catalyst method, a complete destruction of all anthrax spores can be achieved in under 30 minutes. A standard catalyst-free spray destroys fewer than half the spores in the same amount of time. They can be heated, exposed to the harshest chemicals, and they do not easily die .

Cleanups at a Senate office building, several contaminated postal facilities and other U.S. government and private office buildings showed that decontamination is possible, but it is time-consuming and costly. Clearing the Senate office building of anthrax spores cost $ 27 million, according to the Government Accountability Office. Cleaning the Brentwood postal facility outside Washington cost $ 130 million and took 26 months. Since then newer and less costly methods have been developed.

Clean up of anthrax-contaminated areas on ranches and in the wild is much more problematic. Carcasses may be burned, though it often takes up to three days to burn a large carcass and this is not feasible in areas with little wood. Carcasses may also be buried, though the burying of large animals deeply enough to prevent resurfacing of spores requires much manpower and expensive tools. Carcasses have been soaked in formaldehyde to kill spores, though this has environmental contamination issues. Block burning of vegetation in large areas enclosing an anthrax outbreak has been tried; this, while environmentally destructive, causes healthy animals to move away from an area with carcasses in search of fresh graze and browse. Some wildlife workers have experimented with covering fresh anthrax carcasses with shade cloth and heavy objects. This prevents some scavengers from opening the carcasses, thus allowing the putrefactive bacteria within the carcass to kill the vegetative B. anthracis cells and preventing sporulation. This method also has drawbacks, as scavengers such as hyenas are capable of infiltrating almost any exclosure.

The experimental site at Gruinard Island is said to have been decontaminated with a mixture of formaldehyde and seawater by the Ministry of Defence. It's not clear if similar treatment has been applied to US test sites.

8 – 2 - Biological warfare

Colin Powell giving
a presentation to the United Nations Security Council

Anthrax spores can and have been used as a biological warfare weapon. Its first modern incidence occurred when Scandinavian rebels, supplied by the German General Staff, used anthrax with unknown results against the Imperial Russian Army in Finland in 1916.[45] Anthrax was first tested as a biological warfare agent by Unit 731 of the Japanese Kwantung Army in Manchuria during the 1930s; some of this testing involved intentional infection of prisoners of war, thousands of whom died. Anthrax, designated at the time as Agent N, was also investigated by the Allies in the 1940s.

There is a long history of practical bio weapons research in this area. For example, in 1942, British bioweapons trials severely contaminated Gruinard Island in Scotland with anthrax spores of the Vollum-14578 strain, making it a no - go area until it was decontaminated in 1990 . The Gruinard trials involved testing the effectiveness of a sub munition of an "N - bomb"— a biological weapon. Additionally, five million "cattle cakes" impregnated with anthrax were prepared and stored at Porton Down for "Operation Vegetarian" — an anti-livestock weapon intended for attacks on Germany by the Royal Air Force . The infected cattle cakes were to be dropped on Germany in 1944. However, neither the cakes nor the bomb was used; the cattle cakes were incinerated in late 1945.

Weaponized anthrax was part of the U.S. stockpile prior to 1972, when the United States signed the Biological Weapons Convention . President Nixon ordered the dismantling of U.S. bio warfare programs in 1969 and the destruction of all existing stockpiles of bioweapons. In the period 1978–1979 the Rhodesian government used anthrax against cattle and humans during its war with black nationalists. The Soviet Union created and stored 100 to 200 tons of anthrax spores at Kantubek on Vozrozhdeniya Island. They were abandoned in 1992 and destroyed in 2002.

American military and British Army personnel are routinely vaccinated against anthrax prior to active service in places where biological attacks are considered a threat.

Sverdlovsk incident (2 April 1979)

Despite signing the 1972 agreement to end bio weapon production the government of the Soviet Union had an active bioweapons program that included the production of hundreds of tons of weapons-grade anthrax after this period. On 2 April 1979, some of the over one million people living in Sverdlovsk (now called Ekaterinburg, Russia), about 850 miles east of Moscow, were exposed to an accidental release of anthrax from a biological weapons complex located near there. At least 94 people were infected, of whom at least 68 died. One victim died four days after the release, ten over an eight-day period at the peak of the deaths, and the last six weeks later. Extensive cleanup, vaccinations and medical interventions managed to save about 30 of the victims.[52] Extensive cover-ups and destruction of records by the KGB continued from 1979 until Russian President Boris Yeltsin admitted this anthrax accident in 1992. Jeanne Guillemin reported in 1999 that a combined Russian and United States team investigated the accident in 1992.

Nearly all of the night shift workers of a ceramics plant directly across the street from the biological facility (compound 19) became infected, and most died. Since most were men, there were suspicions by NATO governments that the Soviet Union had developed a sex-specific weapon . The government blamed the out break on the consumption of anthrax - tainted meat and ordered the confiscation of all uninspected meat that entered the city. They also ordered that all stray dogs be shot and that people not have contact with sick animals. There was also a voluntary evacuation and anthrax vaccination program established for people from 18 – 55.

To support the cover-up story Soviet medical and legal journals published articles about an outbreak in livestock that caused GI anthrax in people having consumed infected meat, and cutaneous anthrax in people having come into contact with the animals. All medical and public health records were confiscated by the KGB . In addition to the medical problems that the outbreak caused, it also prompted Western countries to be more suspicious of a covert Soviet bioweapons program and to increase their surveillance of suspected sites. In 1986, the US government was allowed to investigate the incident, and concluded that the exposure was from aerosol anthrax from a military weapons facility. In 1992, President Yeltsin admitted that he was "absolutely certain" that "rumors" about the Soviet Union violating the 1972 Bioweapons Treaty were true. The Soviet Union, like the US and UK, had agreed to submit information to the UN about their bioweapons programs but omitted known facilities and never acknowledged their weapons program.

Anthrax bio terrorism

In theory, anthrax spores can be cultivated with minimal special equipment and a first - year collegiate microbiological education . To make large amounts of an aerosol form of anthrax suitable for biological warfare requires extensive practical knowledge, training, and highly advanced equipment .

Concentrated anthrax spores were used for bio terrorism in the 2001 anthrax attacks in the United States, delivered by mailing postal letters containing the spores. The letters were sent to several news media offices as well as to two Democratic senators: Tom Daschle of South Dakota and Patrick Leahy of Vermont. As a result, 22 were infected and five died. Only a few grams of material were used in these attacks and in August 2008 the US Department of Justice announced they believed that Dr. Bruce Ivins, a senior biodefense researcher employed by the United States government, was responsible.] These events also spawned many anthrax hoaxes.

Due to these events, the U.S. Postal Service installed biohazard detection systems at its major distribution centers to actively scan for anthrax being transported through the mail.

Decontaminating mail

In response to the postal anthrax attacks and hoaxes the US Postal Service sterilized some mail using a process of gamma irradiation and treatment with a proprietary enzyme formula supplied by Sipco Industries Ltd.

A scientific experiment performed by a high school student, later published in The Journal of Medical Toxicology, suggested that a domestic electric iron at its hottest setting at least 204 °C used for at least 5 minutes should destroy all anthrax spores in a common postal envelope.

Anthropogenic Hazard

Contents

1 - Introduction

Anthropogenic hazards or human - made hazards can result in the form of a human-made disaster. In this case, *anthropogenic* means threats having an element of human intent, negligence, or error; or involving a failure of a human - made system. It results in huge loss of life and property. It further affects a person's mental, physical and social well - being. This is opposed to natural disasters resulting from natural hazards.

2 - Sociological hazards

2 – 1 – Crime

Crime is a breach of the law for which some governing authority (via the legal systems) can ultimately prescribe a conviction which will carry some form of penalty, such as imprisonment or a fine. At least in the view of the legislators, the criminal act will cause harm to other people. Each legal jurisdiction may define crime differently. While every crime violates the law, not every violation of the law counts as a crime: for example, breaches of contract and of other private law may rank as "offenses" or as "infractions". Modern societies generally regard crimes as offenses against the public or the state, distinguished from torts (offenses against private parties that can give rise to a civil cause of action).

In context, not all crimes constitute man - made hazards.

2 - 1 - 1 – Arson

A building damaged by arson

is the criminal intent of setting a fire with intent to cause damage. The definition of arson was originally limited to setting fire to buildings, but was later expanded to include other objects, such as bridges, vehicles, and private property. Arson is the greatest recorded cause of fire. Some human-induced fires are accidental: failing machinery such as a kitchen stove is a major cause of accidental fires.

2 – 2 – Civil disorder

Civil disorder is a broad term that is typically used by law enforcement to describe forms of disturbance. Although civil disorder does not necessarily escalate to a disaster in all cases, the event may escalate into general chaos. Rioting has many causes, including large-scale criminal conspiracy, socioeconomic factors (unemployment, poverty), hostility between racial and ethnic groups and mass outrage over perceived moral and legal transgressions. Examples of well-known civil disorders and riots are the Poll Tax Riots in the United Kingdom in 1990; the 1992 Los Angeles riots in which 53 people died; the 2008 Greek riots after a 15-year-old boy was fatally shot by police; and the 2010 Thai political protests in Bangkok during which 91 people died.

2 – 3 – Terrorism

September 11 attacks, which are in multiple categories of man made disaster: terrorist attack, air disaster, arson, and structural collapse

Terrorism is a controversial term with varied definitions. One definition means a violent action targeting civilians exclusively. Another definition is the use or threatened use of violence for the purpose of creating fear in order to achieve a political, religious, or ideological goal. Under the second definition, the targets of terrorist acts can be anyone, including civilians, government officials, military personnel, or people serving the interests of governments.

Definitions of terrorism may also vary geographically. In Australia, the Security Legislation Amendment (Terrorism) Act 2002, defines terrorism as "an action to advance a political, religious or ideological cause and with the intention of coercing the government or intimidating the public", while the United States Department of State operationally describes it as "premeditated, politically-motivated violence perpetrated against non-combatant targets by sub national groups or clandestine agents, usually intended to influence an audience".

2 – 4 – War

War is a conflict between relatively large groups of people, which involves physical force inflicted by the use of weapons. Warfare has destroyed entire cultures, countries, economies and inflicted great suffering on humanity. Other terms for war can include armed conflict, hostilities, and police action. Acts of war are normally excluded from insurance contracts and sometimes from disaster planning.

3 - Technological hazards

3 – 1 – Industrial hazards

Industrial disasters occur in a commercial context, such as mining accidents. They often have an environmental impact. The Bhopal disaster is the world's worst industrial disaster to date, and the Chernobyl disaster is regarded the worst nuclear accident in history. Hazards may have longer-term and more dispersed effects, such as dioxin and DDT poisoning.

3 – 2 – Structural collapse

The 1940 Tacoma Narrows Bridge collapsing, in a frame from a 16mm Kodachrome motion picture film taken by Barney Elliott

Structural collapses are often caused by engineering failures. Bridge failures may be caused in several ways, such as under-design (as in the Tay Bridge disaster), by corrosion attack (such as in the Silver Bridge collapse), or by aerodynamic flutter of the deck (as in *Galloping Gertie*, the original Tacoma Narrows Bridge). Failure of dams was not infrequent during the Victorian era, such as the Dale Dyke dam failure in Sheffield, England in the 1860s, causing the Great Sheffield Flood. Other failures include balcony collapses or building collapses such as that of the World Trade Center.

3 – 3 – Power outage

A power outage is an interruption of normal sources of electrical power. Short-term power outages (up to a few hours) are common and have minor adverse effect, since most businesses and health facilities are prepared to deal with them. Extended power outages, however, can disrupt personal and business activities as well as medical and rescue services, leading to business losses and medical emergencies. Extended loss of power can lead to civil disorder, as in the New York City blackout of 1977. Only very rarely do power outages escalate to disaster proportions, however, they often accompany other types of disasters, such as hurricanes and floods, which hampers relief efforts.

Electro magnetic pulses and voltage spikes from whatever cause can also damage electricity infrastructure and electrical devices.

Recent notable power outages include the 2005 Java–Bali Blackout which affected 100 million people, 2012 India blackouts which affected 600 million and the 2009 Brazil and Paraguay blackout which affected 60 million people.

3 – 4 – Fire

Bush fires, forest fires, and mine fires are generally started by lightning, but also by human negligence or arson. They can burn thousands of square kilometers. If a fire intensifies enough to produce its own winds and "weather", it will form into a firestorm. A good example of a mine fire is the one near Centralia, Pennsylvania. Started in 1962, it ruined the town and continues to burn today. Some of the biggest city-related fires are The Great Chicago Fire, The Peshtigo Fire (both of 1871) and the Great Fire of London in 1666.

An active flame front of the Zaca Fire

Casualties resulting from fires, regardless of their source or initial cause, can be aggravated by inadequate emergency preparedness. Such hazards as a lack of accessible emergency exits, poorly marked escape routes, or improperly maintained fire extinguishers or sprinkler systems may result in many more deaths and injuries than might occur with such protections.

3 - 5 - Hazardous materials

3 – 5 – 1 - Radiation contamination

Chernobyl nuclear power plant

When nuclear weapons are detonated or nuclear containment systems are otherwise compromised, airborne radioactive particles (nuclear fallout) can scatter and irradiate large areas. Not only is it deadly, but it also has a long - term effect on the next generation for those who are contaminated. Ionizing radiation is hazardous to living things, and in such a case much of the affected area could be unsafe for human habitation. During World War II, United States troops dropped atomic bombs on the Japanese cities of Hiroshima and Nagasaki. As a result, the radiation fallout contaminated the cities' water supplies, food sources, and half of the populations of each city were stricken with disease. In the Soviet Union, the Mayak industrial complex (otherwise known as Chelyabinsk - 40 or Chelyabinsk-65) exploded in 1957. The Kyshtym disaster was kept secret for several decades. It is the third most serious nuclear accident ever recorded. At least 22 villages were exposed to radiation and resulted in at least 10,000 displaced persons. In 1992 the former soviet union officially acknowledge the accident. Other Soviet republics of Ukraine and Belarus suffered also when a reactor at the Chernobyl nuclear power plant had a meltdown in 1986. To this day, several small towns and the city of Chernobyl remain abandoned and uninhabitable due to fallout.

Another nuclear power disaster that is ongoing is Fukushima Daiichi.

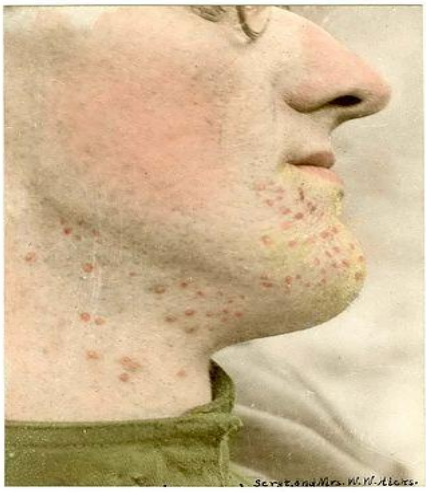
In the 1970s, a similar threat scared millions of Americans when a failure occurred at the Three Mile Island Nuclear Power Plant in Pennsylvania. However, the incident was resolved and the area fortunately retained little contamination.

The Hanford Site is a decommissioned nuclear production complex that produced plutonium for most of the 60,000 weapons in the U.S. nuclear arsenal. There are environmental concerns about radioactivity released from Hanford.

Two major plutonium fires in 1957 and 1969 at the Rocky Flats Plant, located about 15 miles northwest of Denver was not publicly reported until the 1970s.

A number of military accidents involving nuclear weapons have also resulted in radioactive contamination, for example the 1966 Palomares B-52 crash and the 1968 Thule Air Base B-52 crash.

3 – 5 – 2 – CBRNs



Dermatitis (burn) of chin from vapors of mustard gas

CBRN is a catch - all initialism for chemical, biological, radiological, and nuclear. The term is used to describe a non-conventional terror threat that, if used by a nation, would be considered use of a weapon of mass destruction. This term is used primarily in the United Kingdom. Planning for the possibility of a CBRN event may be appropriate for certain high-risk or high-value facilities and governments. Examples include Saddam Hussein's Halabja poison gas attack, the Sarin gas attack on the Tokyo subway and the preceding test runs in Matsumoto, Japan 100 kilometers outside of Tokyo, and Lord Amherst giving smallpox laden blankets to Native Americans.

3 – 6 – Transportation

3 – 6 – 1 – Aviation

The ditching of US Airways Flight 1549 was a well- publicized incident in which all on board survived

An aviation incident is an occurrence other than an accident, associated with the operation of an aircraft, which affects or could affect the safety of operations, passengers, or pilots. The category of the vehicle can range from a helicopter, an airliner, or a space shuttle. The world's worst airliner disaster is the Tenerife crash of 1977, when miscommunications between and amongst air traffic control and an aircrew caused two fully laden jets to collide on the runway, killing 583 people.

3 – 6 – 2 – Rail

Granville - Express wreck at Gare Montparnasse on 22 October 1895

A railroad disaster is an occurrence associated with the operation of a passenger train which results in substantial loss of life. Usually accidents with freight (goods) trains are not considered disasters, unless they cause substantial loss of life or property. One of the most devastating rail disasters occurred in 2004 in Sri Lanka when 1,700 people died in the Sri Lanka tsunami-rail disaster. Other notable rail disasters are the 1989 Ufa accident in Russia which killed 574, and the 1917 Modane train accident in France which killed 540.

3 – 6 – 3 – Road

Traffic collisions are the leading cause of death, and road-based pollution creates a substantial health hazard, especially in major conurbations.

3 – 6 – 4 – Space

Disintegration of the Space Shuttle Challenger

Space travel presents significant hazards, mostly to the direct participants (astronauts or cosmonauts and ground support personnel), but also carry the potential of disaster to the public at large. Accidents related to space travel have killed 22 astronauts and cosmonauts, and a larger number of people on the ground.

Accidents can occur on the ground during launch, preparation, or in flight, due to equipment malfunction or the naturally hostile environment of space itself. An additional risk is posed by (unmanned) low-orbiting satellites whose orbits eventually decay due to friction with the extremely thin atmosphere. If they are large enough, massive pieces travelling at great speed can fall to the Earth before burning up, with the potential to do damage.

The worst space disaster to date occurred on February 15, 1996 in Sichuan, China, when a Long March 3B rocket, carrying the Intelsat 708 telecommunications satellite, suffered a guidance system failure two seconds after liftoff and crashed into a nearby village. The Chinese government officially reported six deaths and 57 injuries, but some U.S. estimates run as high as 200 deaths.

The second worst disaster was the Nedelin catastrophe which occurred in the Soviet Union on October 24, 1960, when an R-16 intercontinental ballistic missile exploded on the launch pad, killing around 120 (best estimate) military ground support personnel. The

Soviet government refuzed to acknowledge the incident until 1989, then claiming only 78 deaths.

One of the worst manned space accidents involved the Space Shuttle *Challenger* which disintegrated in 1986, claiming all seven lives on board. The shuttle disintegrated 73 seconds after taking off from the launch pad in Cape Canaveral, Florida.

Another example is the Space Shuttle *Columbia*, which disintegrated during a landing attempt over Texas in 2003, with a loss of all seven astronauts on board. The debris field extended from New Mexico to Mississippi.

3 – 6 – 5 – travel

The capsized cruise ship Costa Concordia with a large rock lodged in the crushed hull of the ship

Ships can sink, capsize or crash in disasters. Perhaps the most infamous sinking was that of the Titanic which hit an iceberg and sank, resulting in one of the worst maritime disasters in history. Other notable incidents include the capsizing of the Costa Concordia, which killed at least 32 people; and is the largest passenger ship to sink, and the sinking of the MV Doña Paz, which claimed the lives of up to 4,375 people in the worst peacetime maritime disaster in history.

4 – Costs

Some man - made disasters have been particularly notable for the high costs associated with responding to and recovering from them, including :

Deepwater Horizon oil spill, 2010 : Between $ 60 and $ 100 billion.

September 11 attacks, 2001: $ 20.7 billion;

Chernobyl disaster, 1986: $ 15 billion estimated cost of direct loss. It is estimated that the damages could accumulate to €235 billion for Ukraine and € 201 billion for Belarus in the thirty years following the accident;

Three Mile Island, 1979: $1 billion;

Exxon Valdez oil spill, 1989: The clean-up of oil spill cost an estimated $ 2.5 billion; recovery for settlements, $ 1.1 billion; and the economical loss (fisheries, tourism, etc.) suffered due to the damage to the Alaskan ecosystem was estimated at $ 2.8 billion;

AZF chemical plant explosion, 2001: €1.8 billion

The costs of disasters varies considerably depending on a range of factors, such as the geographical location where they occur. When a disaster occurs in a densely populated area in a wealthy country, the financial damage might be huge, but when a comparable disaster occurs in a densely populated area in a poorer country, the actual financial damage might be relatively small, in part due to a lack of insurance. For example, the 2004 Indian Ocean earthquake and tsunami (although obviously not man – made) with a death toll of over 230,000 people, cost $ 15 billion , whereas the Deepwater Horizon oil spill, in which 11 people died, the damages were six-fold.

Anti - Aircraft Warfare

American troops mount the Swedish Bofors 40mm anti - aircraft gun near the Algerian coastline in 1943

Contents

1 - Introduction Air defence is defined by NATO as "all measures designed to nullify or reduce the effectiveness of hostile air action " · They include ground - and air - based weapon systems, associated sensor systems, command and control arrangements and passive measures (e.g. barrage balloons). It may be used to protect naval, ground and air forces in any location. However, for most countries the main effort has tended to be 'homeland defence'. NATO refers to airborne air defence as counter-air and naval air defence as anti-aircraft warfare. Missile defence is an extension of air defence as are initiatives to adapt air defence to the task of intercepting any projectile in flight.

In some countries, such as Britain and Germany during the Second World War, the Soviet Union and NATO's Allied Command Europe, ground based air defence and air defence aircraft have been under integrated command and control. However, while overall air defence may be for homeland defence including military facilities, forces in the field, wherever they are, invariably deploy their own air defence capability if there is an air threat. A surface-based air defence capability can also be deployed offensively to deny the use of airspace to an opponent.

2 – Terminology

The term *air defence* was probably first used by Britain when Air Defence of Great Britain (ADGB) was created as a Royal Air Force command in 1925. However, arrangements in the UK were also called 'anti-aircraft', abbreviated as AA, a term that remained in general use into the 1950s. After the First World War it was sometimes prefixed by 'Light' or 'Heavy' (LAA or HAA) to classify a type of gun or unit.

NATO defines anti - aircraft warfare (AAW) as "measures taken to defend a maritime force against attacks by airborne weapons launched from aircraft, ships, submarines and land - based sites."[2] In some armies the term All - Arms Air Defence (AAAD) is used for air defence by non-specialist troops. Other terms from the late 20th century include GBAD (Ground Based AD) with related terms SHORAD (Short Range AD) and MANPADS ("Man Portable AD Systems": typically shoulder launched missiles). Anti-aircraft missiles are variously called surface-to-air missile, abbreviated and pronounced "SAM" and Surface to Air Guided Weapon (SAGW).

non-English terms for air defence include German flak (from the German Flugzeugabwehrkanone , aircraft defence cannon ; also cited as *Flugabwehrkanone*) and the Russian term Protivovozdushnaya oborona (Cyrillic: Противовоздушная оборона), a literal translation of "anti-air defence", abbreviated as PVO. Nicknames for anti - aircraft guns include AA, AAA or triple - A, an abbreviation of *anti - aircraft artillery*, "ack - ack" (from the spelling alphabet used by the British for voice transmission of "AA") , Archie (a World War I British term probably coined by Amyas Borton and believed to derive via the Royal Flying Corps from the music - hall comedian George Robey's line "Archibald, certainly not!"). In Russian the AA systems are called *zenitnye* (i.e. "pointing to zenith") systems (guns, missiles etc.). In French, air defence is called DCA (Défense Contre Avions).

The maximum distance at which a gun or missile can engage an aircraft is an important figure. However, many different definitions are used but unless the same definition is used, performance of different guns or missiles cannot be compared. For AA guns only the ascending part of the trajectory can be usefully used. One term is 'ceiling', maximum ceiling being the height a projectile would reach if fired vertically, not practically useful in itself as few AA guns are able to fire vertically, and maximum fuze duration may be too short, but potentially useful as a standard to compare different weapons.

The British adopted "effective ceiling", meaning the altitude at which a gun could deliver a series of shells against a moving target; this could be constrained by maximum fuze running time as well as the gun's capability. By the late 1930s the British definition was "that height at which a directly approaching target at 400 mph can be engaged for 20 seconds before the gun reaches 70 degrees elevation".

However , effective ceiling for heavy AA guns was affected by non-ballistic factors:

The maximum running time of the fuze, this set the maximum usable time of flight.

The capability of fire control instruments to determine target height at long range.

The precision of the cyclic rate of fire, the fuze length had to be calculated and set for where the target would be at the time of flight after firing, to do this meant knowing exactly when the round would fire.

3 - General description

India's Akash GBAD surface – to - air missile

The essence of air defence is to detect hostile aircraft and destroy them. The critical issue is to hit a target moving in three-dimensional space; an attack must not only match these three coordinates, but must do so at the time the target is at that position. This means that projectiles either have to be guided to hit the target, or aimed at the predicted position of the target at the time the projectile reaches it, taking into account speed and direction of both the target and the projectile.

Throughout the 20th century air defence was one of the fastest-evolving areas of military technology, responding to the evolution of aircraft and exploiting various enabling technologies, particularly radar, guided missiles and computing (initially electromechanical analog computing from the 1930s on, as with equipment described below) . Air defence evolution covered the areas of sensors and technical fire control, weapons, and command and control. At the start of the 20th century these were either very primitive or non - existent.

Initially sensors were optical and acoustic devices developed during the First World War and continued into the 1930s,[8] but were quickly superseded by radar, which in turn was supplemented by optronics in the 1980s.

and control remained primitive until the late 1930s, when Britain created an integrated system for ADGB that linked the ground-based air defence of the army's AA Command, although field-deployed air defence relied on less sophisticated arrangements. NATO later called these arrangements an "air defence ground environment", defined as "the network of ground radar sites and command and control centres within a specific theatre of operations which are used for the tactical control of air defence operations".

Rules of Engagement are critical to prevent air defences engaging friendly or neutral aircraft. Their use is assisted but not governed by IFF (identification friend or foe) electronic devices originally introduced during the Second World War. While these rules originate at the highest authority, different rules can apply to different types of air defence covering the same area at the same time. AAAD usually operates under the tightest rules.

NATO calls these rules Weapon Control Orders (WCO), they are :

weapons free : a weapon control order imposing a status whereby weapons systems may be fired at any target not positively recognized as friendly.

weapons hold : a weapon control order imposing a status whereby weapons systems may only be fired in self-defence or in response to a formal order.

weapons tight : a weapon control order imposing a status whereby weapons systems may be fired only at targets recognised as hostile.

Until the 1950s guns firing ballistic munitions were the standard weapon; guided missiles then became dominant, except at the very shortest ranges. However, the type of shell or warhead and its fuzing and, with missiles the guidance arrangement, were and are varied. Targets are not always easy to destroy totally, although damaged aircraft may be forced to abort their mission and, even if they manage to return and land in friendly territory, may be out of action for days or permanently. Ignoring small arms and smaller machine-guns, ground - based air defence guns have varied in calibre from 20 mm to at least 150 mm.

Ground - based air defence is deployed in several ways :

Self - defence by ground forces using their organic weapons, AAAD.

Accompanying defence, specialist aid defence elements accompanying armoured or infantry units.

Point defence around a key target, such as a bridge, critical government building or ship.

Area air defence, typically 'belts' of air defence to provide a barrier, but sometimes an umbrella covering an area. Areas can vary widely in size, belts along a nation's border, e.g. the Cold War MIM-23 Hawk and Nike belts that ran north–south across Germany, a military formation's manoeuvre area, or the area of a city or port. In ground operations air defence areas may be used offensively by rapid redeployment across current aircraft transit routes.

Air defence has included other elements, although after the Second World War most fell into disuse :

Tethered barrage balloons to deter and threaten aircraft flying below the height of the balloons, where they are susceptible to damaging collisions with steel tethers.

Searchlights to illuminate aircraft at night for both gun-layers and optical instrument operators. During World War II searchlights became radar controlled.

Large smoke screens created by large smoke canisters on the ground to screen targets and prevent accurate weapon aiming by aircraft.

Passive air defence is defined by NATO as "Passive measures taken for the physical defence and protection of personnel, essential installations and equipment in order to minimize the effectiveness of air and/or missile attack".[1] It remains a vital activity by ground forces and includes camouflage and concealment to avoid detection by reconnaissance and attacking aircraft. Measures such as camouflaging important buildings were common in the Second World War. During the Cold War some airfields painted their runways and taxiways green.

4 – Organization

While navies are usually responsible for their own air defence, at least for ships at sea, organizational arrangements for land-based air defence vary between nations and over time.

The most extreme case was the Soviet Union, and this model may still be followed in some countries: it was a separate service, on a par with the navy or ground force. In the Soviet Union this was called *Voyska PVO*, and had both fighter aircraft and ground-based systems. This was divided into two arms, *PVO Strany*, the Strategic Air defence Service responsible for Air Defence of the Homeland, created in 1941 and becoming an independent service in 1954, and *PVO SV*, Air Defence of the Ground Forces. Subsequently these became part of the air force and ground forces respectively

The divided responsibility echoed Germany's arrangements during the Second World War, where the Luftwaffe was responsible for air defence of Germany while the army protected itself. At the other extreme the United States Army has an Air Defense Artillery branch that provided ground - based air defence for both homeland and the army in the field. Many other nations also deploy an air-defence branch in the army.

In Britain and some other armies, the single artillery branch has been responsible for both home and overseas ground-based air defence, although there was divided responsibility with the Royal Navy for air defence of the British Isles in World War I. However, during the Second World War the RAF Regiment was formed to protect airfields everywhere, and this included light air defences. In the later decades of the Cold War this included the United States Air Force's operating bases in UK. However, all ground-based air defence was removed from Royal Air Force (RAF) jurisdiction in 2004. The British Army's Anti-Aircraft Command was disbanded in March 1955,[12] but during the 1960s and 1970s the RAF's Fighter Command operated long-range air -defence missiles to protect key areas in the UK. During World War II the Royal Marines also provided air defence units; formally part of the mobile naval base defence organization, they were handled as an integral part of the army-commanded ground based air defences.

The basic air defence unit is typically a battery with 2 to 12 guns or missile launchers and fire control elements. These batteries, particularly with guns, usually deploy in a small area, although batteries may be split; this is usual for some missile systems. SHORAD missile batteries often deploy across an area with individual launchers several kilometres apart. When MANPADS is operated by specialists, batteries may have several dozen teams deploying separately in small sections; self-propelled air defence guns may deploy in pairs.

Batteries are usually grouped into battalions or equivalent. In the field army a light gun or SHORAD battalion is often assigned to a manoeuvre division. Heavier guns and long - range missiles may be in air - defense brigades and come under corps or higher command. Homeland air defence may have a full military structure. For example the UK's Anti-Aircraft Command, commanded by a full British Army general was part of ADGB. At its peak in 1941 – 42 it comprised three AA corps with 12 AA divisions between them.

5 – History

5 – 1 - Earliest use

The use of balloons by the Union Army during the American Civil War compelled the Confederates to develop methods of combating them. These included the use of artillery, small arms, and saboteurs. They were unsuccessful, but internal politics led the Union's Balloon Corps to be disbanded mid-war. The Confederates experimented with balloons as well.

The earliest known use of weapons specifically made for the anti-aircraft role occurred during the Franco-Prussian War of 1870. After the disaster at Sedan, Paris was besieged and French troops outside the city started an attempt at resupply via balloon. Gustav Krupp mounted a modified 1- pounder (37 mm) gun — the *ballonkanone* — on top of a horse-drawn carriage for the purpose of shooting down these balloons .

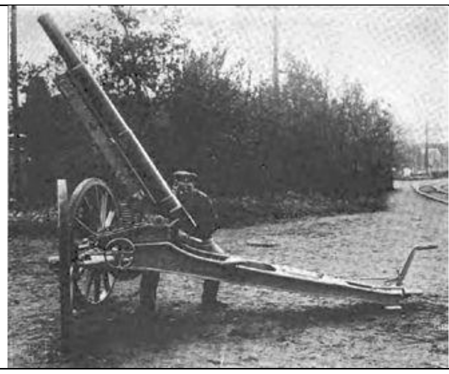
Ballonabwehrkanone by Krupp

By the early 20th century balloon, or airship, guns, for land and naval use were attracting attention. Various types of ammunition were proposed, high explosive, incendiary, bullet-chains, rod bullets and shrapnel. The need for some form of tracer or smoke trail was articulated. Fuzing options were also examined, both impact and time types. Mountings were generally pedestal type, but could be on field platforms. Trials were underway in most countries in Europe but only Krupp, Erhardt, Vickers Maxim, and Schneider had published any information by 1910. Krupp's designs included adaptations of their 65 mm 9 - pounder, a 75 mm 12-pounder, and even a 105 mm gun. Erhardt also had a 12 - pounder, while Vickers Maxim offered a 3-pounder and Schneider a 47 mm. The French balloon gun appeared in 1910, it was an 11 - pounder but mounted on a vehicle, with a total uncrewed weight of 2 tons. However, since balloons were slow moving, sights were simple. But the challenges of faster moving airplanes were recognized.

By 1913 only France and Germany had developed field guns suitable for engaging balloons and aircraft and addressed issues of military organization. Britain's Royal Navy would soon introduce the QF 3-inch and QF 4 - inch AA guns and also had Vickers 1- pounder quick firing "pom - pom"s that could be used in various mountings.

The first US anti - aircraft cannon was a 1-pounder concept design by Admiral Twining in 1911 to meet the perceived threat of airships, that eventually was used as the basis for the US Navy's first operational anti-aircraft cannon: the 3"/23 caliber gun.

5 – 2 - First World War

	
A Canadian anti-aircraft unit of 1918, running to stations	*1909 vintage Krupp 9 pounder anti - aircraft gun*

The British recognized the need for antiaircraft capability a few weeks before World War I broke out; on 8 July 1914, the *New York Times* reported that the British government had decided to 'dot the coasts of the British Isles with a series of towers, each armed with two quick-firing guns of special design,' while 'a complete circle of towers' was to be built around 'naval installations' and 'at other especially vulnerable points.' By December 1914 the Royal Naval Volunteer Reserve (RNVR) was manning AA guns and searchlights assembled from various sources at some nine ports. The Royal Garrison Artillery (RGA) was given responsibility for AA defence in the field, using motorized two-gun sections. The first were formally formed in November 1914. Initially they used QF 1 pounder "pom-pom" (a 37 mm version of the Maxim Gun) .

A Maxim anti - aircraft machine gun.

All armies soon deployed AA guns often based on their smaller field pieces, notably the French 75 mm and Russian 76.2 mm, typically simply propped up on some sort of embankment to get the muzzle pointed skyward. The British Army adopted the 13 - pounder quickly producing new mountings suitable for AA use, the 13 - pdr QF 6 cwt Mk III was issued in 1915. It remained in service throughout the war but 18-pdr guns were lined down to take the 13-pdr shell with a larger cartridge producing the 13-pr QF 9 cwt and these proved much more satisfactory. However, In general, these ad-hoc solutions proved largely useless. With little experience in the role, no means of measuring target, range, height or speed the difficulty of observing their shell bursts relative to the target gunners proved unable to get their fuze setting correct and most rounds burst well below their targets. The exception to this rule was the guns protecting spotting balloons, in which case the altitude could be accurately measured from the length of the cable holding the balloon.

The first issue was ammunition. Before the war it was recognized that ammunition needed to explode in the air. Both high explosive (HE) and shrapnel were used, mostly the former. Airburst fuzes were either igniferious (based on a burning fuze) or mechanical (clock work) . Igniferious fuzes were not well suited for anti - aircraft use. The fuze length was determined by time of flight, but the burning rate of the gunpowder is affected by altitude. The British pom-poms had only contact-fuzed ammunition. Zeppelins, being hydrogen filled balloons, were targets for incendiary shells and the British introduced these with airburst fuzes, both shrapnel type-forward projection of incendiary 'pot' and base ejection of an incendiary stream. The British also fitted tracers to their shells for use at night. Smoke shells were also available for some AA guns, these bursts were used as targets during training .

German air attacks on the British Isles increased in 1915 and the AA efforts were deemed somewhat ineffective, so a Royal Navy gunnery expert, Admiral Sir Percy Scott, was appointed to make improvements, particularly an integrated AA defence for London. The air defences were expanded with more RNVR AA guns, 75 mm and 3-inch, the pom-poms being ineffective. The naval 3-inch was also adopted by the army, the QF 3 inch 20 cwt (76 mm), a new field mounting was introduced in 1916. Since most attacks were at night, searchlights were soon used, and acoustic methods of detection and locating were developed. By December 1916 there were 183 AA Sections defending Britain (most with the 3-inch), 74 with the BEF in France and 10 in the Middle East.

AA gunnery was a difficult business. The problem was of successfully aiming a shell to burst close to its target's future position, with various factors affecting the shells' predicted trajectory. This was called deflection gun - laying, 'off - set' angles for range and elevation were set on the gun sight and updated as their target moved. In this method when the sights were on the target, the barrel was pointed at the target's future position. Range and height of the target determined fuze length. The difficulties increased as aircraft performance improved.

The British dealt with range measurement first, when it was realized that range was the key to producing a better fuze setting. This led to the Height / Range Finder (HRF), the first model being the Barr & Stroud UB2, a 2- metre optical coincident rangefinder mounted on a tripod. It measured the distance to the target and the elevation angle, which together gave the height of the aircraft. These were complex instruments and various other methods were also used. The HRF was soon joined by the Height / Fuze Indicator (HFI) , this was marked with elevation angles and height lines overlaid with fuze length curves, using the height reported by the HRF operator, the necessary fuze length could be read off.

However, the problem of deflection settings — 'aim-off' — required knowing the rate of change in the target's position. Both France and UK introduced tachymetric devices to track targets and produce vertical and horizontal deflection angles. The French Brocq system was electrical, the operator entered the target range and had displays at guns; it was used with their 75 mm. The British Wilson-Dalby gun director used a pair of trackers and mechanical tachymetry; the operator entered the fuze length, and deflection angles were read from the instruments.

By the start of World War I, the 77 mm had become the standard German weapon, and came mounted on a large traverse that could be easily picked up on a wagon for movement. Krupp 75 mm guns were supplied with an optical sighting system that improved their capabilities. The German Army also adapted a revolving cannon that came to be known to Allied fliers as the "flaming onion" from the shells in flight. This gun had five barrels that quickly launched a series of 37 mm artillery shells.

As aircraft started to be used against ground targets on the battlefield, the AA guns could not be traversed quickly enough at close targets and, being relatively few, were not always in the right place (and were often unpopular with other troops), so changed positions frequently. Soon the forces were adding various machine-gun based weapons mounted on poles. These short-range weapons proved more deadly, and the "Red Baron" is believed to have been shot down by an anti-aircraft Vickers machine gun. When the war ended, it was clear that the increasing capabilities of aircraft would require better means of acquiring targets and aiming at them. Nevertheless a pattern had been set: anti - aircraft weapons would be based around heavy weapons attacking high - altitude targets and lighter weapons for use when they came to lower altitudes.

5 – 3 - Inter - war years

World War I demonstrated that aircraft could be an important part of the battlefield, but in some nations it was the prospect of strategic air attack that was the main issue, presenting both a threat and an opportunity. The experience of four years of air attacks on London by Zeppelins and Gotha G.V bombers had particularly influenced the British and was one of if not the main driver for forming an independent air force. As the capabilities of aircraft and their engines improved it was clear that their role in future war would be even more critical as their range and weapon load grew. However, in the years immediately after World War I the prospect of another major war seemed remote, particularly in Europe where the most militarily capable nations were, and little financing was available.

years of war had seen the creation of a new and technically demanding branch of military activity. Air defence had made huge advances, albeit from a very low starting point. However, it was new and often lacked influential 'friends' in the competition for a share of limited defence budgets. Demobilization meant that most AA guns were taken out of service, leaving only the most modern.

However, there were lessons to be learned. In particular the British, who had had AA guns in most theatres in action in daylight and used them against night attacks at home. Further more they had also formed an AA Experimental Section during the war and accumulated a lot of data that was subjected to extensive analysis. As a result they published, in 1924 – 5, the two volume Text book of Anti - Aircraft Gunnery. ***It included five key recommendations for HAA equipment :***

1 - Shells of improved ballistic shape with HE fillings and mechanical time fuzes.

2 - Higher rates of fire assisted by automation.

3 - Height finding by long - base optical instruments.

4 - Centralized control of fire on each gun position, directed by tachymetric instruments incorporating the facility to apply corrections of the moment for meteorological and wear factors.

5 - More accurate sound-location for the direction of searchlights and to provide plots for barrage fire.

Two assumptions underpinned the British approach to HAA fire; first, aimed fire was the primary method and this was enabled by predicting gun data from visually tracking the target and having its height. Second, that the target would maintain a steady course, speed and height. This HAA was to engage targets up to 24,000 feet. Mechanical, as opposed to igniferous, time fuzes were required because the speed of powder burning varied with height so fuze length was not a simple function of time of flight. Automated fire ensured a constant rate of fire that made it easier to predict where each shell should be individually aimed .

In 1925 the British adopted a new instrument developed by Vickers. It was a mechanical analogue computer Predictor AA No 1. Given the target height its operators tracked the target and the predictor produced bearing, quadrant elevation and fuze setting. These were passed electrically to the guns where they were displayed on repeater dials to the layers who 'matched pointers' (target data and the gun's actual data) to lay the guns. This system of repeater electrical dials built on the arrangements introduced by British coast artillery in the 1880s, and coast artillery was the background of many AA officers. Similar systems were adopted in other countries and for example the later Sperry device, designated M3A3 in the US was also used by Britain as the Predictor AA No 2. Height finders were also increasing in size, in Britain, the World War I Barr & Stroud UB 2 (7 feet optical base) was replaced by the UB 7 (9 feet optical base) and the UB 10 (18 feet optical base, only used on static AA sites). Goertz in Germany and Levallois in France produced 5 meter instruments. However, in most countries the main effort in HAA guns until the mid - 1930s was improving existing ones, although various new designs were on drawing boards.

From the early 1930s eight countries developed radar, these developments were sufficiently advanced by the late 1930s for development work on sound locating acoustic devices to be generally halted, although equipment was retained. Furthermore in Britain the volunteer Observer Corps formed in 1925 provided a network of observation posts to report hostile aircraft flying over Britain. Initially radar was used for airspace surveillance to detect approaching hostile aircraft. However, the German Würzburg radar was capable of providing data suitable for controlling AA guns and the British AA

The Treaty of Versailles prevented Germany having AA weapons, and for example, the Krupps designers joined Bofors in Sweden. Some World War I guns were retained and some covert AA training started in the late 1920s. Germany introduced the 8.8 cm FlaK 18 in 1933, 36 and 37 models followed with various improvements but ballistic performance was unchanged. In the late 1930s the 10.5 cm FlaK 38 appeared soon followed by the 39, this was designed primarily for static sites but had a mobile mounting and the unit had 220v 24 kW generators. In 1938 design started on the 12.8 cm FlaK.

The USSR introduced a new 76 mm M1931 in the early 1930s and an 85 mm M1938 towards the end of the decade.

Britain had successful tested a new HAA gun, 3.6-inch, in 1918. In 1928 3.7- inch became the preferred solution, but it took 6 years to gain funding. Production of the QF 3.7 - inch (94 mm) began in 1937; this gun was used both on mobile carriages with the field army and transportable guns on fixed mountings for static positions. At the same time the Royal Navy adopted a new 4.5 - inch (114 mm) gun in a twin turret, which the army adopted in simplified single-gun mountings for static positions, mostly around ports where naval ammunition was available. However, the performance of both 3.7 and 4.5-in guns was limited by their standard fuze No 199, with a 30 second running time, although a new mechanical time fuze giving 43 seconds was nearing readiness. In 1939 a Machine Fuze Setter was introduced to eliminate manual fuze setting.

The US ended World War I with two 3 - inch AA guns and improvements were developed throughout the inter-war period. However, in 1924 work started on a new 105 mm static mounting AA gun, but only a few were produced by the mid-1930s because by this time work had started on the 90 mm AA gun, with mobile carriages and static mountings able to engage air, sea and ground targets. The M1 version was approved in 1940. During the 1920s there was some work on a 4.7 - inch which lapsed, but revived in 1937, leading to a new gun in 1944.

While HAA and is associated target acquisition and fire control was the primary focus of AA efforts, low - level close - range targets remained and by the mid - 1930s were becoming an issue.

Until this time the British, at RAF insistence, continued their World War I use of machine guns, and introduced twin MG mountings for AAAD. The army was forbidden from considering anything larger than .50 - inch. However, in 1935 their trials showed that the minimum effective round was an impact fuzed 2 l b HE shell. The following year they decided to adopt the Bofors 40 mm and a twin barrel Vickers 2 – p dr (40 mm) on a modified naval mount. The air-cooled Bofors was vastly superior for land use, being much lighter than the water - cooled pom-pom, and UK production of the

Bofors 40 mm was licensed. The Predictor AA No 3, as the Kerrison Predictor was officially known, was introduced with it.

The 40 mm Bofors had become available in 1931. In the late 1920s the Swedish Navy had ordered the development of a 40 mm naval anti-aircraft gun from the Bofors company. It was light, rapid - firing and reliable, and a mobile version on a four-wheel carriage was soon developed. Known simply as the 40 mm, it was adopted by some 17 different nations just before World War II and is still in use today in some applications such as on coastguard frigates.

Rheinmetall in Germany developed an automatic 20 mm in the 1920s and Oerlikon in Switzerland had acquired the patent to an automatic 20 mm gun designed in Germany during World War I. Germany introduced the rapid-fire 2 cm FlaK 30 and later in the decade it was redesigned by Mauser - Werke and became the 2 cm FlaK 38 . Nevertheless, while 20 mm was better than a machine gun and mounted on a very small trailer made it easy to move, its effectiveness was limited. Germany therefore added a 3.7 cm. The first, the 3.7 cm Fla K 18 developed by Rheinmetall in the early 1930s, was basically an enlarged 2 cm Fla K 30. It was introduced in 1935 and production stopped the following year. A redesigned gun 3.7 cm FlaK 36 entered service in 1938, it too had a two-wheel carriage.[36] However, by the mid - 1930s the Luftwaffe realised that there was still a coverage gap between 3.7 cm and 8.8 cm guns. They

After World War I the US Army started developing a dual - role (AA / ground) automatic 37 mm cannon, designed by John M. Browning. It was standardised in 1927 as the T9 AA cannon, but trials quickly revealed that it was worthless in the ground role. However, while the shell was a bit light (well under 2 lbs) it had a good effective ceiling and fired 125 rounds per minute; an AA carriage was developed and it entered service in 1939. The Browning 37mm proved prone to jamming, and was eventually replaced in AA units by the Bofors 40 mm. The Bofors had attracted attention from the US Navy, but none were acquired before 1939 . Also, in 1931 the US Army worked on a mobile antiaircraft machine mount on the back of a heavy truck having four .30 caliber water-cooled machine guns and an optical director. It proved unsuccessful and was abandoned.

The Soviet Union also used a 37 mm, the 37 mm M1939, which appears to have been copied from the Bofors 40 mm. A Bofors 25 mm, essentially a scaled down 40 mm, was also copied as the 25 mm M1939.

During the 1930s solid fuel rockets were under development in the Soviet Union and Britain. In Britain the interest was for anti-aircraft fire, it quickly became clear that guidance would be required for precision. However, rockets, or 'unrotated projectiles' as they were called could the used for anti-aircraft barrages. A 2- inch rocket using HE or wire obstacle warheads was introduced first to deal with low-level or dive bombing attacks on smaller targets such as airfields. The 3-inch was in development at the end of the inter-war period.

5 – 4 - Second World War

Poland's AA defences were no match for the German attack and the situation was similar in other European countries. Significant AA warfare started with the Battle of Britain in the summer of 1940. 3.7-inch HAA were to provide the backbone of the ground based AA defences, although initially significant numbers of 3 - inch 20 - cwt were also used. The Army's Anti-aircraft command, which was under command of the Air Defence UK organization, grew to 12 AA divisions in 3 AA corps. 40-mm Bofors entered service in increasing numbers. In addition the RAF regiment was formed in 1941 with responsibility for airfield air defence, eventually with Bofors 40mm as their main armament. Fixed AA defences, using HAA and LAA, were established by the Army in key overseas places, notably Malta, Suez Canal and Singapore.

While the 3.7 inch was the main HAA gun in fixed defences and the only mobile HAA gun with the field army, 4.5 – inch , manned by artillery, was used in the vicinity of naval ports, making use of the naval ammunition supply. 4.5 - inch at Singapore had the first success in shooting down Japanese bombers. Mid war 5.25 - inch HAA gun started being emplaced in some permanent sites around London. This gun was also deployed in dual role coast defence / AA positions.

Germany's high - altitude needs were originally going to be filled by a 75 mm gun from Krupp, designed in collaboration with their Swedish counterpart Bofors, but the specifications were later amended to require much higher performance. In response Krupp's engineers presented a new 88 mm design, the FlaK 36. The "eighty-eight" would go on to become one of the most famous artillery pieces in history. First used in Spain during the Spanish Civil War, the gun proved to be one of the best anti-aircraft guns in the world, as well as particularly deadly against light, medium, and even early heavy tanks.

German 88 mm flak gun in action against Allied bombers

After the Dam busters raid in 1943 an entirely new system was developed that was required to knock down any low-flying aircraft with a single hit. The first attempt to produce such a system used a 50 mm gun, but this proved inaccurate and a new 55 mm gun replaced it. The system used a centralized control system including both search and targeting radar, which calculated the aim point for the guns after considering wind age and ballistics, and then sent electrical commands to the guns, which used hydraulics to point themselves at high speeds. Operators simply fed the guns and selected the targets.

This system, modern even by today's standards, was in late development when the war ended.

The British had already arranged license building of the Bofors 40 mm, and introduced these into service. These had the power to knock down aircraft of any size, yet were light enough to be mobile and easily swung. The gun became so important to the British war effort that they even produced a movie, *The Gun*, that encouraged workers on the assembly line to work harder. The Imperial measurement production drawings the British had developed were supplied to the Americans who produced their own (unlicensed) copy of the 40 mm at the start of the war, moving to licensed production in mid -1941 .

Service trials demonstrated another problem however: that ranging and tracking the new high - speed targets was almost impossible. At short range, the apparent target area is relatively large, the trajectory is flat and the time of flight is short, allowing to correct lead by watching the tracers. At long range, the aircraft remains in firing range for a long time, so the necessary calculations can in theory be done by slide rules - though, because small errors in distance cause large errors in shell fall height and detonation time, exact ranging is crucial. For the ranges and speeds that the Bofors worked at, neither answer was good enough.

British QF 3.7 inch gun in London in 1939

solution was automation, in the form of a mechanical computer, the Kerrison Predictor. Operators kept it pointed at the target, and the

Predictor then calculated the proper aim point automatically and displayed it as a pointer mounted on the gun. The gun operators simply followed the pointer and loaded the shells. The Kerrison was fairly simple, but it pointed the way to future generations that incorporated radar, first for ranging and later for tracking. Similar predictor systems were introduced by Germany during the war, also adding radar ranging as the war progressed.

Although they receive little attention, US Army anti-aircraft systems were actually quite competent. Their smaller tactical needs were filled with four M2 .50 caliber machine guns linked together (known as the "Quad Fifty"), which were often mounted on the back of a half-track to form the Half Track, M16 GMC, Anti-Aircraft. Although of less power than Germany's 20 mm systems, the typical 4 or 5 combat batteries of an Army AAA battalion were often spread many kilometers apart from each other, rapidly attaching and detaching to larger ground combat units to provide welcome defence from enemy aircraft.

AAA battalions were also used to help suppress ground targets. Their larger 90 mm M3 gun would prove, as did the eighty-eight, to make an excellent anti-tank gun as well, and was widely used late in the war in this role. For smaller targets, the U.S. Army made use of its Quad-4 halftracks, which were truck - mounted turrets equipped with 4 parallel-mounted .50 caliber machine guns. Also available to the Americans at the start of the war was the 120 mm M1 gun *stratosphere gun*, which was the most powerful AA gun with an impressive 18 km altitude capability. No 120 M1 was ever fired at an enemy aircraft. The 90 mm and 120 mm guns would continue to be used into the 1950s.

The United States Navy had also put some thought into the problem, and came up with the 1.1" / 75 (28 mm) gun to replace the inadequate .50 caliber. This weapon had the teething troubles that most new weapons have, but the issues with the gun were never sorted out. It was replaced by the Bofors 40 mm wherever possible. The 5" / 38 caliber gun turned out to be an excellent anti-aircraft weapon, once the Proximity fuze had been perfected.

The Germans developed massive reinforced concrete blockhouses, some more than six stories high, which were known as *Hochbunker* "High Bunkers" or "*Flaktürme*" flak towers, on which they placed anti - aircraft artillery. Those in cities attacked by the Allied land forces became fortresses. Several in Berlin were some of the last buildings to fall to the Soviets during the Battle of Berlin in 1945. The British built structures in the Thames Estuary and other tidal areas upon which they based guns. After the war most were left to rot. Some were outside territorial waters, and had a second life in the 1960s as platforms for pirate radio stations.

Some nations started rocket research before World War II, including for anti-aircraft use. Further research started during the war. The first step was unguided missile systems like the British 2-inch RP and 3-inch, which was fired in large numbers from *Z batteries*, and were also fitted to warships. The firing of one of these devices during an air raid is suspected to have caused the Bethnal Green disaster in 1943. Facing the threat of Japanese Kamikaze attacks the British and US developed surface-to-air rockets like British Stooge or the American Lark as counter measures, but none of them were ready at the end of the war. The Germans missile research was the most advanced of the war as the Germans put considerable effort in the research and development of rocket systems for all purposes. Among them were several guided and unguided systems. Unguided systems involved the Fliegerfaust as the first MANPADS. Guided systems were several sophisticated radio, wire, or radar guided missiles like the Wasserfall rocket. Due to the severe war situation for Germany all of those systems were only produced in small numbers and most of them were only used by training or trial units.

Another aspect of anti-aircraft defense was the use of barrage balloons to act as physical obstacle initially to bomber aircraft over cities and later for ground attack aircraft over the Normandy invasion fleets. The balloon, a simple blimp tethered to the ground, worked in two ways. Firstly, it and the steel cable were a danger to any aircraft that tried to fly among them. Secondly, to avoid the balloons, bombers had to fly at a higher altitude, which was more favorable for the guns. Barrage balloons were limited in application, and had minimal success at bringing down aircraft, being largely immobile and passive defenses.

5 – 5 – Post - war

A 1970s - era Talos antiaircraft missile, fired from a cruiser

Post - war analysis demonstrated that even with newest anti-aircraft systems employed by both sides, the vast majority of bombers reached their targets successfully, on the order of 90 %. This was bad enough during the war, but the introduction of the nuclear bomb upset things considerably. Now even a single bomber reaching the target would be unacceptable.

The developments during World War II continued for a short time into the post-war period as well. In particular the US Army set up a huge air defence network around its larger cities based on radar-guided 90 mm and 120 mm guns. But, given the general lack of success of guns against even propeller bombers, it was clear that any defence was going to have to rely almost entirely on interceptor aircraft. Despite this, US efforts continued into the 1950s with the 75 mm Sky sweeper system, an almost fully automated system including the radar, computers, power, and auto - loading gun on a single powered platform. The Sky sweeper replaced all smaller guns then in use in the Army, notably the 40 mm Bofors.

Things changed with the introduction of the guided missile. Although Germany had been desperate to introduce them during the war, none of them became operational during the war. With a few years of development, however, these systems started to mature into practical weapons. The US started an upgrade of their defenses using the Nike Ajax missile, and soon the larger anti - aircraft guns disappeared. The same thing occurred in the USSR after the introduction of their SA - 2 Guideline systems.

A three - man JASDF fire team fires a missile from a Type 91 Kai MANPAD during an exercise at Eielson Air Force Base, Alaska as part of Red Flag - Alaska.

As this process continued, the missile found itself being used for more and more of the roles formerly filled by guns. First to go were the large weapons, replaced by equally large missile systems of much higher performance. Smaller missiles soon followed, eventually becoming small enough to be mounted on armored cars and tank chassis. These started replacing, or at least supplanting, similar gun-based SPAAG systems in the 1960s, and by the 1990s had replaced almost all such systems in modern armies. Man - portable missiles, MANPADs as they are known today, were introduced in the 1960s and have supplanted or even replaced even the smallest guns in most advanced armies.

In the 1982 Falklands War, the Argentine armed forces deployed the newest west European weapons including the Oerlikon GDF-002 35 mm twin cannon and SAM Roland. The Rapier missile system was the primary GBAD system, used by both British artillery and RAF regiment, a few brand - new FIM - 92 Stinger were used by British special forces. Both sides also used the Blowpipe missile. British naval missiles used included Sea Dart and the older Sea Slug longer range systems, Sea Cat and the new Sea Wolf short range systems. Machine guns in AA mountings was used both ashore and afloat.

During the 2008 South Ossetia war air power faced off against powerful SAM systems, like the 1980s Buk-M1.

In Somalia, militia members sometimes welded a steel plate in the exhaust end of an unguided RPG's tube to deflect pressure away from the shooter when shooting upwards at US helicopters. RPGs are used in this role only when more effective weapons are not available.

6 - AA war fare systems

Although the fire arms used by the infantry, particularly machine guns, can be used to engage low altitude air targets, on occasion with notable success, their effectiveness is generally limited and the muzzle flashes reveal infantry positions. Speed and altitude of modern jet aircraft limit target opportunities, and critical systems may be armored in aircraft designed for the ground attack role. Adaptations of the standard auto cannon, originally intended for air-to-ground use, and heavier artillery systems were commonly used for most anti-aircraft gunnery, starting with standard pieces on new mountings, and evolving to specially designed guns with much higher performance prior to World War II.

The ammunition and shells fired by these weapons are usually fitted with different types of fuzes (barometric, time-delay, or proximity) to explode close to the airborne target, releasing a shower of fast metal fragments. For shorter - range work, a lighter weapon with a higher rate of fire is required, to increase a hit probability on a fast airborne target. Weapons between 20 mm and 40 mm caliber have been widely used in this role. Smaller weapons, typically .50 caliber or even 8 mm rifle caliber guns have been used in the smallest mounts.

Unlike the heavier guns, these smaller weapons are in widespread use due to their low cost and ability to quickly follow the target. Classic examples of auto cannons and large caliber guns are the 40 mm auto cannon and the 8.8 cm FlaK 18, 36 gun, both designed by Bofors of Sweden. Artillery weapons of this sort have for the most part been superseded by the effective surface-to-air missile systems that were introduced in the 1950s, although they were still retained by many nations. The development of surface – to - air missiles began in Nazi Germany during the late World War II with missiles such as the Wasserfall, though no working system was deployed before the war's end, and represented new attempts to increase effectiveness of the anti - aircraft systems faced with growing threat from bombers. Land - based SAMs can be deployed from fixed installations or mobile launchers, either wheeled or tracked. The tracked vehicles are usually armoured vehicles specifically designed to carry SAMs.

Larger SAMs may be deployed in fixed launchers, but can be towed / re - deployed at will. The SAMs launched by individuals are known in the United States as the Man-Portable Air Defence Systems (MANPADS) . MANPADS of the former Soviet Union have been exported around the World, and can be found in use by many armed forces. Targets for non – Man PAD SAMs will usually be acquired by air - search radar, then tracked before/while a SAM is "locked - on" and then fired. Potential targets, if they are military aircraft, will be identified as friend or foe before being engaged. The developments in the latest and relatively cheap short-range missiles have begun to replace auto cannons in this role.

The interceptor aircraft (or simply interceptor) is a type of fighter aircraft designed specifically to intercept and destroy enemy aircraft, particularly bombers, usually relying on high speed and altitude capabilities. A number of jet interceptors such as the F-102 Delta Dagger, the F-106 Delta Dart, and the MiG-25 were built in the period starting after the end of World War II and ending in the late 1960s, when they became less important due to the shifting of the strategic bombing role to ICBMs. Invariably the type is differentiated from other fighter aircraft designs by higher speeds and shorter operating ranges, as well as much reduced ordnance payloads.

radar systems use electromagnetic waves to identify the range, altitude, direction, or speed of aircraft and weather formations to provide tactical and operational warning and direction, primarily during defensive operations. In their functional roles they provide target search, threat, guidance, reconnaissance, navigation, instrumentation , and weather reporting support to combat operations.

A Royal Navy Type 45 destroyer is a highly advanced anti - air ship

6 – 1 - Future developments

If current trends continue, missiles will replace gun systems completely in "first line" service . Guns are being increasingly pushed into specialist roles, such as the Dutch Goalkeeper CIWS, which uses the GAU-8/A Avenger 30 mm seven-barrel Gatling Gun for last ditch anti - missile and anti - aircraft defense. Even this formerly front - line weapon is currently being replaced by new missile systems, such as the Rolling Airframe Missile, which is smaller, faster, and allows for mid-flight course correction (guidance) to ensure a hit. To bridge the gap between guns and missiles, Russia in particular produces the Kashtan CIWS, which uses both guns and missiles for final defense. Two six-barreled 30 mm Gsh-6-30 Gatling guns and 9M311 surface to air missiles provide for its defensive capabilities.

Upsetting this development to all - missile systems is the current move to stealth aircraft. Long range missiles depend on long-range detection to provide significant lead. Stealth designs cut detection ranges so much that the aircraft is often never even seen, and when it is, it is often too late for an intercept. Systems for detection and tracking of stealthy aircraft are a major problem for anti-aircraft development.

However, as Stealth technology grows, so does anti-stealth technology. Multiple transmitter radars such as those from Bistatic radars and Low - frequency radars are said to have the capabilities to detect stealth aircraft. Advanced forms of Thermographic cameras such as those that incorporate QWIPs would be able to optically see a Stealth aircraft regardless of the aircraft's RCS. In addition, Side looking radars, High - powered Optical Satellites, and sky - scanning, high-Aperature, high sensitivity Radars such as Radio telescopes, would all be able to narrow down the location of a Stealth aircraft under certain parameters. The newest SAM's have a claimed ability to be able to detect and engage stealth targets, with the most notable being the S - 400 , which is claimed to be able to detect a target with a 0.05 meter squared RCS from 90 km away.[43]

Another potential weapon system for anti - aircraft use is the laser. Although air planners imagined lasers in combat since the late 1960s, only the most modern laser systems are currently reaching what could be considered "experimental usefulness". In particular the Tactical High Energy Laser can be used in the anti - aircraft and anti-missile role. If current developments continue, some believe it is reasonable to suggest that lasers will play a major role in air defense starting in the next ten years.

The future of projectile based weapons may be found in the railgun, currently tests are underway on developing systems that could create as much damage as a BGM-109 Tomahawk, but at a fraction of the cost. In February 2008 the US Navy tested a rail gun; it fired a shell at 9,000 km per hour using 10 mega joules of energy. Its expected performance is over 21,000 km per hour muzzle velocity, accurate enough to hit a 5 meter target from 200 nautical miles 370 km away while shooting at 10 shots per minute. It is expected to be ready in 2020 to 2025 . These systems while currently designed for static targets would only need the ability to be retargeted to become the next generation of AA system.

7 - Force structures

Most Western and Commonwealth militaries integrate air defence purely with the traditional services, of the military (i.e. army, navy and air force) , as a separate arm or as part of artillery. In the United States Army for instance, air defence is part of the artillery arm, while in the Pakistan Army, it was split off from Artillery to form a separate arm of its own in 1990. This is in contrast to some (largely communist or ex-communist) countries where not only are there provisions for air defence in the army, navy and air force but there are specific branches that deal only with the air defence of territory, for example, the Soviet PVO Strany. The USSR also had a separate strategic rocket force in charge of nuclear ICBMs.

7 – 1 – Navy

Soviet AK - 630 CIWS (close - in weapon system)

Smaller boats and ships typically have machine-guns or fast cannons, which can often be deadly to low-flying aircraft if linked to a radar-directed fire-control system radar-controlled cannon for point defence. Some vessels like Aegis cruisers are as much a threat to aircraft as any land - based air defence system. In general, naval vessels should be treated with respect by aircraft , however the reverse is equally true. Carrier battle groups are especially well defended, as not only do they typically consist of many vessels with heavy air defence armament but they are also able to launch fighter jets for combat air patrol overhead to intercept incoming airborne threats.

Nations such as Japan use their SAM equipped vessels to create an outer air defense perimeter and radar picket in the defense of its Home islands, and the United States also uses its Aegis equipped ships as part of its Aegis Ballistic Missile Defense System in the defense of the Continental United States.

Some modern submarines, such as the Type 212 submarines of the German Navy, are equipped with surface - to - air missile systems, since helicopters and anti - submarine warfare aircraft are significant threats. The subsurface launched anti-air missile was first purposed by US Navy Rear Admiral Charles B. Momsen, in a 1953 article.

7 – 1 – 1 - Layered air defence

Air defence in naval tactics, especially within a carrier group, is often built around a system of concentric layers with the aircraft carrier at the center. The outer layer will usually be provided by the carrier's aircraft, specifically its AEW & C aircraft combined with the CAP. If an attacker is able to penetrate this layer, then the next layers would come from the surface to air missiles carried by the carrier's escorts; the area defence missiles, such as the RIM-67 Standard, with a range of up to 100 nmi , and the point defence missiles , like the RIM - 162 ESSM , with a range of up to 30nmi. Finally, virtually every modern warship will be fitted with small calibre guns, including a CIWS, which is usually a radar controlled Gatling gun of between 20mm and 30 mm calibre capable of firing several thousand rounds per minute.

7 – 2 – Army

Armies typically have air defence in depth, from integral MANPADS such as the RBS 70, Stinger and Igla at smaller force levels up to army - level missile defence systems such as Angara and Patriot. Often, the high - altitude long-range missile systems force aircraft to fly at low level, where anti-aircraft guns can bring them down. As well as the small and large systems, for effective air defence there must be intermediate systems. These may be deployed at regiment - level and consist of platoons of self - propelled anti - aircraft platforms, whether they are self - propelled anti - aircraft guns (SPAAGs), integrated air - defence systems like Tunguska or all-in-one surface – to - air missile platforms like Roland or SA-8 Gecko.

On a national level the United States Army was atypical in that it was primarily responsible for the missile air defences of the Continental United States with systems such as Project Nike.

7 – 3 – Air force

The Eurofighter Typhoon is an advanced air - to - air aircraft

Air defence by air forces is typically taken care of by fighter jets carrying air – to - air missiles. However, most air forces choose to augment airbase defense with surface - to - air missile systems as they are such valuable targets and subject to attack by enemy aircraft. In addition, countries without dedicated air defense forces often relegate these duties to the air force.

7 – 4 – Area air defence

Area air defence, the air defense of a specific area or location, (as opposed to point defense), have historically been operated by both armies (Anti - Aircraft Command in the British Army, for instance) and Air Forces (the United States Air Force's CIM-10 Bomarc) . Area defence systems have medium to long range and can be made up of various other systems and networked into an area defence system (in which case it may be made up of several short range systems combined to effectively cover an area). An example of area defence is the defence of Saudi Arabia and Israel by MIM-104 Patriot missile batteries during the first Gulf War, where the objective was to cover populated areas.

8 – Tactics

8 – 1 – Mobility

The Russian Tor missile system can engage targets while moving, thus achieving high survivability.

Most modern air defence systems are fairly mobile. Even the larger systems tend to be mounted on trailers and are designed to be fairly quickly broken down or set up. In the past, this was not always the case. Early missile systems were cumbersome and required much infrastructure; many could not be moved at all. With the diversification of air defence there has been much more emphasis on mobility. Most modern systems are usually either self-propelled (i.e. guns or missiles are mounted on a truck or tracked chassis) or easily towed. Even systems that consist of many components (transporter / erector / launchers , radars , command posts etc.) benefit from being mounted on a fleet of vehicles. In general, a fixed system can be identified, attacked and destroyed whereas a mobile system can show up in places where it is not expected. Soviet systems especially concentrate on mobility, after the lessons learnt in the Vietnam war between the USA and Vietnam. For more information on this part of the conflict, see SA-2 Guideline.

8 – 2 – Air defence versus air defence suppression

Israel , and The US Air Force, in conjunction with the members of NATO, has developed significant tactics for air defence suppression. Dedicated weapons such as anti-radiation missiles and advanced electronics intelligence and electronic countermeasures platforms seek to suppress or negate the effectiveness of an opposing air - defence system. It is an arms race; as better jamming, countermeasures and anti - radiation weapons are developed, so are better SAM systems with ECCM capabilities and the ability to shoot down anti-radiation missiles and other munitions aimed at them or the targets they are defending.

Anti - Cholinergic

Contents

1 - Introductıon

An anti cholinergic agent is a substance that blocks the neurotransmitter acetylcholine in the central and the peripheral nervous system. Anti cholinergics inhibit parasympathetic nerve impulses by selectively blocking the binding of the neurotransmitter acetyl choline to its receptor in nerve cells. The nerve fibers of the parasympathetic system are responsible for the involuntary movement of smooth muscles present in the gastrointestinal tract, urinary tract, lungs, etc. Anti cholinergics are divided into three categories in accordance with their specific targets in the central and/or peripheral nervous system: anti muscarinic agents, ganglionic blockers, and neuromuscular blockers .

2 – Pharmacology

Anti cholinergics are classified according to the receptors that are affected :

Anti muscarinic agents operate on the muscarinic acetylcholine receptors. The majority of anti cholinergic drugs are anti muscarinics.

Anti nicotinic agents operate on the nicotinic acetylcholine receptors. The majority of these are non - depolarizing skeletal muscle relaxants for surgical use that are structurally related to curare. Several are depolarizing agents.

3 – Examples

Examples of common anti cholinergics :

Anti - Muscarinic agents
Atropine
Benztropine (Cogentin)
Biperiden
Ipratropium (Atrovent)
Oxitropium (Oxivent)
Tiotropium (Spiriva)
Glycopyrrolate (Robinul)
Oxybutynin (Ditropan, Driptane, Lyrinel XL)
Tolterodine (Detrol, Detrusitol)
Chlorpheniramine (Chlor-Trimeton)
Diphenhydramine (Benadryl, Sominex, Advil PM, etc.)
Dimenhydrinate (Dramamine)
Orphenadrine
Trihexyphenidyl
Dicyclomine (Dicycloverine)
Anti-Nicotinic agents
Bupropion (Zyban, Wellbutrin) - Ganglion blocker
Hexamethonium - Ganglion blocker
Tubocurarine - Nondeplorizing skeletal muscular relaxant
Dextromethorphan - Cough suppressant and ganglion blocker
Mecamylamine - Ganglion blocker
Doxacurium - Nondeplorizing skeletal muscular relaxant

Plants of the Solanaceae family contain various anti cholinergic tropane alkaloids such as scopolamine, atropine, and hyoscyamine.

Physostigmine is one of only a few drugs that can be used as an antidote for anti cholinergic poisoning. Nicotine also counteracts anti cholinergics by activating nicotinic acetylcholine receptors. Caffeine (although an adenosine receptor antagonist) would counteract the anti cholinergic symptoms by reducing sedation and increase acetylcholine activity, thereby causing alertness and arousal.

4 - Medical and recreational uses

Anti cholinergic drugs are used in treating a variety of conditions:

Gastrointestinal disorders (e.g., gastritis, diarrhea, pylorospasm, diverticulitis, ulcerative colitis, nausea, and vomiting)

Genitourinary disorders (e.g., cystitis, urethritis, and prostatitis)

Respiratory disorders (e.g., asthma, chronic bronchitis, and chronic obstructive pulmonary disease [COPD])

Sinus bradycardia due to a hypersensitive vagus nerve.

Insomnia, although usually only on a short term basis.

Dizziness (including vertigo [a.k.a. 'the spins'] and motion sickness - related symptoms)

Anti cholinergics generally have *antisialagogue* effects (decreasing saliva production), and most have at least some sedative effect, both being advantageous in surgical procedures.[2]

When a significant amount of an anti cholinergic is taken into the body, a toxic reaction known as acute anti cholinergic syndrome may result. This may happen accidentally or intentionally as a consequence of recreational drug use. Anti cholinergic drugs are usually considered the least enjoyable by experienced recreational drug users , possibly due to the lack of euphoria caused by them. In terms of recreational use, these drugs are commonly referred to as deliriants . Because most users do not enjoy the experience, they do not use it again, or do so very rarely. The risk of addiction is low in the anti cholinergic class. The effects are usually more pronounced in the elderly, due to natural reduction of acetylcholine production associated with age.

Exceptions to the above include scopolamine, orphenadrine, dicycloverine / dicyclomine and first-generation antihistamines with central nervous system penetration.

5 - Acute Anti cholinergic Syndrome

Possible effects of anti cholinergics include :

Ataxia ; loss of coordination

Decreased mucus production in the nose and throat; consequent dry, sore throat

Xerostomia or dry-mouth with possible acceleration of dental caries

Cessation of perspiration; consequent decreased epidermal thermal dissipation leading to warm, blotchy, or red skin

Increased body temperature

Pupil dilation (mydriasis); consequent sensitivity to bright light (photophobia)

Loss of accommodation (loss of focusing ability, blurred vision – cycloplegia)

Double - vision (diplopia)

Increased heart rate (tachycardia)

Tendency to be easily startled

Urinary retention

Diminished bowel movement, sometimes ileus (decreases motility via the vagus nerve)

ncreased intraocular pressure; dangerous for people with narrow - angle glaucoma

Shaking

Possible effects in the central nervous system resemble those associated with delirium, and may include:

Confusion

Disorientation

Agitation

Euphoria or dysphoria

Respiratory depression

Memory problems[3]

Inability to concentrate

Wandering thoughts; inability to sustain a train of thought

Incoherent speech

Irritability

Mental confusion (brain fog)

Wakeful myoclonic jerking

Unusual sensitivity to sudden sounds

Illogical thinking

Photophobia
Visual disturbances
Periodic flashes of light
Periodic changes in visual field
Visual snow
Restricted or "tunnel vision"
Visual, auditory, or other sensory hallucinations
Warping or waving of surfaces and edges
Textured surfaces
"Dancing" lines; "spiders", insects; form constants
Lifelike objects indistinguishable from reality
Phantom smoking
Hallucinated presence of people not actually there
Rarely : seizures, coma, and death

Orthostatic hypotension (sudden dropping of systolic blood pressure when standing up suddenly) and significantly increased risk of falls in the elderly population.

A common mnemonic for the main features of anti cholinergic syndrome is the following :
Hot as a hare (hyperthermia)
Blind as a bat (dilated pupils)
Dry as a bone (dry skin)
Red as a beet (vasodilation)
Mad as a hatter (hallucinations/agitation)
The bowel and bladder lose their tone and the heart goes on alone (ileus, urinary retention, tachycardia)

5 – 1 – Remedies

Acute anti cholinergic syndrome is completely reversible and subsides once all of the causative agent has been excreted. Reversible cholinergic agents such as physostigmine can be used in life-threatening cases. Wider use is discouraged due to the significant side effects, such as rapid heart beat and decreased blood pressure.

Piracetam (and other racetams) , Alpha - GPC and Choline are known to activate cholinergic system and alleviate cognitive symptoms caused by extended use of anti cholinergic drugs.

6 - Plant sources

The most common plants containing anti cholinergic alkaloids are :

Atropa belladonna (Deadly Nightshade), source of atropine
Brugmansia species (Brugmansia)
Datura species (Datura)
Hyoscyamus niger (Henbane)
Mandragora officinarum (Mandrake).

7 - Use as a deterrent

Certain preparations of some drugs, such as hydrocodone, are mixed with an anti cholinergic agent to deter intentional overdose.[5]

Anti Coagulant

Contents

1 - Introductıon

Anticoagulants (anti thrombics , fibrinolytic, and thrombolytics) are a class of drugs that work to prevent the coagulation (clotting) of blood. Such substances occur naturally in leeches and blood-sucking insects. A group of pharmaceuticals called anticoagulants can be used *in vivo* as a medication for thrombotic disorders. Some anticoagulants are used in medical equipment, such as test tubes, blood transfusion bags, and renal dialysis equipment.

2 - As medications

Anticoagulants reduce blood clotting. This prevents deep vein thrombosis, pulmonary embolism, myocardial infarction and ischemic stroke.

2 – 1 - Coumarins (vitamin K antagonists)

These oral anticoagulants are derived from coumarin, which is found in many plants. A prominent member of this class is warfarin

(Coumadin). It takes at least 48 to 72 hours for the anticoagulant effect to develop. Where an immediate effect is required, heparin must be given concomitantly. These anticoagulants are used to treat patients with deep - vein thrombosis (DVT) , pulmonary embolism (PE) and to prevent emboli in patients with atrial fibrillation (AF), and mechanical prosthetic heart valves.

2 - 1 – 1 - Adverse effects

Patients aged 80 years or more may be especially susceptible to bleeding complications, with a rate of 13 bleeds per 100 person-years.[1] These oral anticoagulants are used widely as poisons for mammalian pests, especially rodents . Depletion of vitamin K by Coumadin therapy increases risk of arterial calcification and heart valve calcification, especially if too much vitamin D is present.[2]

2 - 1 – 2 - Available agents

Warfarin (Coumadin) is the main agent used in the US and UK.

Acenocoumarol and phenprocoumon are used more commonly outside the US and the UK.

Atromentin

Brodifacoum is used as rat poison, but is not used medically.

Phenindione

2 – 2 - Heparin and derivative substances

Heparin is a biological substance, usually made from pig intestines. It works by activating anti thrombin III, which blocks thrombin from clotting blood. Heparin can be used *in vivo* (by injection), and also *in vitro* to prevent blood or plasma clotting in or on medical devices. In venipuncture, Vacutainer brand blood collecting tubes containing heparin usually have a green cap.

2 – 2 – 1 - Major pharmaceutical heparin recall due to contamination

In March 2008, major recalls of heparin were announced by pharmaceutical companies due to a suspected and unknown contamination of the raw heparin stock imported from China.[4][5] The contaminant was later found to be a compound called oversulfated chondroitin sulfate . The US Food and Drug Administration was quoted as stating at least 19 deaths were believed linked to a raw heparin ingredient imported from the People's Republic of China, and they had also received 785 reports of serious injuries associated with the drug's use. According to the New York Times: 'Problems with heparin reported to the agency include difficulty breathing, nausea, vomiting, excessive sweating and rapidly falling blood pressure that in some cases led to life-threatening shock'.

2 – 2 – 2 - Low molecular weight heparin

Low molecular weight heparin, a more highly processed product, is useful as it does not require monitoring of the APTT coagulation parameter (it has more predictable plasma levels) and has fewer side effects.

2 – 2 – 3 - Synthetic pentasaccharide inhibitors of factor Xa

Fondaparinux is a synthetic sugar composed of the five sugars (pentasaccharide) in heparin that bind to anti thrombin. It is a smaller molecule than low molecular weight heparin.

Idraparinux

2 - 3 - Direct factor Xa inhibitors

Drugs such as rivaroxaban and apixaban work by inhibiting factor Xa directly (unlike the heparins and fondaparinux, which work via anti thrombin activation).

2 – 4 - Direct thrombin inhibitors

Another type of anticoagulant is the direct thrombin inhibitor.[7] Current members of this class include the bivalent drugs hirudin, lepirudin, and bivalirudin; and the monovalent drugs argatroban and dabigatran. An oral direct thrombin inhibitor, ximelagatran (Exanta) was denied approval by the Food and Drug Administration (FDA) in September 2004 [1] and was pulled from the market entirely in February 2006 after reports of severe liver damage and heart attacks. In November 2010, dabigatran was approved by the FDA to treat atrial fibrillation.

2 – 5 – Anti thrombin protein therapeutics

The anti thrombin protein itself is used as a protein therapeutic that can be purified from human plasma or produced recombinantly (for example, Atryn, which is produced in the milk of genetically modified goats.)

Anti thrombin is approved by the FDA as an anticoagulant for the prevention of clots before, during, or after surgery or birthing in patients with hereditary anti thrombin deficiency.

2 – 6 - Other types of anti coagulants

Many other anti coagulants exist, for use in research and development, diagnostics, or as drug candidates.

Batroxobin, a toxin from a snake venom, clots platelet-rich plasma without affecting platelet functions (lyses fibrinogen).

Hementin is an anticoagulant protease from the salivary glands of the giant Amazon leech, *Haementeria ghilianii*.

3 - Food and herbal supplements

Foods and food supplements with blood-thinning effects include nattokinase , lumbrokinase, beer, bilberry, celery, cranberries, fish oil, garlic, ginger, ginkgo, ginseng, green tea, horse chestnut, licorice, niacin, onion, papaya, pomegranate, red clover, soybean, St. John's wort, turmeric, wheatgrass, and willow bark . Many herbal supplements have blood-thinning properties, such as danshen and feverfew. Multivitamins that do not interact with clotting are available for patients on anti coagulants.

However, some foods and supplements encourage clotting and should be avoided when using anticoagulants. These include alfalfa, avocado, cat's claw, coenzyme Q10, and dark leafy greens such as spinach.

Grapefruit interferes with some anticoagulant drugs, increasing the amount of time it takes for them to be metabolized out of the body, and so should be eaten only with caution when on anticoagulant drugs.

4 - General indications

Therapeutic uses of anticoagulants include atrial fibrillation, pulmonary embolism , deep vein thrombosis , venous thromboembolism, congestive heart failure, stroke, myocardial infarction, and genetic or acquired hypercoagulability.

5 - Laboratory use

Laboratory instruments, blood transfusion bags, and medical and surgical equipment will get clogged up and become nonoperational if blood is allowed to clot. In addition, test tubes used for laboratory blood tests will have chemicals added to stop blood clotting. Apart from heparin, most of these chemicals work by binding calcium ions, preventing the coagulation proteins from using them.

EDTA strongly and irreversibly binds calcium. It is in a powdered form. Full Form of EDTA is Ethylene Di amine Tetra Acetic Acid. It chelates calcium ion to prevent blood from clotting.

Citrate is in liquid form in the tube and is used for coagulation tests, as well as in blood transfusion bags. It binds the calcium, but not as strongly as EDTA. Correct proportion of this anticoagulant to blood is crucial because of the dilution, and it can be reversed with the addition of calcium. It can be in the form of sodium citrate or acid - citrate - dextrose.

Oxalate has a mechanism similar to that of citrate. It is the anticoagulant used in fluoride oxalate tubes used to determine glucose and lactate levels.

Anti - Convulsant

Contents

1 - Introduction

The anti convulsants (also commonly known as anti epileptic drugs) are a diverse group of pharmaceuticals used in the treatment of epileptic seizures. Anti convulsants are also increasingly being used in the treatment of bipolar disorder, since many seem to act as mood stabilizers, and for the treatment of neuropathic pain. The goal of an anticonvulsant is to suppress the rapid and excessive firing of neurons that start a seizure. Failing this, an effective anticonvulsant would prevent the spread of the seizure within the brain and offer protection against possible excitotoxic effects, that may result in brain damage. Some studies have cited that anti convulsants themselves are linked to lowered IQ in children. However these adverse effects must be balanced against the significant risk epileptiform seizures pose to children and the distinct possibility of death and devastating neurological sequela secondary to seizures. Anti convulsants are more accurately called antiepileptic drugs (abbreviated "AEDs"), and are sometimes referred to as anti seizure drugs. While the term 'anticonvulsant' is a fair description of AEDs, the use of this term tends to lead to confusion between epilepsy and non - epileptic convulsions. Convulsive non - epileptic seizures are quite common, and these types of seizures do not respond to antiepileptic drugs. In epilepsy, an area of the cortex is typically hyper-irritable. This condition can often be confirmed by completing a diagnostic EEG. Antiepileptic drugs function to help reduce this area of irritability and thus prevent epileptiform seizures.

Conventional antiepileptic drugs block sodium channels or enhance g-amino butyric acid (GABA) function. Several antiepileptic drugs have multiple or uncertain mechanisms of action.[2] Next to the voltage-gated sodium channels and components of the GABA system, their targets include $GABA_A$ receptors, the GAT-1 GABA transporter, and GABA transaminase . Additional targets include voltage-gated calcium channels, SV2A , and α2δ . By blocking sodium or calcium channels, antiepileptic drugs reduce the release of excitatory glutamate, whose release is considered to be elevated in epilepsy, but also that of GABA . This is probably a side effect or even the actual mechanism of action for some antiepileptic drugs, since GABA can itself, directly or indirectly, act pro convulsively. Another potential target of anti epileptic drugs is the peroxisome proliferator-activated receptor alpha . The drug class was the US's 5th – best - selling in 2007.

Some anti convulsants have shown anti epileptogenic effects in animal models of epilepsy. That is, they either prevent the expected development of epilepsy or can halt or reverse the progression of epilepsy. However, no drug has been shown to prevent epileptogenesis (the development of epilepsy after an injury such as a head injury) in human trials.

2 – Approval

The usual method of achieving approval for a drug is to show it is effective when compared against placebo, or that it is more effective than an existing drug. In monotherapy (where only one drug is taken) it is considered unethical by most to conduct a trial with placebo on a new drug of uncertain efficacy. This is because untreated epilepsy leaves the patient at significant risk of death. Therefore, almost all new epilepsy drugs are initially approved only as adjunctive (add – on) therapies. Patients whose epilepsy is currently uncontrolled by their medication (i.e., it is refractory to treatment) are selected to see if supplementing the medication with the new drug leads to an improvement in seizure control. Any reduction in the frequency of seizures is compared against a placebo . The lack of superiority over existing treatment, combined with lacking placebo-controlled trials, means that few modern drugs have earned FDA approval as initial monotherapy. In contrast, Europe only requires equivalence to existing treatments, and has approved many more. Despite their lack of FDA approval, the American Academy of Neurology and the American Epilepsy Society still recommend a number of these new drugs as initial monotherapy.

3 – Drugs

In the following list, the dates in parentheses are the earliest approved use of the drug.

3 – 1 – Aldehydes

Paraldehyde (1882). One of the earliest anti convulsants. It is still used to treat status epilepticus, particularly where there are no resuscitation facilities.

3 – 2 - Aromatic allylic alcohols

Stiripentol (2001 - limited availability) . Indicated for the treatment of severe myoclonic epilepsy in infancy (SMEI) .

3 – 3 – Barbiturates

Barbiturates are drugs that act as central nervous system (CNS) depressants, and by virtue of this they produce a wide spectrum of effects, from mild sedation to anesthesia. The following are classified as anti convulsants :

Phenobarbital (1912). See also the related drug primidone.

Methyl phenobarbital (1935). Known as mephobarbital in the US. No longer marketed in the UK

Barbexaclone (1982). Only available in some European countries.

Phenobarbital was the main anticonvulsant from 1912 till the development of phenytoin in 1938. Today, phenobarbital is rarely used to treat epilepsy in new patients since there are other effective drugs that are less sedating. Phenobarbital sodium injection can be used to stop acute convulsions or status epilepticus, but a benzodiazepine such as lorazepam, diazepam or midazolam is usually tried first. Other barbiturates only have an anti convulsant effect at anaesthetic doses.

3 – 4 – Benzodiazepines

The benzodiazepines are a class of drugs with hypnotic, anxiolytic, anticonvulsive, amnestic and muscle relaxant properties. Benzodiazepines act as a central nervous system depressant. The relative strength of each of these properties in any given benzodiazepine varies greatly and influences the indications for which it is prescribed. Long-term use can be problematic due to the development of tolerance to the anticonvulsant effects and dependency . Of the many drugs in this class, only a few are used to treat epilepsy:

Clobazam (1979). Notably used on a short-term basis around menstruation in women with catamenial epilepsy.

Clonazepam (1974).

Clorazepate (1972).

The following benzodiazepines are used to treat status epilepticus:

Diazepam (1963). Can be given rectally by trained care-givers.

Midazolam (N/A). Increasingly being used as an alternative to diazepam. This water-soluble drug is squirted into the side of the mouth but not swallowed. It is rapidly absorbed by the buccal mucosa.

Lorazepam (1972). Given by injection in hospital.

Nitrazepam, temazepam, and especially nimetazepam are powerful anticonvulsant agents, however their use is rare due to an increased incidence of side effects and strong sedative and motor-impairing properties.

3 – 5 – Bromides

Potassium bromide (1857). The earliest effective treatment for epilepsy. There would not be a better drug until phenobarbital in 1912. It is still used as an anticonvulsant for dogs and cats.

3 – 6 – Carbamates

Felbamate (1993). This effective anticonvulsant has had its usage severely restricted due to rare but life - threatening side effects.

3 – 7 – Carboxamides

The following are carboxamides:

Carbamazepine (1963). A popular anticonvulsant that is available in generic formulations.

Oxcarbazepine (1990). A derivative of carbamazepine that has similar efficacy but is better tolerated and is also available generically.

Eslicarbazepine acetate (2009)

3 – 8 - Fatty acids

The following are fatty - acids :

The valproates — valproic acid, sodium valproate, and divalproex sodium (1967).
Vigabatrin (1989).
Progabide
Tiagabine (1996).
Vigabatrin and progabide are also analogs of GABA.

3 – 9 - Fructose derivatives
Topiramate (1995).

3 – 10 - GABA analogs
Gabapentin (1993).
Pregabalin (2004).

3 – 11 - Hydantoins
The following are hydantoins:
Ethotoin (1957).
Phenytoin (1938).
Mephenytoin
Fosphenytoin (1996).

3 – 12 - Oxazolidinediones
The following are oxazolidinediones :
Paramethadione
Trimethadione (1946).
Ethadione

3 – 13 – Propionates
Beclamide

3 – 14 – Pyrimidinediones
Primidone (1952).

3 – 15 - Pyrrolidines
Brivaracetam
Levetiracetam (1999).
Seletracetam

3 – 16 – Succinimides
The following are succinimides :
Ethosuximide (1955).
Phensuximide
Mesuximide

3 – 17 – Sulfonamides
Acetazolamide (1953).
Sultiame
Methazolamide
Zonisamide (2000).

3 – 18 – Triazines
Lamotrigine (1990).

3 – 19 – Ureas
Pheneturide
Phenacemide

3 – 20 - Valproylamides (amide derivatives of valproate
Valpromide
Valnoctamide

4 – Non - medical anti convulsants

Some times, ketogenic diet or vagus nerve stimulation are described as "anticonvulsant" therapies as well.

5 - Treatment guidelines

According to guidelines by the AAN and AES,[25] mainly based on a major article review in 2004,[26] patients with newly diagnosed epilepsy who require treatment can be initiated on standard anti convulsants such as carbamazepine, phenytoin, valproic acid / valproate semi sodium, phenobarbital, or on the newer anti convulsants gabapentin, lamotrigine, oxcarbazepine or topiramate. The choice of anti convulsants depends on individual patient characteristics . Both newer and older drugs are generally equally effective in new onset epilepsy . The newer drugs tend to have fewer side effects . For newly diagnosed partial or mixed seizures, there is evidence for using gabapentin, lamotrigine, oxcarbazepine or topiramate as monotherapy.[25] Lamotrigine can be included in the options for children with newly diagnosed absence seizures.[25]

6 – History

The first anticonvulsant was bromide, suggested in 1857 by Charles Locock who used it to treat women with "hysterical epilepsy" (probably *catamenial epilepsy*). Bromides are effective against epilepsy, and also cause impotence, which is not related to its anti-epileptic effects. Bromide also suffered from the way it affected behaviour, introducing the idea of the 'epileptic personality' which was actually a result of medication. Phenobarbital was first used in 1912 for both its sedative and antiepileptic properties. By the 1930s, the development of animal models in epilepsy research led to the development of phenytoin by Tracy Putnam and H. Houston Merritt, which had the distinct advantage of treating epileptic seizures with less sedation. By the 1970s, an National Institutes of Health initiative, the Anticonvulsant Screening Program, headed by J. Kiffin Penry, served as a mechanism for drawing the interest and abilities of pharmaceutical companies in the development of new anticonvulsant medications.

6 – 1 - Marketing approval history

The following table lists anticonvulsant drugs together with the date their marketing was approved in the US, UK and France. Data for the UK and France are incomplete. In recent years, the European Medicines Agency has approved drugs throughout the European Union. Some of the drugs are no longer marketed.

Drug	Brand	US	UK	France
acetazolamide	Diamox	1953	1988	
carbamazepine	Tegretol	1974	1965	1963
clobazam	Frisium		1979	
clonazepam	Klonopin / Rivotril	1975	1974	
diazepam	Valium	1963		

divalproex sodium	Depakote	1983		
eslicarbazepine				
ethosuximide	Zarontin	1960	1955	1962
ethotoin	Peganone	1957		
felbamate	Felbatol	1993		
fosphenytoin	Cerebyx	1996		
gabapentin	Neurontin	1993	1993	1994
lamotrigine	Lamictal	1994	1991	1995
lacosamide	Vimpat	2008		
levetiracetam	Keppra	1999	2000	2000
mephenytoin	Mesantoin	1946		
metharbital	Gemonil	1952		
methsuximide	Celontin	1957		
methazolamide	Neptazane	1959		
oxcarbazepine	Trileptal	2000	2000	
phenobarbital			1912	1920
phenytoin	Dilantin / Epanutin	1938	1938	1941
phensuximide	Milontin	1953		
pregabalin	Lyrica	2004	2004	2004
primidone	Mysoline	1954	1952	1953
sodium valproate	Epilim		1977	1967
stiripentol	Diacomit		2001	2001
tiagabine	Gabitril	1997	1998	1997
topiramate	Topamax	1996	1995	
trimethadione	Tridione	1946		
valproic acid	Depakene / Convulex	1978	1993	
vigabatrin	Sabril	2009	1989	
zonisamide	Zonegran	2000	2005	2005

7 - Use in pregnancy

During pregnancy, the metabolism of several anti convulsants is affected. There may be an increase in the clearance and resultant decrease in the blood concentration of lamotrigine, phenytoin, and to a lesser extent carbamazepine, and possibly decreases the level of levetiracetam and the active oxcarbazepine metabolite, the monohydroxy derivative. Therefore, these drugs should be monitored during use in pregnancy. Taking valproic acid or divalproex sodium during pregnancy should be cautioned against, as this class of medications has been linked to birth defects (teratogenic).

There is inadequate evidence to determine if newborns of women with epilepsy taking anti convulsants have a substantially increased risk of hemorrhagic disease of the newborn.

Regarding breastfeeding, some anti convulsants probably pass into breast milk in clinically significant amounts, including primidone and levetiracetam . On the other hand, valproate, phenobarbital, phenytoin, and carbamazepine probably are not transferred into breast milk in clinically important amounts.

In animal models, several anticonvulsant drugs have been demonstrated to induce neuronal apoptosis in the developing brain.

Anti - Depressant

Contents

1 - Introduction

Antidepressants are drugs used for the treatment of major depressive disorder and other conditions, including dysthymia, anxiety disorders, obsessive compulsive disorder, eating disorders, chronic pain, neuropathic pain and, in some cases, dysmenorrhoea, snoring, migraines, attention - deficit hyperactivity disorder (ADHD), substance abuse and sleep disorders. They can be used alone or in combination with other medications.

The most important classes of antidepressants are the selective serotonin reuptake inhibitors (SSRIs), serotonin – norepinephrine reuptake inhibitors (SNRIs), tricyclic antidepressants (TCAs) and monoamine oxidase inhibitors (MAOIs). Other drugs used or proposed for the treatment of depression include buprenorphine,[1] tryptophan, low - dose antipsychotics , and St John's wort.[4]

2 - Efficacy

To establish efficacy, an antidepressant must show that it can produce a therapeutic effect for the condition for which it is taken. An antidepressant should be more efficacious than placebo to justify the risk associated with side effects. For depression, the Hamilton Depression Rating Scale (HAM-D) is often used to measure the severity of depression . The maximum score for the 17 - item HAM-D questionnaire is 52; the higher the score, the more severe the depression. What constitute a sufficient response to a drug has not been well established, but total remission or virtual elimination of all depression symptoms is the goal, however, remission rates are rarely published. For placebo, the percentage of symptom reduction is approximately 31 to 38 %, compared to 46 to 54% for antidepressants.

On the basis of 234 studies, no clinically relevant superiority of one antidepressant over another was detected for the treatment of acute, continuation, and maintenance phases of depression, taking into account age, sex, ethnicity, or comorbid conditions. Individual drugs differed in onset of action, adverse events, and some measures of health-related quality of life.

The largest and most expensive study conducted to date, on the effectiveness of pharmacological treatment for depression, was commissioned by the National Institute of Mental Health . The study was dubbed "The Sequenced Treatment Alternatives to Relieve Depression" (STAR*D) Study. The results are summarized here.

After the first course of treatment, 27.5 % of the 2,876 participants reached remission with a HAM-D score of 7 or less. 21 % dropped out.

After the second course of treatment, 21 to 30 % of the remaining 1,439 participants remitted. Only 310 participants were willing or available to continue the study. Switching medications can achieve remission in about 25 % of patients.

After the third course of treatment, 17.8 % of the remaining 310 participants remitted.

After the fourth and last course of treatment, 10.1 % of the remaining 109 participants remitted.

After a one year follow - up, of the 1085 remitted participants, 93 % participants had either relapsed or dropped out of the study.

There were no statistical or meaningful clinical differences in remission rates, response rates, or times to remission or response among any of the medications compared in this study. These included bupropion sustained release , bupropion, citalopram , lithium, mirtazapine , nortriptyline , sertraline , tri iodo thyronine , tranylcy promine , and venlafaxine extended release.

A 2008 review of randomized controlled trials concluded that symptomatic improvement with SSRIs was greatest by the end of the first week of use, but that some improvement continued for at least 6 weeks.

A 2002 review concluded that there was no evidence that antidepressants reduce the risk of recurrence of depression when their use is terminated. The authors of this review advocated that antidepressants be combined with therapy, and pointed to interpersonal psychotherapy (IPT) and cognitive behavioral therapy (CBT).

2 – 1 - Clinical guidelines

The UK National Institute for Clinical Excellence (NICE) 2004 guidelines indicate that antidepressants should not be used for the initial treatment of mild depression, because the risk - benefit ratio is poor; that for moderate or severe depression an SSRI is more likely to be tolerated than a tricyclic ; and that antidepressants for severe depression should be combined with a psychological treatment such as Cognitive Behavioral Therapy.

The American Psychiatric Association 2000 Practice Guideline for the Treatment of Patients with major depressive disorder indicates that, if preferred by the patient, antidepressant medications may be provided as an initial primary treatment for mild major depressive disorder; antidepressant medications should be provided for moderate to severe major depressive disorder unless electroconvulsive therapy is planned; and a combination of antipsychotic and antidepressant medications or electroconvulsive therapy should be used for psychotic depression. It states that efficacy is generally comparable between classes and within classes and that the initial selection will largely be based on the anticipated side - effects for an individual patient, patient preference, quantity and quality of clinical trial data regarding the medication, and its cost.

2 – 2 - Limitations and strategies

Between 30 % and 50 % of individuals treated with a given antidepressant do not show a response . In clinical studies, approximately one - third of patients achieve a full remission, one - third experience a response and one - third are non responders. Partial remission is characterized by the presence of poorly defined residual symptoms. These symptoms typically include depressed mood, psychic anxiety, sleep disturbance, fatigue and diminished interest or pleasure. It is currently unclear which factors predict partial remission. However, it is clear that residual symptoms are powerful predictors of relapse, with relapse rates 3 – 6 times higher in patients with residual symptoms than in those who experience full remission. In addition , antidepressant drugs tend to lose efficacy over the course of treatment . A number of strategies are used in clinical practice to try to overcome these limits and variations . They include switching medication , augmentation, and combination.

2 - 2 – 1 - "Trial and error" switching

The American Psychiatric Association 2000 Practice Guideline advises that where no response is achieved following six to eight weeks of treatment with an antidepressant, to switch to an antidepressant in the same class, then to a different class of antidepressant. The remission rate reported by the STAR*D study was 21 % using this method .

A 2006 meta - analysis review found wide variation in the findings of prior studies; for patients who had failed to respond to an SSRI antidepressant, between 12 % and 86 % showed a response to a new drug. However, the more antidepressants an individual had already tried, the less likely they were to benefit from a new antidepressant trial , However, a later meta-analysis found no difference between switching to a new drug and staying on the old medication; although 34 % of treatment resistant patients responded when switched to the new drug, 40 % responded without being switched . Thus, the clinical response to the new drug might be a placebo effect associated with the belief that one is receiving a different medication .

2 - 2 – 2 - Augmentation and combination

For a partial response, the American Psychiatric Association guidelines suggest augmentation, or adding a drug from a different class. These include: lithium and thyroid augmentation, dopamine agonists, sex steroids, NRIs, glucocorticoid - specific agents, or the newer anti convulzants.

A combination strategy involves adding an additional antidepressant, usually from a different class so as to have effect on other mechanisms. Although this may be used in clinical practice, there is little evidence for the relative efficacy or adverse effects of this strategy.

Opponents of switching, augmentation and combination argue that treatment may also propel the illness to a malignant and treatment-unresponsive course with iatrogenic psychiatric-like symptoms and treatment resistance or episode acceleration.[26]

2 - 2 – 3 - Long - term use

The therapeutic effects of antidepressants typically do not continue once the course of medication ends, resulting in a high rate of relapse. A recent meta - analysis of 31 placebo-controlled antidepressant trials, mostly limited to studies covering a period of one year, found that 18 % of patients who had responded to an antidepressant relapsed while still taking it, compared to 41% whose antidepressant was switched for a placebo .

In a five-year follow up, relapse rates was 23 % greater for users greater than one year, but not different for 6 or 12 months users.[28] In addition, gradual loss of therapeutic benefit occurs during the course of treatment . A strategy involving the use of pharmacotherapy in the treatment of the acute episode, followed by psychotherapy in its residual phase, has been suggested by some studies .

2 - 2 – 4 - Antidepressant - induced mania

Another possible problem with antidepressants is the chance of antidepressant - induced mania in patients with bipolar disorder. Many cases of bipolar depression are very similar to those of unipolar depression. Therefore, the patient can be misdiagnosed with unipolar depression and be given antidepressants. Studies have shown that antidepressant - induced mania can occur in 20 – 40 % of bipolar patients.

2 - 3 – Mild depression

Various researchers have contested the ability of antidepressants to relieve depression, skeptical that the drugs aid patients significantly more than placebo.

A review of antidepressant trials submitted to the FDA by the industry for drug approval revealed that when a trial was successful, the results of the trial was published 94% of the time, however, when the trial was not found to be more effective than placebo, it was only published 50 % of the time. This demonstrated a measure of bias in reporting by industry. Combined, 51% of all studies showed efficacy. The difference in effect between active placebos and several antidepressants appeared small and strongly affected by publication bias.

Controversy regarding the efficacy of antidepressants has arisen due to studies showing that antidepressants fail to provide significantly greater efficacy than placebo in some studies. A 2002 study claimed that the difference between antidepressants and placebo is close to negligible.

A meta - analysis done by two psychologists led them to believe that although the drugs did help people, the difference between the pills and placebo was not meaningful for patients; a later publication by the same author concluded newer-generation medicines were below the criteria of clinical significance.

A study published in the *Journal of the American Medical Association* (*JAMA*) demonstrated that the magnitude of the placebo effect in clinical trials of depression have been growing over time, while the effect size of tested drugs has remained relatively constant. The authors suggest that one possible explanation for the growing placebo effect in clinical trials is the inclusion of larger number of participants with shorter term, mild, or spontaneously remitting depression as a result of decreasing stigma associated with antidepressant use . Another study focusing on paroxetine (Paxil) and imipramine found that antidepressant drugs were hardly better than placebo in cases of mild or moderate depression they surveyed.

The Cochrane Collaboration recently performed a systematic review of clinical trials of the generic antidepressant amitriptyline. The study concluded that in spite of moderate evidence for publication bias, there is strong evidence that the efficacy of amitriptyline is superior to placebo.

A review commissioned by the National Institute for Clinical Excellence concluded that there is strong evidence that SSRIs have greater efficacy than placebo on achieving a 50% reduction in depression scores in moderate and severe major depression, and that there is some evidence for a similar effect in mild depression. The treatment guidelines developed in conjunction with this review suggest that antidepressants should be considered in patients with moderate to severe depression and those with mild depression that is persistent or resistant to other treatment modalities.

In 2005, antidepressants became the most prescribed drug in the United States, causing more debate over the issue. Some doctors believe this is a positive sign that people are finally seeking help for their issues. Others disagree, saying that this shows that people are becoming too dependent on antidepressants.[41]

In 2012, Aimee Hunter and her team used electro encephalo graphy (EEG) and showed that taking placebo decreased pre - frontal brain activity in those subjects who had prior use of an antidepressants, similar to the expected antidepressant response, but increased brain activity in antidepressant - naive subjects. She attributes this antidepressant response of placebo, in repeat users, to a memory effect.

However, the later experiment conducted by John H. Krystal at Yale University School of Medicine to assess whether growth mixture modeling can provide insights into antidepressant and placebo responses in clinical trials of patients with major depression showed that Duloxetine and SSRI did not differ in efficacy, and compared with placebo they significantly decreased the odds of following the nonresponder trajectory. Antidepressant responders had significantly better Hamilton Depression Rating Scale (HAM-D) scores over time than placebo-treated patients, but antidepressant nonresponders had significantly worse HAM-D scores over time than the placebo-treated patients.

2 - 4 - Comparative efficacy and tolerability

Comparative efficacy and tolerability table

Drug	Relative efficacy	Tolerability	Danger in overdose	Weight gain	Ortho hypot	Inactivating effects	Activating effects	Anti-ACh	QTc i. p.	GI toxicity	SD
Tricyclic antidepressants (TCAs)											
Drug	Relative efficacy	Tolerability	Danger in overdose	Weight gain	Ortho hypot	Inactivating effects	Activating effects	Anti-ACh	QTc i. p.	GI toxicity	SD
Amitriptyline	3	1	3	4	3	4	v	4	3	1	4/3
Amoxapine	2	2	4	2	2	2	2	2	2	v	ND
Clomipramine	3	2/1	2	2	2	4/3	v	4	2	1	4
Desipramine	2	2/1	3	1	1	1/v	1	1	2	1/v	ND
Dosulepin (Dothiepin)	2	1	4	?	3/2	3/2	v	3/2	2	v	3/2
Doxepin	2	2/1	3	3	4	3	v	3	3	v	3
Imipramine	3	1	3	4	4/3	3	1	3	3	1	3
Lofepramine	2	3	1	1	1	1	1	2	1	?	?
Maprotiline	2	2/1	4	2	2	3	v	2	3	v	ND
Nortriptyline	2	2	2	1	2	1	v	1	2	v	ND
Protriptyline	2	2/1	2	1	2	1	1	2	3	1	4/3
Tianeptine	2	4	?	?	?	?	?	?	?	?	?
Trimipramine	2	1	2	4	3	4	1	4	2	2	v
Monoamine oxidase inhibitors (MAOIs)											
Drug	Relative efficacy	Tolerability	Danger in overdose	Weight gain	Ortho hypot	Inactivating effects	Activating effects	Anti-ACh	QTc i. p.	GI toxicity	SD
Isocarboxazid	2	1	3	1	2	1	2	1	v	1	4
Moclobemide	2	3	1	v	v	v	?	v	v	v	1/v
Phenelzine	2	1	3	2	3	1	1	1	v	1	4
Seligiline	?	3	2	v	1	v	1	1	v	v	v
Tranylcypromine	2	1	3	1	2	v	2	1	v	1	4
Selective serotonin reuptake inhibitors (SSRIs)											
Drug	Relative efficacy	Tolerability	Danger in overdose	Weight gain	Ortho hypot	Inactivating effects	Activating effects	Anti-ACh	QTc i. p.	GI toxicity	SD
Citalopram	2	3	2	1	1	v	1	v	2	1	3
Escitalopram	3	3	1	1	1	v	1	v	1	1	3
Fluoxetine	2	3	1	1	1	v	2	v	1	1	3
Fluvoxamine	2	3	2	1	1	1	1	v	1/v	2	3
Paroxetine	2	3	1	2	2	1	1	1	1/v	1	4
Sertraline	3	3	1	1	1	v	2	v	1/v	2	3

Serotonin-norepinephrine reuptake inhibitors (SNRIs)

Drug	Relative efficacy	Tolerability	Danger in overdose	Weight gain	Ortho hypot	Inactivating effects	Activating effects	Anti-ACh	QTc i. p.	GI toxicity	SD
Desvenlafaxine	2	3/2	1/2	v	v	v	2	v	v	2/1	3
Duloxetine	2	3	1	v	v	v	2	v	v	2	3
Milnacipran	2	3	?	v	v	v	2	1	v	2	v
Venlafaxine	3	2	2	v	v	v	2	v	1	2 (IR) 1 (XR)	3

Noradrenergic and specific serotonergic antidepressants (NaSSAs)

Drug	Relative efficacy	Tolerability	Danger in overdose	Weight gain	Ortho hypot	Inactivating effects	Activating effects	Anti-ACh	QTc i. p.	GI toxicity	SD
Mianserin	2	3	?	4	v	4	v	1	1	v	1
Mirtazapine	3	3	1	4	v	4	v	1	1	v	1

Serotonin antagonist and reuptake inhibitors (SARIs)

Drug	Relative efficacy	Tolerability	Danger in overdose	Weight gain	Ortho hypot	Inactivating effects	Activating effects	Anti-ACh	QTc i. p.	GI toxicity	SD
Nefazodone	2	3	2/1	v	1	2	v	1	v	2	v
Trazodone	2 [51]	3	1	1	3	4	v	v	2	3	1

Serotonin modulator and stimulators (SMSs)

Drug	Relative efficacy	Tolerability	Danger in overdose	Weight gain	Ortho hypot	Inactivating effects	Activating effects	Anti-ACh	QTc i. p.	GI toxicity	SD
Vilazodone	2	3/2	?	v	v	v	2	v	v	4	2
Vortioxetine	2	3	?	v	v	v	1/v	v	v	3	1

Other

Drug	Relative efficacy	Tolerability	Danger in overdose	Weight gain	Ortho hypot	Inactivating effects	Activating effects	Anti-ACh	QTc i. p.	GI toxicity	SD
Agomelatine	2	3	1	v	v	1	1	v	v	1	1/v
Bupropion	2	3	3/2	v	v	v	2/1	v	1	1	v
Reboxetine	1	3	1	v	v	v	2	v	v	1	1

3 - Adverse effects

Difficulty tolerating adverse effects is the most common reason for antidepressant discontinuation.[*medical citation needed*]

3 – 1 – General

For bipolar depression, antidepressants (most frequently SSRIs) can exacerbate or trigger symptoms of hypomania and mania.

Almost any medication involved with serotonin regulation has the potential to cause serotonin toxicity (also known as *serotonin syndrome*) – an excess of serotonin that can induce mania, restlessness, agitation, emotional lability, insomnia and confusion as its primary symptoms.[63][64] Although the condition is serious, it is not particularly common, generally only appearing at high doses or while on other medications. Assuming proper medical intervention has been taken (within about 24 hours) it is rarely fatal.

MAOIs tend to have pronounced (some times fatal) interactions with a wide variety of medications and over - the - counter drugs. If taken with foods that contain very high levels of tyramine (e.g., mature cheese, cured meats, or yeast extracts), they may cause a potentially lethal hypertensive crisis. At lower doses the person may be bothered by only a headache due to an increase in blood pressure.

In response to these adverse effects, a different type of MAOI has been developed: the reversible inhibitor of monoamine oxidase A (RIMA) class of drugs. Their primary advantage is that they do not require the person to follow a special diet, while being purportedly effective as SSRIs and tri cyclics in treating depressive disorders.

3 – 2 – Pregnancy

Pregnancy can trigger a range of emotions that make it more difficult to cope with depression. The risk of medication discontinuation and relapse have to be weighed against the risk to the developing fetus and baby. Some antidepressants have lower risk for the baby during pregnancy, but the FDA advises for the risk of birth defects with the use of Paxil and the MAOI should be avoided. A neonate (infant less than 28 days old) may experience a withdrawal syndrome from abrupt discontinuation of the antidepressant at birth. The use of antidepressants during pregnancy is associated with an increased risk of spontaneous abortion , birth defects , and developmental delays . Antidepressants have been shown to be present in varying amounts in breast milk, but their effects on infants are currently unknown.

Moreover, SSRIs inhibit nitric oxide synthesis, which leads to vasoconstriction. This is significant in pregnancy as SSRIs have been associated with the development of hypertension (high blood pressure) and pre - eclampsia of pregnancy. This in turn can lead to fetal prematurity.

3 – 3 – Suicide

The relationship between antidepressant use and suicide risk is uncertain, complicated, and the target of medical research. Some studies have shown that the use of some antidepressants correlate with an increased risk of suicide in some patients and especially youth. This problem has been serious enough to warrant government interventions in some places to label greater likelihood of suicide as a risk of using antidepressants . The circumstances under which this can happen are not clear, and other studies show that antidepressants treat suicidal ideation.

3 – 4 – Sexual

Sexual side - effects are also common with SSRIs, such as loss of sexual drive , failure to reach orgasm, and erectile dysfunction. Although usually reversible, these sexual side - effects can, in rare cases, last for months or years after the drug has been completely with drawn. This is referred to as Post SSRI Sexual Dysfunction .

In a study of 1022 outpatients, overall sexual dysfunction with all antidepressants averaged 59.1 % with SSRIs values between 57 and 73%, mirtazapine 24 % , nefazodone 8 %, amineptine 7 % and moclobemide 4 % . Moclobemide, a selective reversible MAO - A inhibitor, does not cause sexual dysfunction , and can actually lead to an improvement in all aspects of sexual function.

Biochemical mechanisms suggested as causative include increased serotonin, particularly affecting 5 - HT_2 and 5-HT_3 receptors; decreased dopamine; decreased norepinephrine; blockade of cholinergic and $\alpha_1$adrenergic receptors; inhibition of nitric oxide synthetase; and elevation of prolactin levels. Mirtazapine is reported to have fewer sexual side - effects, most likely because it antagonizes 5-HT_2 and 5-HT_3 receptors and may, in some cases, reverse sexual dysfunction induced by SSRIs by the same mechanism.

Bupropion, a weak NDRI and nicotinic antagonist, may be useful in treating reduced libido as a result of SSRI treatment. However, these results are preliminary, and as such must be taken *cum grano salis*.

3 – 5 – REM Sleep

All major antidepressant drugs – except trimipramine, bupropion,[85] mirtazapine, and nefazodone – suppress REM sleep, and it has been proposed that the clinical efficacy of these drugs largely derives from their suppressant effects on REM sleep. The three major classes of antidepressant drugs (MAOIs, TCAs, and SSRIs), profoundly suppress REM sleep . Mirtazapine either has no effect on REM sleep or increases it slightly . The MAOIs almost completely suppress REM sleep, while the TCAs and SSRIs have been shown to produce immediate (40 - 85 %) and sustained (30-50%) reductions in REM sleep. This effect often causes increased fatigue in patients who take large doses of antidepressants for extended periods of time. Such fatigue can occasionally interfere with a patient's everyday activities. Abrupt discontinuation of MAOIs can cause a temporary phenomenon known as "REM rebound" in which the patient experiences extremely vivid dreams and nightmares.

3 – 6 – Changes in weight

Changes in appetite or weight are common among antidepressants, but largely drug - dependent and are related to which neurotransmitters they affect. Mirtazapine and paroxetine, for example, have the effect of weight gain and/or increased appetite, while others (such as bupropion and venlafaxine) achieve the opposite effect.

The antihistaminic properties of certain TCA- and TeCA-class antidepressants have been shown to contribute to the common side-effects of increased appetite and weight gain associated with these classes of medication.

3 – 7 – Withdrawal symptoms

If an SSRI is suddenly discontinued, it frequently produces an event of "SSRI discontinuation syndrome" that has a both a bodily and psychological withdrawal component.

Withdrawal syndromes have been reported with TCAs, MOAIs , SNRIs , and with SSRIs. Researchers from the Nordic Cochrane Center in Denmark compared the signs and symptoms of SSRI discontinuation to those of the benzodiazepine withdrawal syndrome and concluded that the withdrawal reactions were so similar that both withdrawal reactions indicated a dependence syndrome. Elsewhere, concerns have been raised that SSRIs cause dependence.

When treatment is prolonged over 6 – 9 months, processes oppose the initial effects of antidepressant drugs (loss of clinical effects) . When drug treatment ends, these processes may be unopposed and yield withdrawal symptoms and increased vulnerability to relapse. Such processes are not necessarily reversible. The more antidepressants are switched or potentiated, the more likely oppositional tolerance can take place.

Some of the withdrawal symptoms of SSRI discontinuation include: nausea, chills, muscles aches, dizziness, anxiety, irritability, insomnia, fatigue , and, in some patients, electric shock sensations.

Moreover, when changes in antidepressant dosage occur, whether up or down, a doubling of the risk of suicide is seen.

To minimize the intensity of withdrawal and rebound effects[104] antidepressants should be discontinued over a period of several weeks or months depending on a person's response to reductions. A suggested regimen is a decrease in the SSRI by about 25 % per week. This is a guideline; the actual amount of time required to withdraw from a given antidepressant is unique to the drug. Certain antidepressants may have long half - lives and remain in the person's system for a period of time long enough to prevent a sudden "drop" in concentration, meaning that withdrawal or rebound effects are unlikely or less pronounced.

Most cases of discontinuation syndrome last between one and four weeks but a substantial minority, perhaps up to 15 % of users, have persistent withdrawal symptoms evident one year post-withdrawal. Paroxetine and venlafaxine seem to be particular difficult to discontinue and prolonged withdrawal syndrome lasting over 18 months have been reported with paroxetine. Peer - support groups exist to help patients taper off of their antidepressants.

4 – Pharmacology

The earliest and probably most widely accepted scientific theory of antidepressant action is the monoamine hypothesis (which can be traced back to the 1950s), which states that depression is due to an imbalance (most often a deficiency) of the mono amine neuro transmitters (namely serotonin, norepinephrine and dopamine). It was originally proposed based on the observation that certain hydrazine anti - tuberculosis agents produce antidepressant effects, which was later linked to their inhibitory effects on monoamine oxidase, the enzyme that catalyzes the breakdown of the monoamine neurotransmitters. All currently marketed antidepressants have the monoamine hypothesis as their theoretical basis, with the possible exception of agomelatine which acts on a dual melatonergic-serotonergic pathway . Despite the success of the monoamine hypothesis it has a number of limitations: for one, all mono aminergic antidepressants have a delayed onset of action of at least a week; and secondly, there are a sizeable portion (> 40 %) of depressed patients that do not adequately respond to mono aminergic antidepressants. Further evidence to the contrary of the monoamine hypothesis are the recent findings that a single intravenous infusion with ketamine, an antagonist of the NMDA receptor — a type of glutamate receptor — produces rapid (within 2 hours), robust and sustained (lasting for up to a fortnight) antidepressant effects . To overcome these flaws with the monoamine hypothesis a number of alternative hypotheses have been proposed, including the glutamate, neurogenic, epigenetic, cortisol hyper secretion and inflammatory hypotheses.

5 – Types

6 – Adjuncts

Adjunct medications are an umbrella term used to describe substances that increase the potency or "enhance" antidepressants.[116] They work by affecting variables very close to the antidepressant, sometimes affecting a completely different mechanism of action. This is may be attempted when depression treatments have not been successful in the past.

Types of adjunct medication techniques generally fall into the following categories :

Two or more antidepressants taken together

From the same class (affecting the same area of the brain, often at a much higher level)

From different classes (affecting multiple parts of the brain not covered simultaneously by either drug alone)

A stimulant with an antidepressant (e.g., amphetamine and fluoxetine)

An antipsychotic, particularly atypical antipsychotics, for reasons not clearly understood

A review article published in 2007 found psychostimulants may be effective in treatment - resistant depression with concomitant antidepressant therapy. A more certain conclusion could not be drawn due to substantial deficiencies in the studies available for consideration, and the somewhat contradictory nature of their results.

Chronic nicotine intake via nicotine patches results in an increased response to standard antidepressants. Similarly varenicline has been shown to augment sub - therapeutic doses of SSRIs to produce an antidepressant effect.

Atypical antipsychotics such as aripiprazole (Abilify), quetiapine (Seroquel), olanzapine, and risperidone are also popular adjuncts and appear to be an effective adjunctive treatment option in this indication. Lithium may also be used as an adjunct in major depressive disorder. Triiodothyronine (T_3) has also been successfully used as an adjunct in major depressive disorder.

6 – 1 – Nicotine

Nicotine is believed to act as an antidepressant , by stimulating the release of dopamine and norepinephrine; in addition, nicotine is believed to exert an antidepressant effect due to the desensitization of nicotinic receptors, which occurs as a result of tolerance. Clinical trials have demonstrated nicotine (administered using a dermal nicotine patch) exerts an antidepressant effect in both depressed nonsmokers and smokers, and can be considered for treatment-resistant depression. The proposed mechanism of chronic nicotine use causing desensitization of nicotinic receptors – thereby leading to an antidepressant effect – is consistent with the theory first proposed over 30 years ago and subsequent research that confirmed excessive acetylcholine activity in the brain leads to depressive symptoms. Varenicline, a nicotinic receptor - acting drug used to wean people off of nicotine dependence, has also demonstrated antidepressant properties.

6 – 2 – Caffeine

Individuals using caffeine at moderate doses (fewer than 6 cups of coffee per day), have a reduced incidence of depressive symptoms and an overall reduced risk of suicide. Anxiety is an important side-effect of caffeine that occurs more commonly in individuals suffering from panic disorder or social phobia or when taken in excessive amounts.

6 – 3 – Ketamine

Early studies have shown that ketamine may be effective in treatment - resistant depression, though experts have stated that it is not yet ready for clinical practice but rather may lead to the development of novel medications in the future . It produces a rapid antidepressant effect, acting within two hours as opposed to the several weeks taken by typical antidepressants to work.

Some research has attributed the effect to ketamine being an NMDA receptor antagonist , though others have suggested that blocking the NMDA receptor is an intermediate step that increases the activity of another receptor, AMPA, which is what is responsible for ketamine's rapid antidepressant actions.

6 – 4 – Nutrition

Omega - 3 fatty acids have been proposed as a treatment for depression, alone or in combination with other treatments. One small pilot study of childhood depression (ages 6 – 12) suggested omega 3 fatty acids may have therapeutic benefits for treating childhood depression . A 2005 review article that included double - blind studies, randomized control trials, and epidemiological studies linking omega - 3 fatty acids consumption and depression found that low fish consumption (the primary source of omega - 3 fatty acids) correlated to increased rates of depression. Additionally, case - control and cohort studies of unipolar and postpartum depression indicated low blood levels of omega-3 fatty acids in depressed patients.

A 2008 review of clinical studies of the effectiveness of omega-3 fatty acids on depression has shown somewhat inconsistent results: "Of the evaluated studies, 13 showed a significant positive association between omega - 3 and depression, while six studies did not show a relationship between the referred variables " · To be read with caution because of limited data, a 2008 Cochrane systematic review found in the one eligible study that omega-3 fatty acids are an effective adjunctive therapy for depressed but not manic symptoms in bipolar disorder. The authors found an "acute need" for more randomized, controlled trials.

7 – History

Before the 1950s, opioids, amphetamine, and methamphetamine were commonly used as antidepressants. Their use was later restricted due to their addictive nature and side effects. Extracts from the herb St John's wort had been used as a "nerve tonic" to alleviate depression.

St John's wort

7 – 1 - Isoniazid , iproniazid , and imipramine

In 1951, Irving Selikoff and Edward Robitzek, working out of Sea View Hospital on Staten Island, began clinical trials on two new anti-tuberculosis agents developed by Hoffman - LaRoche, isoniazid and iproniazid. Only patients with a poor prognosis were initially treated; nevertheless, their condition improved dramatically. Selikoff and Robitzek noted "a subtle general stimulation ... the patients exhibited renewed vigor and indeed this occasionally served to introduce disciplinary problems " . The promise of a cure for tuberculosis in the Sea View Hospital trials was excitedly discussed in the mainstream press.

In 1952, learning of the stimulating side effects of isoniazid, the Cincinnati psychiatrist Max Lurie tried it on his patients. In the following year, he and Harry Salzer reported that isoniazid improved depression in two thirds of their patients and coined the term *antidepressant* to describe its action . A similar incident took place in Paris, where Jean Delay, head of psychiatry at Sainte - Anne Hospital, heard of this effect from his pulmonology colleagues at Cochin Hospital. In 1952 (before Lurie and Salzer) , Delay, with the resident Jean-Francois Buisson, reported the positive effect of isoniazid on depressed patients . For reasons unrelated to its efficacy, isoniazid as an antidepressant was soon over shadowed by the more toxic iproniazid , although it remains a mainstay of tuberculosis treatment. The mode of antidepressant action of isoniazid is still unclear. It is speculated that its effect is due to the inhibition of diamine oxidase, coupled with a weak inhibition of monoamine oxidase A.

Selikoff and Robitzek also experimented with another anti-tuberculosis drug, iproniazid; it showed a greater psychostimulant effect, but more pronounced toxicity . Later, Jackson Smith, Gordon Kamman, George Crane, and Frank Ayd , described the psychiatric applications of iproniazid. Ernst Zeller found iproniazid to be a potent monoamine oxidase inhibitor. Nevertheless, iproniazid remained relatively obscure until Nathan Kline, the influential and flamboyant head of research at Rockland State Hospital, began to popularize it in the medical and popular press as a "psychic energizer". Roche put a significant marketing effort behind iproniazid, including promoting its off-label use for depression. Its sales grew until it was recalled in 1961, due to reports of lethal hepatotoxicity.

The antidepressant effect of a tricyclic, a three ringed compound, was first discovered in 1957 by Roland Kuhn in a Swiss psychiatric hospital. Antihistamine derivatives were used to treat surgical shock and later as neuroleptics. Although in 1955 reserpine was shown to be more effective than placebo in alleviating anxious depression, neuroleptics were being developed as sedatives and antipsychotics.

Attempting to improve the effectiveness of chlorpromazine, Kuhn – in conjunction with the Geigy Pharmaceutical Company – discovered the compound "G 22355", later renamed imipramine. Imipramine had a beneficial effect in patients with depression who showed mental and motor retardation. Kuhn described his new compound as a "thymoleptic" "taking hold of the emotions," in contrast with neuroleptics, "taking hold of the nerves" in 1955-56. These gradually became established, resulting in the patent and manufacture in the US in 1951 by Häfliger and SchinderA.

7 – 2 - Second generation antidepressants

Antidepressants became prescription drugs in the 1950s. It was estimated that no more than 50 to 100 individuals per million suffered from the kind of depression that these new drugs would treat, and pharmaceutical companies were not enthusiastic in marketing for this small market. Sales through the 1960s remained poor compared to the sales of tranquilizers, which were being marketed for different uses.

Imipramine remained in common use and numerous successors were introduced. The use of monoamine oxidase inhibitors (MAOI) increased after the development and introduction of "reversible" forms affecting only the MAO - A subtype of inhibitors, making this drug safer to use.

By the 1960s, it was thought that the mode of action of tricyclics was to inhibit norepinephrine reuptake. However, norepinephrine reuptake became associated with stimulating effects. Later tricyclics were thought to affect serotonin as proposed in 1969 by Carlsson and Lindqvist as well as Lapin and Oxenkrug.

Researchers began a process of rational drug design to isolate antihistamine-derived compounds that would selectively target these systems. The first such compound to be patented was zimelidine in 1971, while the first released clinically was indalpine. Fluoxetine was approved for commercial use by the US Food and Drug Administration (FDA) in 1988, becoming the first blockbuster SSRI. Fluoxetine was developed at Eli Lilly and Company in the early 1970s by Bryan Molloy, Klaus Schmiegel, David Wong and others. SSRIs became known as "novel antidepressants" along with other newer drugs such as SNRIs and NRIs with various selective effects.

St John's wort fell out of favor in most countries through the 19th and 20th centuries, except in Germany, where Hypericum extracts were eventually licensed, packaged and prescribed. Small-scale efficacy trials were carried out in the 1970s and 1980s, and attention grew in the 1990s following a meta - analysis . It remains an over - the - counter drug (OTC) supplement in most countries. Research continues to investigate its active component hyperforin, and to further understand its mode of action.

8 - Society and culture

8 – 1 - Prescription trends

In the United Kingdom, the use of antidepressants increased by 234 % in the 10 years up to 2002 . In the US a 2005 independent report stated that 11 % of women and 5 % of men in the non -

institutionalized population (2002) take antidepressants.[157] A 1998 survey found that 67 % of patients diagnosed with depression were prescribed an anti depressant.[n] A 2007 study suggested that 25 % of Americans were over diagnosed with depression, regardless of any medical intervention. The findings were based on a national survey of 8,098 people.

A 2002 survey found that about 3.5 % of all people in France were being prescribed antidepressants, compared to 1.7 % in 1992, often for conditions other than depression and often not in line with authorizations or guidelines. Between 1996 and 2004 in British Columbia, antidepressant use increased from 3.4 % to 7.2 % of the population . Data from 1992 to 2001 from the Netherlands indicated an increasing rate of prescriptions of SSRIs, and an increasing duration of treatment . Surveys indicate that antidepressant use, particularly of SSRIs, has increased rapidly in most developed countries, driven by an increased awareness of depression together with the availability and commercial promotion of new anti depressants . Antidepressants are also increasingly used worldwide for non - depressive patients as studies continue to show the potential of immunomodulatory, analgesic and anti - inflammatory properties in antidepressants .

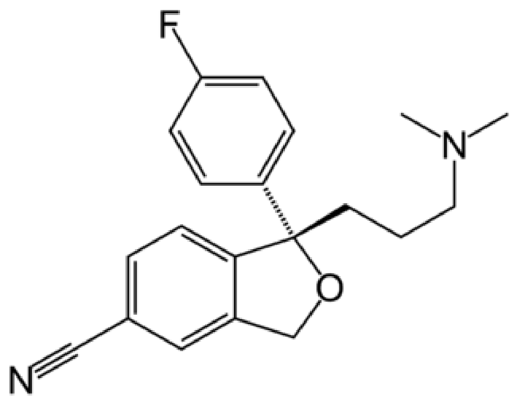
The choice of a particular antidepressant is reported to be based, in the absence of research evidence of differences in efficacy, on seeking to avoid certain side - effects, and taking into account comorbid (co – occurring) psychiatric disorders, specific clinical symptoms and prior treatment history.

It is also reported that, despite equivocal evidence of a significant difference in efficacy between older and newer antidepressants , clinicians perceive the newer drugs, including SSRIs and SNRIs, to be more effective than the older drugs (tri cyclics and MAOIs) . Currently, the most commonly prescribed antidepressants are selective serotonin reuptake inhibitors (SSRIs), even though a Cochrane systematic review found no major difference in efficacy between SSRIs and tricyclic antidepressants . A survey in the UK found that male general physicians were more likely to prescribe antidepressants than female doctors.

The number of antidepressants prescribed by the National Health Service (NHS) in the UK almost doubled during one decade, authorities reported in 2010. Furthermore the number increased sharply in 2009 when 39.1 million prescriptions were issued, compared to 20.1 million issued in 1999. Also, physicians issued 3.18 million more prescriptions in 2009 than in 2008. Health authorities believed the increase was partly linked to the recession. However, other reasons include a diagnosis improvement, a reduction of the stigma on mental ill - health, and more distress caused by the economic crisis. Furthermore, physicians' concern is that some people who exhibit milder symptoms of depression are being prescribed drugs unnecessarily due to the lack of other options including talk therapies, counseling and cognitive behavioral therapy. One more factor that may be increasing the consumption of antidepressants is the fact that these medications now are used for other conditions including social anxiety and post traumatic stress.

The use of antidepressants in the US doubled over one decade, from 1996 to 2005. Antidepressant drugs were prescribed to 13 million in 1996 and to 27 million people by 2005. In 2008, more than 164 million prescriptions were written. During this period, patients were less likely to undergo psychotherapy.

8 – 2 - Most commonly prescribed



Structural formula of the SSRI escitalopram, in its free base form.

United States : The most commonly prescribed antidepressants in the US retail market in 2010 were :

Sertraline	Zoloft	SSRI	33,409,838
Citalopram	Celexa	SSRI	27,993,635
Fluoxetine	Prozac	SSRI	24,473,994
Escitalopram	Lexapro	SSRI	23,000,456
Trazodone	Desyrel	SARI	18,786,495
Duloxetine	Cymbalta	SNRI	14,591,949
Paroxetine	Paxil	SSRI	12,979,366
Amitriptyline	Elavil	TCA	12,611,254
Venlafaxine XR	Effexor XR	SNRI	7,603,949
Bupropion XL	Wellbutrin	NDRI	7,317,814
Mirtazapine	Remeron	TeCA	6,308,288
Venlafaxine ER	Effexor	SNRI	5,526,132
Bupropion SR		NDRI	4,588,996
Desvenlafaxine	Pristiq	SNRI	3,412,354
Nortriptyline	Sensoval	TCA	3,210,476
Bupropion ER		NDRI	3,132,327
Venlafaxine	Effexor	SNRI	2,980,525
Bupropion	Wellbutrin XL	NDRI	753,516

Germany: The most commonly prescribed antidepressant in Germany is reported to be (concentrated extracts of) Hypericum perforatum (St John's wort) .

Netherlands: In the Netherlands, paroxetine, marketed as Seroxat among generic preparations, is the most prescribed antidepressant, followed by the tricyclic antidepressant amitriptyline, citalopram and venlafaxine.

MAOIs can be as effective as tricyclic antidepressants, although they generally are used less frequently because they have a higher incidence of dangerous side effects and interactions.

8 – 3 – Litigation

2012 GlaxoSmithKline 3 billion dollars (US) - Paxil, The company touted Paxil for off - label use in children and adolescents, despite data that failed to show it was effective for these age groups, – Wellbutrin for marketing its antidepressant for off-label uses, including weight loss, substance abuse and sexual dysfunction and the seizure drug Lamictal.

2012 Johnson & Johnson $ 1.6 and $ 2.2 billion Risperdal off-label marketing

2012 Abbott Laboratories $ 698 million for off - label marketing Depakote for use in dementia patients who became agitated or aggressive, despite lack of evidence that the drug was effective for that use.

2009 Eli Lilly $ 1.4 billion for marketing Zyprexa for children and the elderly dementia patients, both off - label uses. It is only approved to treat two disorders, schizophrenia and bipolar disorder.

2010 AstraZeneca $ 520 million for off-label marketing of Seroquel.

2009 Pfizer $ 301 million for off - label marketing of Geodon.

2007 Bristol-Myers Squibb $ 515 million for off-label marketing of Abilify for children and adolescents, and geriatric patients suffering from dememtia.

2004 Pfizer $ 430 million for off - label marketing of Neurontin.

Ely Lilly In one of the only three cases to ever go to trial for SSRI indication in suicide, Eli Lilly and Company was caught corrupting the judicial process by making a deal with the plaintiff's attorney to throw the case, in part by not disclosing damaging evidence to the jury. The case, known as the Fentress Case, involved a Kentucky man, Joseph Wesbecker, on Prozac, who went to his workplace and opened fire with an assault rifle, killing 8 people (including Fentress), and injuring 12 others before turning the gun on himself. The jury returned a 9 - to - 3 verdict in favor of Lilly. The judge, in the end, took the matter to the Kentucky Supreme Court, which found that "there was a serious lack of candor with the trial court and there may have been deception, bad faith conduct, abuse of judicial process and, perhaps even fraud." The judge later revoked the verdict and instead recorded the case as settled. The value of the secret settlement deal has never been disclosed, but was reportedly "tremendous".

8 – 4 - Publication of research findings

Ghost writing of studies for industry - sponsored drug trials is common. Of all 44 trials approved between 1994 and 1995 by the ethics committees of Copenhagen and Frederiksberg in Denmark, up to 91%, that is 40 of the 44 trials, has some form of ghostwriting, and for the most part, the ghost was a statistician. Cases relating to gabapentin , paroxetine , sertraline, fenfluramine / phentermine (fen – phen) are well documented, while many others, relating to olanzapine, quetiapine, remain under seal by the courts .

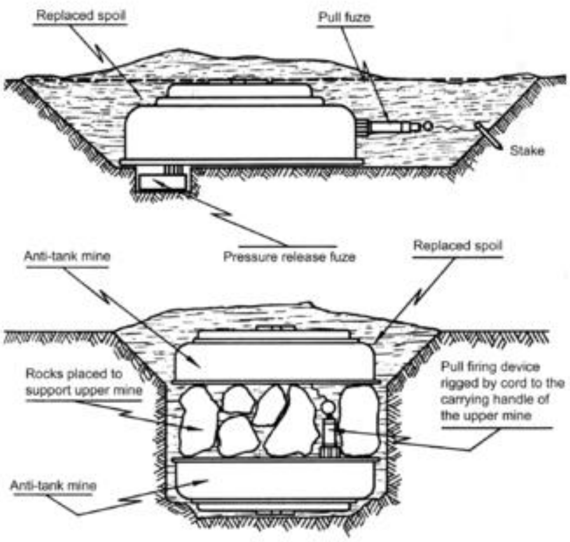
Publication bias. Trials for which results were unfavorable were less likely to be published. Published data suggest a favorable risk-benefit profile for some SSRIs; however, addition of unpublished data indicates that risks could outweigh benefits of these drugs to treat depression in children and young people . Of 90 drugs approved by the FDA between 1998 and 2000 , trials that did not show statistically significant results were 34 % less likely to have been published ; on the other hand, positive results are often published more than once. Based on Healy's examination of the data produced from the Cochrane study of Olanzapine for schizophrenia, the four initial trials of Zyprexa gave rise to 234 publications, most of which were ghost written.

Lack of access to raw data, data suppression, misrepresentation, and manipulation has eroded value of trial results. Demands on access to data has been met by resistance on the part of industry.

A meta-analysis by UK, US and Canadian researchers was published in 2008, surveying all pharmaceutical company-sponsored drug trials on the six most widely prescribed new-generation antidepressants submitted for approval to the FDA between 1987 and 1999. The results showed that the difference in efficacy between antidepressants and placebo was minimal, but that it increased from virtually no difference at moderate levels of initial depression to a relatively small difference for patients with very severe depression. The difference reached conventional criteria for clinical significance for patients at the upper end of the very severely depressed category, due to a reduction in the efficacy of placebo . The study received widespread media coverage in some countries, but was met with criticism from the professional community.

Eli Lilly and Company responded by highlighting that the study did not take into account more recent studies on its product, Prozac, and that it was proud of the difference Prozac has made to millions of people. GlaxoSmithKline warned that this one study should not be used to cause unnecessary alarm and concern for patients. Two leading UK psychiatrists/pharmacologists, with financial and professional links to pharmaceutical companies, argued that short-term approval trials are not very suitable for evaluating effectiveness, that the unpublished trials are of poorer quality, that the meta-analysis authors came from a "psychology background" rather than drug testing background, and that the media and "elements of the medico/scientific community [sic]" have "a down on antidepressants" and that the media do not appreciate the seriousness of depression, and blame and stigmatize sufferers. Wyeth pointed out that the data were good enough for FDA approval of the drugs.

Anti-handling device



The typical configuration of anti-handling devices used with M15 anti-tank landmines. The upper diagram shows a pull-fuze screwed into a secondary fuze well in the side of the mine. Additionally, an M5 anti-lift device has been screwed into another fuze well, hidden under the mine. An inexperienced deminer might detect and render safe the pull-fuze, but then be killed when he lifted the mine, triggering the M5 pressure-release firing device underneath.
The lower diagram shows two anti-tank landmines connected by a cord attached to the upper mine's carrying handle. The cord is attached to a pull fuze installed in a secondary fuze well in the bottom mine.

Contents

1 - Introduction

An anti - handling device is an attachment to or integral part of a landmine or other munition e.g. some fuze types found in general purpose air - dropped bombs, cluster bombs and sea mines . It is designed to prevent tampering. When the protected device is disturbed, it detonates, killing or injuring anyone within the blast area. There is a strong functional overlap of booby traps and anti-handling devices: a munition with an anti - handling device fitted has, for all intents and purposes, been booby - trapped.

2 – Purpose

Anti - handling devices serve two military purposes :

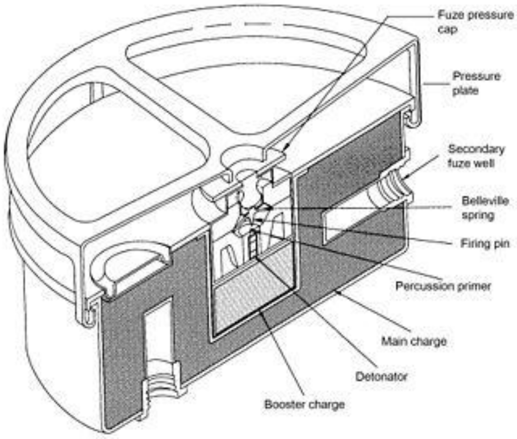
To prevent the capture and reuse of the munition by enemy forces.

To hinder bomb disposal or demining operations, both directly and by deterrence, thereby creating a much more effective hazard or barrier.

Anti - handling devices greatly increase the impact of munitions on civilian populations in the areas in which they are used because their mechanisms are so easily triggered. An unexploded bomb may or may not detonate if it is lifted or overturned, whereas an anti-tank mine with an anti - handling device fitted is almost guaranteed to detonate if it is lifted / overturned, because it is specifically designed to do so. Additionally, munitions fitted with anti - handling devices increase the difficulty and cost of post-conflict clearing operations, due to the inherent dangers of attempting to render them safe.

Not all munitions will have an anti-handling device fitted or enabled. Perhaps one in ten antitank mines in a large defensive minefield will have booby trap firing devices screwed into their secondary fuze wells. Even so, deminers and EOD personnel are forced to assume that all items they encounter may have been booby trapped, and must therefore take extra precautions. This has the effect of significantly slowing down the clearance process, even allowing for the fact that the anti - tank mines in question may be interspersed with various different types of minimum metal antipersonnel mines such as the VS-50 or TS - 50 , some of which can also have anti-handling features.

3 – History



Cutaway view of an M4 anti-tank mine dating from circa 1945, showing two additional fuze wells designed for use with booby-trap firing devices. Either or both fuze wells may have firing devices screwed into them if required

A stack of five M15 mines dating from circa 1960s. The top two mines show additional fuze wells

Side view of an M19 anti- tank mine, dating from circa 1970s showing an additional fuze well on the side of the mine (sealing cap has been removed) designed for use with booby - trap firing devices. There is another empty fuze well (not visible) located underneath the mine

Technology to incorporate sophisticated anti-handling mechanisms in fuzes has existed since at least 1940 e.g. the Luftwaffe's ZUS - 40 anti - removal fuze (of which 3 slightly different versions existed) which was used during the London Blitz and elsewhere . ZUS - 40s were designed to fit underneath most Luftwaffe bomb fuzes. When a delayed-action bomb containing a ZUS-40 was dropped on a target, the massive jolt after it hit the ground freed a ball - bearing inside the ZUS - 40, thereby arming a spring-loaded firing pin. However, so long as the main bomb fuze remained inside its fuze well, the cocked firing pin in the ZUS-40 was prevented from springing forward. ZUS-40s were often fitted underneath a type 17 clockwork long delay fuze, which gave up to 72 hours delayed detonation. Rendering safe a type 17 fuze was normally a simple and straightforward process i.e. unscrew the fuze locking ring, remove the fuze from its pocket in the side of the bomb and unscrew the gaine. However, fitting a ZUS - 40 underneath a type 17 fuze made the render-safe process much more complicated and dangerous. Removing the main time-delay fuze more than a centimetre from its fuze pocket (without neutralizing the anti-handling device underneath) automatically released the cocked firing pin inside the ZUS - 40, which sprang forward to strike a large percussion cap, thereby causing detonation of the bomb and the death of anyone kneeling beside it. Because the ZUS-40 was designed to be concealed underneath a conventional bomb fuze, it was very difficult to know whether a particular bomb was fitted with an anti - handling device or not. In any case, many electrically fired German bomb fuzes (which could be fitted above a ZUS – 40) already had a tiny pendulum - based "trembler" device inside them, which closed the circuit and triggered detonation if the bomb was subjected to rough handling. Some German anti - handling fuzes were even more sophisticated and therefore particularly dangerous to EOD personnel e.g. the type 50 and 50BY fuzes. These were normally fitted to 250 / 500 kg bombs and contained two mercury tilt switches which detected movement across vertical and horizontal axes. The fuzes fully armed themselves approximately 30 seconds after hitting the ground. Subsequently, if the bomb was moved in any way, the mercury switch completed an electrical circuit and triggered detonation. To complicate matters still further, German bombs could have two separate fuze pockets fitted, with different fuze types screwed into each one. As a result, one bomb could incorporate two separate anti-handling devices working independently of each other e.g. a type 17 clockwork fuze with a ZUS - 40 hidden underneath it screwed into one fuze pocket, and a type 50 BY in the other. Even comparatively small air-dropped munitions could incorporate an anti-handling feature e.g. the type 70 fuze fitted to Butterfly bombs. However, fuzes with an integral anti - handling feature were not only found in air-dropped bombs. For example, the T.Mi.Z.43 fuze (dating from 1943) fitted to Teller mines automatically triggered detonation if (in an attempt to render the mine safe) the pressure plate was unscrewed . Although the designs of these anti - handling fuzes varied, all were specifically designed to kill bomb disposal personnel who had the task of rendering them safe.

Allied forces developed their own designs of anti - handling devices during World War II. For example, the American M123A1, M124A1 , M125 and M131 series of chemical long delay tail - fuzes (which remained in service until circa 1960s) were used in air-dropped bombs. Frequently fitted to M64 (500 lb) , M65 (1000 lb) and M66 (2000 lb) general-purpose bombs, these fuzes were primarily designed to operate as chemical long-delay fuzes, with settings ranging between 15 minutes and 144 hours. The time delay mechanism was simple but effective: after being dropped from the aircraft a small propeller at the rear of the bomb revolved, gradually screwing a metal rod into the fuze, crushing an ampoule of acetone solvent contained within it. When this happened the fuze was fully armed and the timer countdown had started. The acetone soaked into an absorbent pad next to a celluloid disk which held back a spring-loaded firing pin from a percussion cap connected to an adjacent detonator. Acetone slowly dissolved the celluloid disk, gradually weakening it until the cocked firing pin was released and the bomb detonated . The time delay of the fuze varied according to the acetone concentration and the thickness of the celluloid disk. Removing a chemical long delay fuze from a bomb after it had been dropped would have been a straightforward process had it not been for the fact that there was an integral anti - withdrawal mechanism designed to kill anyone who tried to render the bomb safe: fuzes such as the M123 (and its derivatives) contained a tiny ball - bearing at the lower end which slid out of a recess when the fuze armed itself a few seconds after being released from an aircraft . The ball - bearing jammed into the screw - threads inside the fuze well, preventing the fuze from being removed. Because the lower end of the fuze was locked in place deep inside the bomb (where it was hard get at) this posed major problems for enemy EOD personnel: attempting to unscrew a fully armed chemical long - delay fuze caused it to split into two separate fuze assemblies i.e. upper and lower. This action automatically triggered detonation by releasing the cocked firing pin in the lower fuze assembly, with lethal results for anyone nearby. Although many decades have passed, unexploded bombs dating from World War II with chemical long - delay fuzes fitted remain extremely hazardous to EOD personnel. This is because corrosion makes the fuze mechanism (which is still holding back the spring-loaded firing pin from a percussion cap) much more sensitive to disturbance. As a result, there is a high risk that any movement will either reactivate the timer mechanism or immediately release the firing pin. Typically, this happens when the bomb is first discovered on a construction site (e.g. accidentally scraping against the bomb with a backhoe), or whilst it is being examined by EOD personnel e.g. gently rotating the bomb casing to gain better access to the rear end. One of these scenarios occurred in June 2010, when an unexploded 500 kilogram allied bomb fitted with a chemical long - delay fuze killed 3 German EOD personnel and wounded 6 others in Gottingen, whilst they were preparing to render it safe . Another allied bomb fitted with a chemical long-delay fuze was discovered in Munich during August 2012, and had to be detonated in situ (shattering windows over a wide area and causing major damage to surrounding buildings) because it was considered too dangerous to disarm.

The British "Number 37 Long Delay Pistol" (used by RAF Bomber Command during World War II) was another chemical long delay fuze which used a very similar type of anti-removal mechanism. A later design of British nose fuze called the number 845 Mk 2 operated purely in anti - disturbance mode. It contained a mercury switch which triggered detonation if the bomb was moved after a 20 second arming delay, which started when the bomb hit the ground.

Since then, many nations have produced a wide variety of munitions with fuzes which incorporate some form of anti-handling function, including very small weapons such as cluster bombs.[19][20] Alternatively, they have produced munitions with features which make it very easy to add an anti-tamper function e.g. extra (but empty) threaded fuze wells on anti-tank landmines, into which the detonators on booby-trap firing devices (plus booster attachments) can be screwed.

4 – Classes

US Army field manual FM 20 – 32 classifies four classes of anti-handling devices:

Anti - lifting devices. A device which initiates an explosion when a protected mine is lifted or pulled out of its hole.

Anti - disturbance device. A device which initiates an explosion when a protected mine is lifted, tilted or disturbed in any way e.g. a notable variant of the VS-50 mine featuring an integral mercury switch.

Anti - defuzing device. A device which initiates an explosion when an attempt is made to remove a fuze from a protected mine.

Anti - disarming device. A device which initiates an explosion when an attempt is made to set the arming mechanism of a mine to safe.

5 - of anti - handling fuzes

The different classes of anti-handling devices are normally created using a variety of fuzes. This is a list of the types of fuzes used as anti-handling devices :

Pull fuzes — these are typically installed in secondary fuze wells located on the side or bottom of landmines. The fuze is normally connected to a thin wire attached to the ground, so the wire is automatically pulled if the mine is lifted, shifted or disturbed in any way. Simple pull - fuzes release a spring-loaded striker. More sophisticated versions are electronic i.e. feature a break-wire sensor which detects a drop in voltage. Either way, pulling on the hidden wire triggers detonation.

***Anti - lifting fuzes* —** these are frequently screwed into an auxiliary fuze pocket located underneath anti-tank landmines. The act of lifting or shifting the mine releases a cocked striker, triggering detonation. The M5 universal firing device is a classic example of an anti-lift fuze. Its standard gauge screw thread allows it to be fitted to various munition types, ranging from an M26 hand grenade up to an M15 antitank landmine.

***Tilt / Vibration switches* —** this is a fuze installed inside the device which triggers detonation if the sensor is tilted beyond a certain angle or is subject to any vibration. Typically, some form of pendulum arrangement, spring-loaded "trembler" or mercury switch is used to detect this.

***Anti - mine detector fuzes* —** developed during the Second World War to detect the magnetic field of mine detectors.

***Electronic fuzes* —** modern electronic fuzes may incorporate anti - handling features. Typically, these fuzes incorporate one or more of the following sensors: seismic, magnetic, light sensitive, thermal or acoustic sensitive. Potentially, such fuzes can discriminate between various types of mine clearance operations i.e. resist activation by devices such as mine flails, plows, or explosives, whilst still detonating when handled by demining personnel. Additionally, electronic fuzes may have an inbuilt self-destruct capability i.e. some form of timer countdown designed to trigger detonation hours, days or even months after deployment, possibly whilst people are attempting to render the device safe. Although fuzes with a self-destruct capability are not anti-handling devices *per se*, they do add an extra complicating factor to the EOD process.

Anti - Personnel Mine

Sand-colored VS - 50 mine intended for use in desert environments

Contents

1 - Introduction

Anti - personnel mines are a form of land mine designed for use against humans, as opposed to anti - tank mines, which are designed for use against vehicles . Anti - personnel mines may be classified into blast mines or fragmentation mines, the latter may or may not be bounding mines.

The mines are often designed to injure, not kill, victims in order to increase the logistical (mostly medical) support required by enemy forces that encounter them. Some types of anti-personnel mines can also damage the tracks on armored vehicles or the tires of wheeled vehicles.

The International Campaign to Ban Landmines has sought to ban land mines culminating in the 1997 Ottawa Treaty, although this treaty has not yet been accepted by a number of countries including the USA, Russia, People's Republic of China, Pakistan and India.

2 – Use

Italian Valmara 69 bounding type anti - personnel mine

Anti - personnel mines are used in a similar manner to anti - tank mines, in static "mine fields" along national borders or in defense of strategic positions as described in greater detail in the land mine article. What makes them different from most anti - tank mines, however, is their smaller size, which enables large numbers to be simultaneously deployed over a large area. This process can be done manually, via dispensers on land vehicles, or from helicopters or aircraft. Alternatively, they can be dispensed by cargo-carrying artillery shells.

Other uses specific to anti-personnel mines, are where they are deployed on an ad hoc basis in the following situations :

When laying an ambush.

Protecting a temporary base.

To evade pursuit (e.g. M86 Pursuit Deterrent Munition)

To protect equipment by employing the mines as booby traps.

To booby trap other mines as a form of anti-handling device

3 - Blast mines

Typically, anti - personnel blast mines are activated i.e. they are triggered when the victim steps on it. Their primary purpose is to blow the victim's foot or leg off, disabling them. Injuring, rather than killing, the victim is viewed as preferable in order to increase the logistical (evacuation, medical) burden on the opposing force.

3 – 1 – Effect

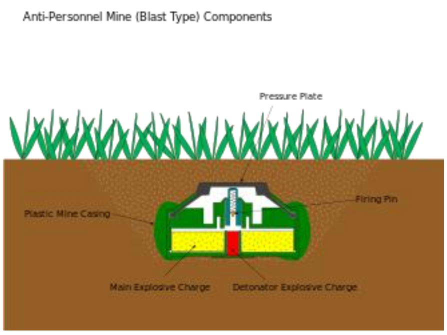
When a person steps on a blast mine and activates it, the mine's main charge detonates, creating a blast shock wave consisting of hot gases travelling at extremely high velocity. The shock wave sends a huge compressive force upwards, ejecting the mine casing and any soil covering the mine along with it. When the blast wave hits the surface, it quickly transfers the force into the subject's footwear and foot. This results in a massive compression force being applied to the victim's foot. In most cases, the victim's foot is blown off by the blast wave.

The resulting injuries to a human body depend on the size of the mine's main charge, the depth, type of soil it was laid in and how the victim contacted it e.g. stepping on the mine using all or part of the foot. Different types of soil will result in different amounts of energy being transferred upward into the subject's foot, with saturated "clay-like" soil transferring the most. Larger main charges result in a release of significantly more energy, driving the blast wave further up a target's foot and leg and causing greater injury, in some cases even described as severe as traumatic amputation of the foot up to the knee.

Secondary injuries from a blast mine are often caused by the material that has been torn loose by the mine's explosion. This consists of the soil and stones that were on top of the mine, parts of the victim's footwear and the small bones in the victim's foot. This debris creates wounds typical of similar secondary blast effects or shrapnel. Special footwear, including combat boots or so-called "blast boots", is only moderately protective against the destructive effects of blast mines, and the loss of a foot is a typical outcome.

Blast mines have little effect on armoured vehicles, but can damage a wheeled vehicle if it runs directly over the mine. Small blast mines will severely damage a tire, rendering it irreparable while some types could also damage adjacent running gear.

3 – 2 – Components



Typical components of an anti - personnel blast mine.

3 – 2 – 1 - Mine casing

The mine casing houses the components of the mine and protects it from its environment. Early land mines, such as the ones used in the World War II era, had casings made of steel or aluminium. However, by the middle of World War II, the British Army was using the first, practical, portable metal detectors — the Polish mine detector. The Germans responded with mines that had a wooden or glass casing to make detection harder.

Wooden mines had been used by the Russians in 1939, before the appearance of metal detectors, in order to save steel. Some, like the PP Mi-D mine, continued to be used into the 1980s as they were easy to make and hard to detect. Wood has the disadvantage of rotting and splitting, rendering the mine non-functional after a comparatively short time in the ground.

Mines manufactured after the 1950s generally use plastic casings to hinder detection by electronic mine detectors. Some, referred to as Minimum metal mines, are constructed with as little metal as possible – often around 1 gram (0.035 oz) – to make them difficult to detect. Mines containing absolutely no metal have been produced, but are uncommon. By its nature, a mine without any metal components in it cannot be found using a metal detector.

3 – 2 – 2 - Pressure plate / fuze mechanism

The fuze mechanism is designed to set off the detonator, either by striking it with a spring - loaded firing pin, compressing a friction sensitive pyrotechnic composition, or by passing an electric charge through it. Most mines employ a spring-loaded striker that hits a stab detonator when activated by the victim. Typically, the detonator contains a tiny pellet of lead azide. The fuze is the most complicated component in any landmine, though the amount of effort required to design and manufacture a simple fuze mechanism is quite low. For example, the retraction mechanism inside a cheap plastic ballpoint pen could easily be adapted to function as a basic anti-personnel landmine fuze after minor modifications.[*citation needed*] It follows that any factory capable of manufacturing retractable ballpoint pens could easily manufacture such fuzes.

More sophisticated examples, such as the Italian SB-33 mine have a fuze mechanism that detonates the mine if subject to gradual, steady pressure, but locks the fuze if subject to a sudden shock. This defeats one of the main methods of clearing a path through a minefield — detonating the mines with explosive devices, such as Mine - clearing line charges.

3 – 2 – 3 – Booster

The booster charge is a highly sensitive explosive that will explode easily when subjected to the shock of the detonator. Typically, a pea-sized pellet of RDX is used. The purpose of the booster is to amplify the shock of the detonator and initiate the main explosive charge.

3 – 2 – 4 - Main charge

The main charge consists of a stable explosive that is detonated by the booster charge. This is necessary, because making a mine out of highly sensitive detonator or booster explosive would be more expensive, and make the device more sensitive and thereby susceptible to accidental detonation. In most AP blast mines TNT, Composition B or phlegmatized RDX are used. On a U.S. M14 mine, 29 grams of tetryl is used, while 240 grams of TNT is used in a Russian PMN mine.

3 – 3 – Deployment

Anti - personnel blast mines are the most common type of land mine and typically deployed on the surface (hidden by leaves or rocks) or buried under soil at depths of 10 – 20 mm. They are activated by pressure i.e. when the victim steps on them, but could also be a vehicle driving over them.

They were designed for use as area denial weapons. Weapons of this type are supposed to deny opposing military forces access to a specific area.

4 - Fragmentation mines

While blast mines are designed to cause severe injury to one person, fragmentation mines (such as the World War II era German S - mine) are designed to project fragments across a wide area, causing shrapnel wounds to nearby personnel.

Fragmentation mines are generally much larger and heavier than blast mines, and contain a large amount (often several kilograms) of ferrous metal. As such, they are easy to detect if the environment is not too heavily contaminated with iron.

4 – 1 – Effect

These mines are deemed more effective than purely "blast effect" mines, because the shrapnel effect covers a greater area, potentially injuring more combatants.

The shrapnel from these mines can even disable some armoured vehicles, by puncturing their tires and — in the case of soft-skinned vehicles — also penetrating the skin and damaging internal components or injuring personnel. Because fragmentation mines generally contain a much larger charge than blast mines, they can cause severe damage to an unarmoured vehicle which runs directly over one.

4 – 2 - Types of fragmentation mine

4 – 2 – 1 – Stake

These mines (such as the Russian POMZ) are entirely above ground, having a fragmenting warhead mounted on a stake at a suitable height, concealed by vegetation or rubbish and triggered by one or more tripwires.

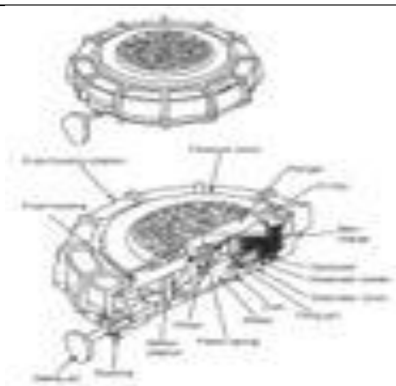
4 – 2 – 2 – Bounding

Bounding mines have a small lifting charge that, when activated, launches the main body of the mine out of the ground before it detonates at around chest height. This produces a more lethal spray of shrapnel over a larger area. One such—the US M16 mine—can cause injuries up to 200 meters away. The steel shrapnel makes bounding mines easy to detect, so they may be surrounded by Minimum metal mines to make mine clearance harder.

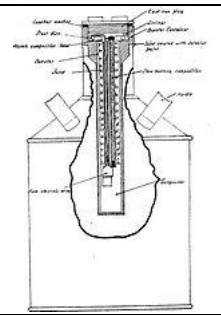
4 – 2 – 3 – Directional

Directional fragmentation weapons (such as the M18 Claymore) differ from other types in that they are designed to direct their fragments only in limited arc. They are placed so that the blast will be directed at the target area and away from friendly forces. This design also allows forces to protect themselves by placing these types of mines near their own positions, but facing the enemy. They are triggered in a conventional manner with either tripwire or command detonation. They are generally referred to as *claymore mines* from the US mine of this type.

5 – Gallery

	
Stake mine - a Yugoslav IMP mine with tripwire (Balkans 1996)	*Bounding mine – German S-Mine*
	
Blast mine - American M14	*Directional mine - Russian MON-50*
	
Blast mine - Italian VS-MK2 (cross-sectional view)	*Blast mines - Russian PMN1 and PMN2*
	
Blast mine - Italian TS-50 in-situ	

6 - Other mine types



British chemical mine c1940: Chemical Mine No 1 Mk 1

During World War II, flame mines known as the flame fougasse were produced by the British during the invasion crisis of 1940. Later, the Russians produced a flame-mine, called the FOG-1. This was copied by the Germans to produce the Abwehrflammenwerfer 42, these devices were effectively disposable, trip-wire triggered flamethrowers.

Chemical mines have also been made. They were made by Britain, the US and the Soviet Union during World War II, but never deployed. During the Cold War, the US produced the M23 chemical mine containing VX (nerve agent). A small explosive charge burst the mine open and dispersed the chemical when the mine was triggered.

7 – Examples

World War II anti-personnel mines

S-mine (*Bouncing Betty*): infamous German bouncing mine; widely copied after the war.

Glasmine 43: German mine made largely from glass, to make it difficult to detect.

PDM-6 and PMD-7: Russian World War II mines, made from wood.

Post-War, US anti-personnel mines

Gravel mines, 1960s–1970s. Simple, small mine with no moving parts. Millions were dropped during the Vietnam War.

M16: improved version of the German S-mine.

BLU-43 (*Dragontooth*), 1970s. Air-dropped mine used during the Vietnam War.

GATOR mine system: modern dispersal system, includes AP (*BLU-92/B*) and anti-tank mines.

M18 Claymore: directional mine.

M86 Pursuit Deterrent Munition: tripwire triggered bounding mine that automatically deploys its own tripwires. It is intended to be dropped by special forces when evading a pursuing enemy.

Post-War, Russian anti-personnel mines

PFM-1 (*butterfly mine*, NATO: *Blue Parrot*), modern.

POMZ: tripwire triggered, stake-mine.

MON-50: Russian directional mine; similar to the American M18 Claymore.

PMN mine: one of the most commonly encountered mines during de-mining operations.

MON-200: large mine with a 12 kg TNT charge. Also effective against light vehicles.

Post-War, British anti-personnel mines

HB 876 mine: 1970s–1999. An air dropped mine used as part of the JP233 runway attacking system. Each attack with a JP233 also dropped 215 HB 876s that were intended to make repair of the damaged runway slow and dangerous.

Yugoslav anti-personnel mines

MRUD: Directional mine similar to the M18 Claymore.

8 – Patentability

Anti - personnel mines are a typical example of subject-matter excluded from patentability under the European Patent Convention, because the publication or exploitation of such inventions are contrary to the "order public" and/or morality (Article 53 (a) EPC).

9 - Criticism of name

Rob Nixon has criticized the use of the adjective "anti-personnel" to describe land mines, noting that the word "personnel" signifies people engaged in a particular organization, whereas in reality "four-fifths of land mine casualties are civilians", in particular children. Thus, he argues, the name "flatters their accuracy by implying that they target an organization, military or otherwise " .

Anti - personnel weapon

An anti-personnel weapon is one primarily used to incapacitate people, as opposed to attacking structures or vehicles. Anti-personnel weapons have been made and used since the discovery of weapons for hunting .

The development of defensive fortification and combat vehicles gave rise to weapons designed specifically to attack them, and thus a need to distinguish between those systems and ones intended to attack people. For instance, an anti - personnel landmine will explode into small and sharp splinters that tear flesh but have little effect on metal surfaces, while anti-tank mines have considerably different design, using much more explosive to effect damage to armored fighting vehicles.

Many modern weapons systems can be employed in different roles, for example a tank's main gun can fire armor - piercing ammunition in the anti - tank role, high - explosive ammunition in the anti - structure role and fragmentation shells in the anti - personnel role.

There are also more exotic classes of weapons, such as neutron bombs, chemicals, and biological weapons, which are only designed to attack people. As there is greater international criticism of them, they are therefore rarely used. These are not generally referred to as anti - personnel weapons, but by their own names or group terms (e.g., NBC weapons) by which they are specifically banned. Such weapons often create much collateral damage and may affect large numbers of civilians.

Anti - Tank Dog

Soviet military dog training school, 1931

Contents

1 - Introduction

Anti-tank dogs (Russian: собаки-истребители танков *sobaki-istrebiteli tankov* or противотанковые собаки *protivotankovye sobaki*; German: *Panzerabwehrhunde* or *Hundeminen*, "dog-mines") were dogs taught to carry explosives to tanks, armored vehicles and other military targets. They were intensively trained by the Soviet and Russian military forces between 1930 and 1996 and used in 1941–1942 against German tanks in World War II. Although the original dog training routine was to leave the bomb and retreat so that the bomb would be detonated by the timer, this routine failed and was replaced by an impact detonation procedure which killed the dog in the process. The U.S. military trained anti-tank dogs in 1943 for use against fortifications, but never deployed them. Dogs strapped with explosives were unsuccessfully used by Iraqi insurgents in the 2000s.

2 – History

In 1924, the Revolutionary Military Council of the Soviet Union approved the use of dogs for military purposes, which included a wide range of tasks such as rescue, delivery of first aid, communication, tracking mines and people, assisting in combat, transporting food, medicine and injured soldiers on sledges, and detonation of enemy targets. For these purposes, a specialized dog training school was founded in the Moscow Oblast. Twelve regional schools were opened soon after, three of which trained anti - tank dogs.

The Soviet Army had no dedicated dog trainers, therefore they recruited hunters and circus and police dog trainers. Several leading animal scientists were also involved, in order to help organize a wide-scale training program. German Shepherd Dogs were favored for the program for their physical abilities and ease of training, but other breeds were used as well. The idea of using dogs as mobile mines was developed in the 1930s, together with the dog-fitting mine design. In 1935, anti-mine dog units were officially included in the Soviet Army.

3 – Training

The original idea was for a dog to carry a bomb strapped to its body, and reach a specific static target. The dog would then release the bomb by pulling with its teeth a self - releasing belt and return to the operator. The bomb could then be detonated either by a timer or remote control, though the latter was too rare and expensive at the time to be used. A group of dogs practiced this for six months, but the reports show that no dogs could master the task. They performed well on a single target but became confuzed after the target or location was changed and often returned to the operator with the bomb unreleased, which in a live situation would have killed both the dog and the operator.

Continual failures brought about a simplification. The bomb was fastened on the dog and detonated upon contact with the target, killing the animal. Whereas in the first program, the dog was trained to locate a specific target, this task was simplified to find any enemy tank. Dogs were trained by being kept hungry and their food was placed under tanks. The tanks were at first left standing still, then they had their engines running, which was further combined with sporadic blank - shot gunfire and other battle - related distractions. This routine aimed to teach the dogs to run under the tanks in battlefield situations.

Each dog was fitted with a 10 – 12 - kilogram mine carried in two canvas pouches adjusted individually to each dog. The mine had a safety pin which was removed right before the deployment; each mine carried no markings and was not supposed to be disarmed. A wooden lever extended out of a pouch to about 20 centimeters in height. When the dog dived under the tank, the lever struck the bottom of the tank and detonated the charge. Because the chassis was the most vulnerable area of these vehicles, it was hoped the explosion would gut the vehicle.

4 - Deployment by the Soviet Union

Military parade on Red Square, Moscow, May 1, 1938

The use of anti - tank dogs was escalated during 1941–1942, when every effort was made by the Soviet Army to stop the German advance at the Eastern Front of World War II. In that period, the dog training schools were mostly focused on producing anti-tank dogs. About 40,000 dogs were deployed for various tasks in the Soviet Army.

The first group of anti - tank dogs arrived at the frontline at the end of the summer of 1941 and included 30 dogs and 40 trainers. Their deployment revealed some serious problems. In order to save fuel and ammunition, dogs had been trained on tanks which stood still and did not fire their guns. In the field, the dogs refuzzed to dive under moving tanks. Some persistent dogs ran near the tanks, waiting for them to stop but were shot in the process. Gunfire from the tanks scared away many of the dogs. They would run back to the trenches and often detonated the charge upon jumping in, killing Soviet soldiers. To prevent that, the returning dogs had to be shot, often by their controllers and this made the trainers unwilling to work with new dogs. Some went so far as to say that the army did not stop with sacrificing people to the war and went on to slaughter dogs too; those who openly criticized the program were prosecuted by "special departments" (military counterintelligence). Out of the first group of 30 dogs, only four managed to detonate their bombs near the German tanks, inflicting an unknown amount of damage. Six exploded upon returning to the Soviet trenches, killing and injuring soldiers . Three dogs were shot by German troops and taken away, despite furious attempts by the Soviets to prevent this, which provided examples of the detonation mechanism to the Germans. A captured German officer later reported that they learned of the anti - tank dog design from the killed animals, and considered the program desperate and inefficient. A German propaganda campaign sought to discredit the Soviet Army, saying that Soviet soldiers refuze to fight and send dogs instead.

Another serious training mistake was revealed later; the Soviets used their own diesel - engine tanks to train the dogs rather than German tanks which had gasoline engines. As the dogs relied on their acute sense of smell, the dogs sought out familiar Soviet tanks instead of strange - smelling German tanks.

The efficiency of using anti - tank dogs in World War II remains uncertain. There are claims by the Soviet sources that around 300 German tanks were damaged by Soviet anti - tank dogs . This claim was questioned by Russian historians as propaganda, trying to justify the dog training program . There are however documented claims of individual successes of the program, with the number of damaged tanks usually being within a dozen . For example, at the front of the 160th Infantry Division near Hlukhiv, six dogs had damaged five German tanks; near the airport of Stalingrad, anti - tank dogs destroyed 13 tanks. At the Battle of Kursk, 16 dogs disabled 12

German tanks which had broken through the Soviet lines of defense near Tamarovka , Bykovo (height 244,5).

The German forces knew about the Soviet dogs from 1941 onwards, and so took measures to defend against them. An armored vehicle's top - mounted machine gun proved ineffective due to the relatively small size of the attackers as the dogs were too low to the ground and because of the dog's speed and the difficulty in spotting them. Consequently, every German soldier received orders to shoot any dog in combat areas.

The hostility of German soldiers and officers to the dogs is mentioned in the semi - fictional novel *Kaputt* by Curzio Malaparte. As an Italian correspondent on the Eastern front during 1941 – 42, Malaparte recounted how one of the German soldiers' first tasks upon entering and occupying villages in Ukraine was to seek out and kill any dog on sight.

After 1942, the use of anti-tank dogs by the Soviet Army rapidly declined, and training schools were redirected to producing the more needed mine-seeking and delivery dogs. However, training of anti-tank dogs continued after World War II, until June 1996.

5 - Use by other countries

The Japanese Army received about 25,000 dogs from their ally Germany and organized several dog training schools in Japan, and one in China at Nanjing. Some dogs were trained for demolition, but instead of strapping explosives to the dog, it was attached to dog - drawn carts . Their deployment had little success, mostly due to poor training . In the late 1940s, anti - tank dogs were used by the Viet Minh forces fighting in Indochina.

In 1943, U.S. forces considered using armed dogs against fortifications. The aim was for a dog to run into a bunker carrying a bomb, which would then be detonated by a timer. Dogs in this secret program were trained at Fort Belvoir. The dogs, called "demolition wolves", were taught to run to a bunker, enter it, and sit whilst waiting for a simulated explosion. Each dog carried a bomb strapped to its body in canvas pouches, as with the Russian method. The program was terminated on December 17, 1943 out of safety concerns. During the training, dogs often returned to the senders without entering the bunker or waiting there for supposed period of time which would have caused friendly casualties in a live fire situation. It was feared that in the actual battle, dogs would return much more often, scared by enemy fire. Attempts to continue the program in 1944 and 1945 failed.

William A. Prestre, a Swiss citizen living in Santa Fe, New Mexico, proposed using large dogs to kill Japanese soldiers. He convinced the military to lease an entire island in the Mississippi River to house the training facilities. There the army hoped to train as many as two million dogs. The idea was to begin island invasions with landing craft releasing thousands of dogs against the Japanese defenders, then followed up by troops as the Japanese defenders scattered in confusion. One of the biggest problems encountered was getting Japanese soldiers to train the dogs, as very few Japanese soldiers were being captured. Eventually, Japanese - American soldiers volunteered for the training. The biggest problem was the dogs, as they were either too docile, did not respond to training teaching them to rush across beaches, or were terrified by shellfire. After millions of dollars were spent, the program was abandoned.

Around 2007, insurgents attempted to use bomb-equipped dogs during the Iraq War. Remote controls were used to detonate the bomb. In one documented incident in Iraq, the dog was detonated without inflicting damage. This caused protests among Iraqis, even though dogs are treated as an "unclean" animal in the Muslim world, as in Islam, it is considered sinful to kill animals for reasons other than food . More often, donkeys were used, as they were more reliable. Donkeys are traditionally equipped with sacks and thus could carry a large explosive charge without looking suspicious.

Anti - Tank Warfare

Contents

1 - Introduction

Anti - tank warfare arose as a result of the need to develop technology and tactics to destroy tanks during the First World War. Because tanks represent an enemy's greatest force projection (aside from nuclear artillery and tanks vs. tank engagements), anti-tank warfare has been incorporated into the doctrine of nearly every combat service since.

PARS 3 LR with HEAT warhead of the German Army.

The predominant anti-tank weapons at the start of the Second World War were the tank-mounted gun, limbered (towed) anti-tank guns and anti-tank grenades used by the infantry as well as ground-attack aircraft such as the Junkers Ju 87 *Stuka*.

Anti-tank warfare evolved rapidly, particularly on the Eastern Front, to include new infantry and infantry support weapons such as the bazooka, anti-tank combat engineering, specialized anti-tank aircraft and self-propelled tank destroyers. Both the Red Army and the German Army developed methods of combating tank-led offensives, including deployment of static anti-tank weapons embedded in in-depth defensive positions, protected by anti-tank obstacles and minefields, and supported by mobile anti-tank reserves and ground attack aircraft.

From the Korean War to the Cold War, Europe and other countries faced the possibility that a nuclear weapon could be detonated over an area of tank concentration in one strike. While technology was developed to protect crews of armored vehicles from the effects of radiation, the same could not be done for all their supporting arms and the supply train on which tanks depend for spares, fuel and maintenance. In the NATO countries little if any development took place on defining a doctrine of how to use armed forces without the use of tactical nuclear weapons. In the Soviet sphere of influence the legacy doctrine of operational maneuver was being theoretically examined to understand how a tank-led force could be used even with the threat of limited use of nuclear weapons on the European battlefield. The solution they arrived at was maneuver warfare while massively increasing the number of anti-tank weapons. To achieve this, Soviet military theorists (such as Vasily Sokolovsky) realized that anti-tank weapons had to assume an offensive role rather than the traditionally defensive role of the Great Patriotic War by becoming more mobile. This led to the development of improved guided anti-tank missiles, though similar design work was being performed in Western Europe and the United States.

The French SS.10 missile was the first successfully used in anti-tank combat—by the Israel Defense Forces during the Suez Crisis of 1956 , but the impact of Soviet anti-tank missile tactics was not evident until 1973, when Russian 9K11 Malyutka (Sagger) missiles were used by the Egyptian and Syrian armies during the Yom Kippur War against Israel. The outcome suggested that although the French missiles were a threat, they could be countered. The explosive power delivered by the missiles convinced NATO tank designers to continue their emphasis on increased armor, while Soviet designers retained their emphasis on mobility of tank-led forces. The utility of the light anti-tank weapon was also recognized by both sides of the Cold War and led to further development of both shoulder-launched and man-portable weapons used by the infantry squad, while heavier missiles were mounted on dedicated missile tank-destroyers, including dedicated anti-tank helicopters, and even heavier guided anti-tank missiles launched from aircraft. Also being developed were new varieties of artillery munitions in the form of top-attack shells, and shells that were used to saturate areas with anti-armor bomblets. Helicopters could be used as well to rapidly deliver scattered anti-tank mines.

Since the end of the Cold War in 1993, the only major new threat to tanks and other vehicles, has been the remotely detonated

Improvised explosive devices (IED's) used in asymmetric warfare though it is really little different from a homemade land mine.

2 - Tank threat

Anti-tank warfare evolved as a countermeasure to the threat of the tank's appearance on the battlefields of the Western Front of the First World War. The tank had been developed to negate the German system of trenches, and allow a return to manoeuver against enemy's flanks and to attack the rear with cavalry.

The use of the tank was primarily based on the assumption that once they were able to eliminate the German trench lines with their machine gun and Infantry support gun positions, the Allied infantry would follow and secure the breach, and the cavalry would exploit the breach in the trench lines by attacking into the depth of German-held territory, eventually capturing the field artillery positions and interdicting logistics and reserves being brought up from the rear areas. Naval crews initially used to operate the installed naval guns and machine guns were replaced with Army personnel who were more aware of the infantry tactics with which the tanks were intended to cooperate. However, there was no way to communicate between the tank's crew and the accompanying infantry, or between the tanks participating in combat. Radios were not yet made portable or robust enough to be mounted in a tank, although Morse Code transmitters were installed in some Mark IVs at Cambrai as messaging vehicles,.[1] Attaching a field telephone to the rear would become a practice only during the next war. With greater use of tanks by both sides it was realized that the accompanying infantry could be forced to ground by ambush fire, thus separating them from the tanks, which would continue to advance, eventually finding themselves exposed to close-assaults by German infantry and sappers.

The early tanks were mechanically rudimentary. The 0.23-to-0.47-inch (5.8 to 11.9 mm) armor generally prevented penetration by small arms fire and shell fragments. However, even a near miss from a field artillery or an impact from a mortar HE round easily disabled the tank, or destroyed it if the fuel tank was ruptured, incinerating the tank's crew. The need for a 'male' variant was recognized as a tactical necessity to defeat any infantry field pieces found in the trench lines which could easily disable tank track with the HE ammunition. This was achieved by mounting a QF 6 pounder Hotchkiss light 57 mm naval gun mounted in the hull barbettes. Hull and track engineering was largely dictated by the terrain—the need to cross wide trenches—although the relationship between ground pressure and soil-vehicle mechanics was not resolved until the Second World War. Turrets were later introduced on medium and light tanks to react to ambushes during the advance .

3 - First World War

The tank, when it appeared on the Western Front in September 1916, was a total surprise to the German troops, though not to the German General Staff. The French Army Staff was highly critical of the British Army's early fielding of the Mark I vehicles in small numbers because the French trials showed the armored vehicles to be highly unreliable. They judged that large numbers had to be employed to sustain an offensive despite losses to mechanical failure or vehicles being foundered in intractable no man's land terrain. These losses, coupled with those from enemy artillery fire, later amounted to as high as 70% of the starters during some operations. Deploying small numbers of tanks would therefore cause the Allies to lose the element of surprise, allowing Germans to develop countermeasures.

3 – 1 - Anti-tank weapons

Because the German Army was the only force in need of anti-tank weapons, it was they that had to develop a viable technology to combat the tank. These technologies took three ammunition approaches: use of grenades by infantrymen, including the *Geballte Ladung* ("Bundled Charge") of several stick grenades bound together by pioneers; early attempts at the small-caliber anti-tank rifles like the 13 mm Mauser bolt-action; and 3.7 cm TaK Rheinmetall in starrer Räder-lafette 1916 anti-tank gun on a light carriage which could destroy a tank[2] using large-caliber armor piercing ammunition issued in 1917 to special commands; and the existing 77 mm field guns (such as the 7.7 cm FK 16) of the infantry division's artillery regiment were also eventually issued with special armor piercing (AP) ammunition.

3 – 2 - Anti-tank tactics

With the appearance of Allied tanks the German Army were quick to introduce new anti-tank defense detachments within the pioneer battalions of the infantry divisions. These were initially issued 1.3 cm caliber long barrel rifles firing solid shot. However these suffered from fouling after 2–3 rounds and had a recoil that was unsustainable by the mechanism or the rifleman. Stick grenades were used to destroy the tracks by individual pioneers, however this required for accompanying machine-gunners to first separate the supporting Allied infantry line from the tanks, which proved difficult. Another tactic was to lure the tank beyond the German trench-line, re-establishing it just as the Allied infantry approached. The tank would then be engaged by the divisional *7.7 cm* guns brought forward, that would try to disable the tracks with ordinary HE shells (and later AP ammunition). If the crews of the disabled tanks refuzed to surrender, they were engaged with flamethrowers, or a mortar would be fired on the stricken vehicle until a direct hit was achieved on the top surface, usually resulting in an internal fire. Finally, anti-tank obstacles were prepared on the likely approaches by deepening and widening existing ground cratering, the precursors of the anti-tank trench. Finally in early 1917 the *3.7 cm TaK* from Rheinmetall was rushed to the frontline, and proved effective in destroying the tanks despite limited elevation and traverse.

4 - Development between the World wars

Lack of consensus on the design and use of the tank after the First World War also influenced the development of its anti-tank countermeasures. However, because Germany was restricted by the Treaty of Versailles#Military restrictions in its military capability, and there were no other challenges to France and Britain, very little development took place in anti-tank warfare until the 1930s.

The Interwar period was dominated by the strategic thinking with fortified borders at its core. These included obstacles consisted of natural features such as ditches, streams and urban areas, or constructed obstacles such as anti-tank ditches, minefields, dragon's teeth, or log barriers. The pinnacle of this strategic thinking was considered to be the Maginot Line which replaced infantry-filled trenches with artillery-filled bunkers, including casemates housing 37 or 47 mm anti-tank guns, and steel turrets armed with a pair of machine guns and a 25 mm anti-tank gun, although Germany was forbidden to produce tanks. The construction was partially based on the Allied experience with the Hindenburg Line which was breached with tank support during the battles of Cambrai and St. Quentin Canal, although German Command was more impressed by the surprise achieved by the Canadian troops at the Battle of the Canal du Nord. This came to influence their planning in 1940.

The Maginot line defenses - up to 16 miles deep from the forward positions to the rear line - were intended to prevent a surprise attack and delay any attack while the French Army was mobilized. With the relative numerical inferiority between the France and Germany, it was a more effective use of manpower. Within the line passive anti-tank obstacles were supported by anti-infantry and anti-tank bunkers. After Belgium declared neutrality in 1936, France began work on extending the line along the Belgian border.

Improved artillery was seen as the quickest solution to anti-tank defense, and one of the earliest post-war anti-tank gun designs was the 25 mm Hotchkiss model from France. It was intended to replace an Atelier de Puteaux 37 mm weapon designed in 1916 to destroy machine gun positions. Rheinmetall commenced design of a 37 mm anti-tank gun in 1924 and the first guns were produced in 1928 as 3.7 cm Pak L/45, later adopted in Wehrmacht service as 3.7 cm Pak 36. It made an appearance during the Spanish Civil War, as did the Bofors 37 mm developed in Sweden, and used by many early Second World War combatants. The British Army accepted for service the (40 mm) Ordnance QF 2 pounder which was developed as a tank gun. The Soviet Red Army after the Russian Civil War also begun a search for an anti-tank gun with a French Hotchkiss 37 mm L.33 tank gun, but soon upgraded this to a higher velocity L.45 Model 1935 while also making a licensed copy of the German 3.7 cm PaK 35. However, the Red Army was almost immediately taught a lesson about anti-tank warfare when a tank battalion sent to aid the Spanish Communists in the Spanish Civil War was almost entirely destroyed in an engagement.

At this time the predominant ammunition used against tanks was the armor piercing kinetic energy shell that defeated armor by direct pressure, spiking or punching through it. During the late 1930s shaped charge ammunition was experimented with that used chemical energy for armor penetration. More difficult to manufacture, its advantage was in that on impact it created a high-velocity jet of molten metal which created tremendously high pressures, hydrodynamically deforming the armor. The depth of the penetration, though proportional to the length of the jet and the square root of its density, is also dependent on the strength of the armor. With the development of this new ammunition begun more advanced research into steel manufacturing, and development of spaced armor that caused "jet waver" by detonating prematurely or at the wrong angle to the surface of the main armor.

The only significant attempt to experiment in the use of tanks in the late 1920s was that of the British Army's Experimental Mechanized Force that influenced future development of tanks, armored troops and entire armies of both its future enemies and allies in the next war.

In Spain the anti-tank defense of the Nationalists was organized by the Wehrmacht officers, and the anti-tank guns were incorporated into a system of obstacles that were constructed with the intent to stop an attack by tanks by slowing it down, separating them from supporting infantry (advancing on foot) with machine-gun and mortar fire, and forcing tanks to conduct deliberate head-on assaults with engineer support, or seek a less-defended area to attack. Minefields laid with purpose-designed mines were used for the first time, destroying tank tracks, and forcing combat engineers to clear them on foot. Delay meant that Nationalist field artillery could engage the lightly armored Soviet tanks. This meant a change in Republican operational and eventually strategic planning, and a more protracted combat operations, with more casualties at a greater cost.

The only change to the German anti-tank tactics of the First World War was that now an effective anti-tank weapon was available to support the defending infantry. However, the Soviet tanks armed with 45 mm guns easily destroyed the German light tanks.

Ironically, in the early 1930s until the Spanish War, German officers were conducting secret testing of a new way of employing tanks, infantry and artillery offensively in the Soviet Union with the cooperation of the Red Army. In Germany these developments eventually culminated in tactics that later came to be known as Blitzkrieg, while in the Soviet Union they formed the core of the deep battle operational doctrine. The successful test of the latter was during the Battles of Khalkhin Gol although the Red Army foundered on the Mannerheim Line in 1940, largely due to the purge in the Officer Corps, claiming many of the senior proponents of the new doctrine. Anti-tank artillery would be included in mobile tank-led Wehrmacht and Red Army units due to the possibility of encountering enemy tanks in a meeting engagement.

The new doctrines of using the tank, were divided into infantry and cavalry schools of thought. The former regarded the tank as a mobile artillery system to be used for infantry support. This suggested that the infantry needed to be armed with integral anti-tank weapons. The latter advocated use of tanks in the traditional cavalry way of high-tempo attacks intended to outflank the enemy infantry and sever its communication lines. This approach suggested that the tank was the best anti-tank system, and only limited anti-tank troops were required to accompany them. For this reason the late 30s tank configurations came in a great diversity, ranging from light tankettes and cavalry tanks to multi-turreted heavy tanks resembling bunkers, all of which had to be considered in training by the anti-tank artillery troops. The development of these doctrines was the most significant influence on the rapid development in anti-tank technology and tactics in the Second World War.

5 - Second World War

Two aspects of how the Second World War commenced helped to delay development of anti-tank warfare: resignation and surprise. After Poland was attacked, its allies in the West were resigned to its defeat by a numerically superior Wehrmacht. The little information that was brought out about the conduct of combat during that campaign did nothing to convince either France, Britain or the USSR of the need for improved anti-tank technology and tactics. The reliance on the Maginot Line, and the subsequent surprise of the German offensive left no time to develop existing capabilities and tactics in the West. The British were preparing the stop lines and the anti-tank islands to slow enemy progress and restrict the route of an attack. The Red Army however was fortunate in having several excellent designs for anti-tank warfare that were either in final stages of development for production, or had been rejected earlier as unnecessary and could now be rushed into production. The relative ease with which the older models of Red Army's tank fleet were destroyed by German anti-tank weapons, using tactics already seen in Spain, once and for all focused Stavka attention on anti-tank warfare as Soviet armies were repeatedly encircled by panzer-led strategic pincer maneuvers. Of the three iconic Soviet weapons of the Second World War, two were made exclusively for anti-tank warfare, the T-34 and the Ilyushin Il-2 *Shturmovik*. The former was one of the most manufactured tanks in history, and the latter, itself dubbed the 'flying tank', was one of the most manufactured aircraft. The war also saw the creation and almost immediate abandonment of the self-propelled tank destroyer which would be replaced post war by the anti tank guided missile.

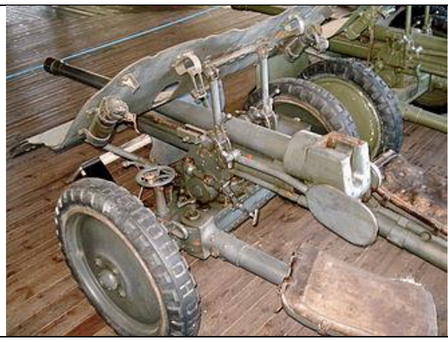
5 – 1 – Aircraft

As tanks were rarely used in conflicts between the two World Wars, no specific aircraft or tactics were developed to combat them from the air. One solution adopted by almost all European air forces was to use bomb loads for conventional bombers that were composed from small bombs allowing a higher density during bombing. This created a greater chance of causing a direct impact on the thinner top armor of the tank while also having the ability to damage track and wheels through proximity detonation. The first aircraft capable of engaging tanks were the Junkers Ju-87 "Stuka" using dive bombing to place the bomb close to the target. Some French and German fighters fitted with 20 mm cannon were also able to engage thinner top armor surfaces of the tanks early in the war. The Stuka was also given cannons for anti-armor role though it was obsolete by 1942, and was joined by the Henschel Hs 129 that mounted a podded 30 mm (1.2 in) MK 101 cannon beneath its fuzelage, while the Red Army Air Force fielded the Soviet Ilyushin Il-2 armed with a pair of 23 mm cannons and unguided rockets, but armored to enable the pilots to approach German tanks at very low altitude, ignoring small arms, machine-gun and even small anti-aircraft cannon fire that usually provided tanks with protection against the bombers. The RAF mounted two underwing pod-mounted 40 mm Vickers S cannon on the Hawker Hurricane (as the Mk. IID) to give it more firepower against tanks which saw service in North Africa in 1942 and the Hawker Typhoon was given HE rockets though these were more effective against other ground vehicles. From March 1943 the Red Army Air Force produced the more agile Yakovlev Yak-9T (37 mm cannon) and K (45 mm cannon) bomber interceptor also used for ground attack, both guns in mounts attached to the engine, that had them firing through a hollow-center propeller shaft.

5 – 2 – Field artillery

Field artillery were often the first ground combat arm to engage detected concentration of troops which included tanks through artillery airborne observers, either in assembly areas (for refueling and rearming), during approach marches to the combat zone, or as the tank unit was forming up for the attack. Conventional artillery shells were very effective against the tank's thinner top armor if fired in appropriate density while the tanks were concentrated, enabling direct hits by a sufficiently powerful shell. Even a non-penetrating shell could still disable a tank through dynamic shock, internal armor shattering or simply overturning the tank. More importantly the tanks could be disabled due to damage to tracks and wheels, and their supporting vehicles and personnel could be damaged and killed, reducing unit's ability to fight in the longer term. Because tanks were usually accompanied by infantry mounted on trucks or half-tracked vehicles that lacked overhead armor, field artillery that fired a mix of ground and air-burst ammunition was likely to inflict heavy casualties on the infantry as well. Field guns such as the Ordnance QF 25 pounder were provided with armor-piercing shot for direct engagement of enemy tanks.

5 – 3 – Anti-tank guns

	
German PaK 38 50-mm anti-tank gun	*Bofors 37 mm anti-tank gun as used by several nations*

Anti-tank guns are guns designed to destroy armored vehicles from defensive positions. In order to penetrate vehicle armor they fire smaller caliber shells from longer-barreled guns to achieve higher muzzle velocity than field artillery weapons, many of which are howitzers. The higher velocity, flatter trajectory ballistics provide terminal kinetic energy to penetrate the moving/static target's armor at a given range and contact's angle. Any field artillery cannon with barrel length 15 to 25 times longer than its caliber was able also to fire anti-tank ammunition, such as the Soviet A-19.

Prior to World War II few anti-tank guns had calibers larger than 50 mm. Examples of guns in this class include the German 37 mm, US 37 mm (the largest gun able to be towed by the jeep), French 25 mm and 47 mm guns, British QF 2-pounder (40 mm), Italian 47 mm and Soviet 45 mm. All of these light weapons could penetrate the thin armor found on most pre-war and early war tanks.

At the start of World War II many of these weapons were still being used operationally, along with a newer generation of light guns that closely resembled their WWI counterparts. After Soviet T-34 and KV tanks were encountered these guns were recognized as ineffective against sloped armor, with the German lightweight 37 mm gun quickly nicknamed the "tank door knocker" (German: *Panzeranklopfgerät*), for revealing its presence without penetrating the armor.

Germany quickly introduced more powerful anti-tank guns, some which had been in the early stages of development prior to the war. By late 1942 the Germans had an excellent 50-mm high-velocity design, while they faced the QF 6-pounder introduced in the North African Campaign by the British Army, and later adopted by the US Army. By 1943 Wehrmacht was forced to adopt still larger calibers on the Eastern Front, the 75 mm and the famous 88 mm guns. The Red Army used a variety of 45 mm, 57 mm, and 100 mm guns, as well as deploying general-purpose 76.2 mm and 122-mm guns in the anti-tank role. For the Invasion of Normandy the British QF 17 pounder, whose design had begun before the 6 pounder entered service, was produced that proved to be a highly effective anti-tank gun also used as a tank and tank destroyer gun.

5 – 3 - 1 - Self-propelled anti-tank guns

A British Archer tank destroyer, based on the hull of a Valentine tank

As towed anti-tank cannon guns grew in size and weight, they became less mobile and more cumbersome to maneuver, and required ever larger gun crews, who often had to wrestle the gun into position while under heavy artillery and/or tank fire. As the war progressed, this disadvantage often resulted in the loss or destruction of both the antitank gun and its trained crew. This gave impetus to the development of the self-propelled, lightly armored "tank destroyer" (TD). The tank destroyer was usually based on the hull of existing tank designs, using either a gun integrated into the hull or a fully rotating turret much like that of a conventional tank. These self-propelled (SP) AT guns were first employed as infantry support weapons in place of towed antitank guns. Later, due to a shortage of tanks, TDs sometimes replaced the former in offensive armored operations.

Early German-designed tank destroyers, such as the Marder I, employed existing light French or Czech design tank chassis, installing an AT gun as part of an armored, turret-less superstructure. This method to reduced both weight and conversion costs. The Soviet Union later adopted this style of self-propelled anti-tank gun or tank destroyer. This type of tank destroyer had the advantage of a reduced silhouette, allowing the crew to more frequently fire from defilade ambush positions. Such designs were easier and faster to manufacture and offered good crew protection, though the lack of a turret limited the gun's traverse to a few degrees. This meant that if the TD became immobilized due to engine failure or track damage, it could not rotate its gun to counter opposing tanks, making it an easy target. This vulnerability was later exploited by opposing tank forces. Late in the war, it was not unusual to find even the largest and most powerful tank destroyer abandoned on the field after a battle, having been immobilized by a single high explosive shell to the track or front drive sprocket.

US Army pre-war infantry support doctrines emphasized the use of tank destroyers with open-top fully rotating turrets, featuring less armor than the standard M4 Sherman tanks, but with more powerful cannon. A 76 mm long-barrel tank cannon was fitted to the M10 and M18 designs. Late in 1944, the M36 appeared, equipped with a 90 mm cannon. With rotating turrets and good combat maneuver ability, American TD designs generally worked well, although their light armor was no match for enemy tank cannon fire during one on one confrontations. Another disadvantage proved to be the open, unprotected turret, and casualties from artillery fire soon led to the introduction of folding armor turret covers. Near the war's end, a change in official doctrine caused both the self-propelled tank destroyer and the towed antitank gun to fall from favor in U.S. service, increasingly replaced by conventional tanks or infantry level antitank weapons. Despite this change, the M36 tank destroyer continued in service, and was used in combat as late as the Korean War.

5 – 4 - Infantry

5 – 4 - 1 - Rifles

Anti-tank rifles were introduced in some armies before the Second World War to provide infantry with a stand-off weapon when confronted with a tank assault. The intention was to preserve good morale of the infantry by using a weapon that could actually defeat a tank.

Anti-tank rifles were developed in several countries during the 1930s. By the beginning of WW2, anti-tank rifle teams could knock out most tanks from a distance of about 500 m, and do so with a weapon that was man-portable and easily concealed. Although the AT rifle performance was negated by the increased armor of medium and heavy tanks by 1942, they remained viable against lighter-armored and unarmored vehicles, and against field fortification embrasures.

Notable examples include the Finnish Lahti L-39 (which was also used as a sniper rifle during the Continuation War), the automatic Japanese Type 97 20 mm anti-tank rifle, the German Panzerbüchse 38, Panzerbüchse 39, the Polish wz.35 and the Soviet 14.5 mm PTRD and PTRS-41.

Although by 1943 other armies judged the anti-tank rifle to lack combat effectiveness due to their diminished ability to penetrate the thicker armor of new tanks, the anti-tank rifle remained in Soviet use during the conflict for its place in the system of anti-tank defensive tactics.

5 – 4 - 2 - Rockets and shaped charges

British PIAT

The development of light, man-portable, anti-tank weapons increased during the Second World War. Most were based on the Munroe effect which led to the development of the high explosive shaped charge. These weapons were called High Explosive Anti-Tank (HEAT). The destructive effect was reliant entirely on the kinetic energy of the explosion rather than the ballistic speed of the round on the damage inflicted to the armor. The effect was also concentrated and could penetrate more armor for a given amount of explosives. The first HEAT rounds were rifle grenades, but better delivery systems were soon introduced: the British PIAT was propelled by an explosive charge combined with a powerful spring, the US Bazooka and the German *Panzerschreck* used rockets; The German *Panzerfaust* was a small recoilless gun. The HEAT warhead was retroactively used to give more power to smaller calibre weapons such as in the conversion of the otherwise limited German 37 mm PaK guns to fire a large shell (that fitted over the barrel rather than down in it) to a greater range than the *Panzerschreck* could manage.

After the war research on infantry anti-tank weapons continued, with most designers focused on two primary goals: First an anti-tank weapon that could defeat more heavily armored postwar tanks and fighting vehicles, and second a weapon lightweight and portable enough for infantry use.

5 – 4 - 3 - Mines and other explosives

	
Sticky bomb in production	*A statue of a Vietminh soldier holding a Lunge AT Mine.*

Though unsophisticated, the satchel charge was an effective anti-tank weapon during World War II; the blast could sever the tracks of a tank, damage internal components or injure the crew.

Hawkins mine

The Wehrmacht employed the Goliath tracked mine, an unmanned demolition vehicle

The Soviet Union employed anti-tank dogs during World War II, with very limited success; as a counterpart to the German Goliath the Teletank was used as a remote-controlled unmanned tank.

The Japanese forces employed suicide attacks with pole-mounted anti-tank mines dubbed Lunge Mines during late World War II

5 – 4 – 4 – Grenades

Regular fragmentation grenades were ineffective against tanks, so many kinds of anti-tank grenades were developed. These ranged from hollow charge designs (e.g., the British No. 68 AT Grenade), to ones that simply contained a lot of explosive (the British No. 73 Grenade). To increase their effectiveness, some grenades were designed so that they adhered to the tank either through an adhesive (sticky bomb) or with a magnet. The Germans used a magnetic grenade, the Hafthohlladung to ensure that the shaped charge would fire at the optimal 90° angle to the armor.

There was also a special type of grenade called the *Nebelhandgranaten* or *Blendkörper* ("smoke hand grenades"), which was supposed to be smashed over an air vent and fill the tank with smoke, widely used by both sides in World War II. Molotov cocktails also saw much use, especially in the Winter War, early tanks (such as the T-26) being very vulnerable to them, but later tanks required a well-thrown bottle directly over the engine compartment to have any effect at all.

On the whole, thrown anti-tank weapons suffered from a variety of drawbacks. In addition to the inherently short range, they required careful aim to be effective, and those that relied on explosive force were often so powerful that the user had to take cover immediately.

5 – 5 – Tactics

Anti-tank tactics developed rapidly during the war but along different paths in different armies based on the threats they faced and the technologies they were able to produce. Very little development took place in UK because weapons available in 1940 were judged adequate for engaging Italian and German tanks during most of the North African Campaign. Its experience therefore failed to influence US Army's anti-tank doctrine prior to 1944. From 1941 German anti-tank tactics developed rapidly as a result of being surprised by the previously unknown Soviet tank designs, forcing introduction of new technologies and new tactics. The Red Army was also faced with a new challenge in anti-tank warfare after losing most of its tank fleet and a considerable part of its anti-tank capable cannons.

Anti-tank tactics during the war were largely integrated with the offensive or defensive posture of the troops being supported, usually infantry. Much of anti-tank tactics depend on the range effectiveness of various weapons and weapon systems available. These are divided as follows:

Operational range over the horizon (20–40 km range) – bomber aircraft and long range artillery

Tactical staging areas (7–20 km range) – ground attack aircraft and field artillery including MRLs

Tactical zone forming-up area and rear combat zone (2–7 km range) – heavy anti-tank guns and mortars

Tactical forward combat zone (1–2 km range) – anti-tank guns and tanks deployed in defense

Engagement distance (200–1000 m range) – mines and anti-tank rifles

Close combat distance (25–200 m range) – infantry anti-tank weapons

Ground-to-air cooperation was not yet systematic in any army of the period, but given sufficient warning ground attack aircraft could support ground troops even during an enemy attack in an attempt to interdict the enemy units before they come into tactical combat zone. Various bomb loads can be used depending on what type of tank unit is engaged in at the time or who its accompanying troops are. This is an indirect form of anti-tank warfare where the tanks are denied the opportunity to even reach combat.

Field artillery was particularly effective in firing against tank formations because although they were rarely able to destroy a tank by direct penetration, they would severely crater the area preventing the tanks from moving therefore causing them to become nearly stationary targets for the ground attack aircraft, or disrupting the enemy schedule and allowing own troops more time to prepare their defense.

Anti-tank defense proper was by 1942 designed in First World War fashion with several prepared trench lines incorporating anti-tank weapons of different capabilities. Depending on terrain and available line-of-sight, the longer-ranged guns could begin to fire on approaching tanks from as far as 2 kilometers, which was also the range at which German Panther and Tiger tank gunners were trained to fire. Anti-tank guns were usually deployed to cover terrain more suitable for tanks, and were protected by minefields laid at about 500 meters to 1 kilometer from their positions by combat engineers. In the Red Army the anti-tank rifle units would be positioned throughout the forward trench line and would engage the lighter tanks and any other vehicles, such as infantry half-tracks in an attempt to separate them from the tanks. The anti-tank guns deployed further back would often hold their fire until enemy tanks were within the most effective range for their ammunition. Where there were insufficient anti-tank weapons, engineers would construct anti-tank obstacles such as dragon's teeth.

Towed anti-tank guns were thought to be the primary means of defeating tanks. At the battle of Kursk for example, the Red Army deployed more artillery regiments than infantry regiments and towed gun densities reached over 20 guns per kilometer of defended tactical zone. A towed gun was much cheaper than a tank and could be concealed in a shallow position. When time allowed, dugouts with strong overhead cover could be constructed. Guns deployed on reverse slopes and in flanking positions could take a toll of attacking tanks. However, gun crews were vulnerable to artillery, mortar HE fire and enemy infantry. Their positions had to be carefully selected and once engaged, they generally could not redeploy. Experience strongly suggested that towed AT guns were less effective than self-propelled AT weapons and took heavier casualties.

Self-propelled anti-tank guns were rare at the beginning of WW2, although the Belgian Army deployed a few T.15 tank destroyers and the French army was developing several wheeled and tracked designs. The advantages of mobility and even thin armor protection were so compelling that most armies were using self-propelled AT guns by mid-war. Examples of these weapons included the US M10, German Marder II, and Soviet SU-85.

The British Army had abandoned the anti-tank rifle by 1942 and the Wehrmacht by 1943, while the US Army never adopted the weapon, although the USMC used Boys anti-tank rifles in the Pacific Theater. The Red Army did not abandon the anti-tank rifle due to the importance it occupied in its doctrine of anti-tank in-depth defense, first demonstrated during the defense of Moscow and again during the Kursk battles. This became particularly true later in the war when the Red Army assumed an almost constant offensive, and anti-tank in-depth defensive deployments were used for protecting flanks of the operational breakthroughs against German tactical counterattacks. By firing on the lighter armored infantry and support vehicles (e.g. artillery tractors) the anti-tank rifle units helped to separate the supporting infantry (*panzergrenadiers*) and artillery of the German tanks and so forced the tanks to halt at short distances from the concealed anti-tank guns leaving them exposed to fire from larger, longer ranged anti-tank guns. PTRS-41 semi-automatic anti-tank rifles were also used for sniping since an additional tracer round enabled rapid fire adjustment by the gunner. Although optical sniper scopes were tried with the PTRS-41, the weapons proved too inaccurate at sniping distances (800 m or more), and the recoil to much for effective use of the scopes.

5 – 5 – 1 - Infantry close assault

The tank is still vulnerable to infantry, especially in close country or built-up areas. Rough terrain may expose the floor armor, and high ground such as multi-story buildings may expose the top armor. Their large size and loud noise can allow enemy infantry to spot, track and evade tanks until an opportunity presents itself for counter-attack.

Because tank crews have limited visibility from inside the tank, infantry can get close to a tank given enough concealment and if the hatches are closed. If tank crewmen unbutton for better visibility they become vulnerable to small arms fire. An infantryman cannot be targeted by a tank's main gun when close as it cannot depress sufficiently. Close defense weapons such as pistol ports, hull-, coaxial- and pintle-mounted machine guns gave them some protection however.

Whilst many hand-held infantry anti-tank weapons will not penetrate the front armor of a tank, they may penetrate the less heavily armored top, rear, and sides. Damage to the tracks or running gear can inflict a mobility kill. Early WWII tanks had open vision slits which could be fired through to kill the crew. Later tanks' slits had thick glass, as well as sights and periscopes which could still be damaged with powerful small arms such as anti-tank rifles and heavy machine guns, hampering the crew. If all else fails, the hatch could also be forced open and grenades thrown inside, although later tank designs often have hatches designed to be difficult to open from the outside.

Tanks were also vulnerable to hand-placed anti-tank mines. Infantry have even immobilized tanks using a set of plates covered with leaves and dirt as dummy mines – the ruse being augmented by the crew's obscured vision – infantry can then attack the stopped tank. This tactic was taught to the British Home Guard during World War II since they were not often provided with long-range anti-tank weapons.

In some cases in World War II, a tactic of some infantry was to run directly up to a tank, avoiding their main and machine guns, and pour petroleum over and into the tank and light it, sometimes blocking the exit, burning the crew alive.

In the Japanese army, the use of satchel charges and pole charges was widespread. Although the charges could knock out any allied tank, the tactic was extremely close-range and the sappers were vulnerable to allied weapons.

6 - Korean War

The Korean War highlighted the difficulties that can arise with tank forces when vulnerable logistical support is combined with terrain not suitable for tanks. In the early stages of the war, North Korea's well-equipped tank divisions were pushed back to the Yalu River, the border with China, by superior American air power combined with artillery and infantry support. However, when the Chinese entered the war, they managed to reverse the American advances with infantry power alone. Because of the terrain and the need to keep the tanks supplied, American tanks were limited to two main roads. The Chinese merely occupied the land between the roads and harried the American supply lines and troop transports along the road. The Chinese infantry stuck to land that was impassable to tanks, such as rocky prominences and rice paddies, neutralizing the advantage of both American armored divisions and air support.

In the U.S., the 2.36 in (60 mm) M9A1 bazooka rocket launcher evolved into the more powerful 3.5 in (89 mm) M20 "Super Bazooka", which was used to good effect against North Korean armored spearheads during the Korean War. However, the M20 proved difficult and cumbersome to portage on foot over long distances. The Anti-Tank Aircraft Rocket, developed by the navy, also proved effective against North Korean tanks.

7 - Cold War

In the Cold War era, HEAT became an almost universal choice outside of artillery and tank units. The British had developed the High explosive squash head (HESH) warhead as a weapon for attacking fortifications during the war, and found it surprisingly effective against tanks. Although these systems allowed infantry to take on even the largest tanks, and, like HEAT, its effectiveness was independent of range, infantry typically operated at short range. A major influence in anti-tank warfare came with the development and evolution of anti-tank guided missiles (ATGW) that could be fired by infantry operators, from ground vehicles and by aircraft. Increasing use of combined arms tactics allowed the attacking infantry to suppress the anti-tank crews effectively, meaning that they could typically get off only one or two shots before being countered or forced to move.

7 – 1 – Aircraft

Cold War aircraft, such as the A-10 Thunderbolt II and SU-25 Frogfoot, have been specifically built for close air support, including tank destruction. They can use a variety of weaponry, including large-caliber anti-tank guns, air-to-surface missiles (e.g. AGM-65 Maverick), volleys of unguided rockets, and various bombs (unguided or laser-guided and with or without submunitions such as HEAT bomblets, an example of which would be the CBU-100 Cluster Bomb).

7 – 2 – Helicopters

British Army Westland WAH-64 Apache, an anti-tank helicopter

Anti-tank missiles were first used in a helicopter-borne role by the French in the late 1950s, when they mounted SS.11 wire-guided missiles on Alouette II helicopters.[6] While, initially, there were many teething problems, the possibilities were clear, such as providing the ability to attack the more lightly armored top of the tank.

The anti-tank helicopter armed with ATGWs (Anti-Tank Guided Weapons) or anti-tank cannons is one of the biggest threats to a modern tank. The helicopter can position itself where it is not easily seen from a tank and then attack from any quarter, exposing the weaker parts of the tank's armor. The limited visibility from a closed-down tank also makes sighting a helicopter harder.

Most helicopter-launched ATGWs have sufficient range that they can under the right conditions be fired at a range too long for the tank to retaliate with its own weapons. This may change with the Israelis fielding the Lahat missile that can be fired from the main gun of the Merkava MBT. With both anti-tank and anti-helicopter role, it does level the playing field somewhat. The Indian Arjun tank has also been modified to fire this missile. The People's Republic of China has developed 100 mm gun-launched missiles based on Russian designs such as the GP2 (based on the Russian Bastion). It has been reported to have successfully engaged aerial targets, as well as being an anti-tank missile. Similar missiles are available for Chinese tanks equipped with the 105 mm gun. The Russians have also displayed a similar if more advanced system in the Reflex. The system involves an automatic targeting of an aerial/land target instigated by a laser warning system.

Although putting weapons on helicopters (probably) dates back to 1955 with the Bell 47, the first specific attack helicopter that went into mass production was the Bell AH-1 Cobra in 1966. The AH-1 was equipped with TOW missiles in 1973 for anti-tank capability.[7]

7 – 3 – Artillery

In the last thirty years, however, a variety of artillery projectiles have been developed specifically to attack tanks. These include laser-guided projectiles, such as the US's Copperhead Cannon Launched Guided Projectile (CLGP), which increases the chances of a direct hit. Some of these CLGPs (including the Copperhead) have HEAT warheads instead of common HE.

Guided and unguided scatter munitions and submunitions have also been developed: a single artillery shell containing a number of smaller munitions designed to attack a tank. A six-gun battery might be able to fire several hundred submunitions in a minute or two.

In one form, the shell bursts in the air above the tank and a number of shaped charge (HEAT) or HEDP (High Explosive Dual Purpose) bomblets or grenades rain down. Any that hit the tank have a good chance of causing damage, since they are attacking the thin top armor.

Another form scatters a number of small anti-tank mines in the tank's path, which probably will not penetrate the armor but can damage a track, leaving the tank immobile and vulnerable.

More sophisticated are sub munitions with a homing capability. Once again the shell explodes above the tank position and dispenses a number of sub munitions. The munitions contain some circuitry to identify tanks, such as IR or millimeter radar; when a tank is identified, a rocket propellant is fired to shoot the projectile at the tank. These munitions will often descend by parachute, to allow time for target acquisition and attack.

All of the above but the CLGP can be fired from medium (122/152/155-mm) artillery, both tube and rocket. There has also been development of large caliber (81 mm and larger) guided mortar munitions with both internal (e.g., IR or radar) or external (i.e., laser designator) guidance.

7 – 4 – Missiles

The development of the (wire) guided missile, or Anti-Tank Guided Weapon (ATGW) systems came into use in the late 1950s and 1960s that could defeat any known tank at ranges beyond that of the guns of the accompanying infantry. The United Kingdom, France, and other NATO countries were among the first to develop such weapons (e.g., the Malkara missile by the UK and Australia in 1958). The Soviet Union, and now Russia, put extensive development into these weapons; the first man-portable model to enter service was the AT-3 in 1961. The United States was one of the last, coming up with the BGM-71 TOW in 1970. For a time, it appeared that the tank was a dead end. A small team of infantry with a few missiles in a well-concealed position could take on a number of the largest and most expensive tanks. In the 1973 Yom Kippur War, Soviet first-generation wire-guided missiles employed by the Egyptian forces inflicted heavy casualties on Israeli tank units, causing a major crisis of confidence for tank designers.

Active protection systems such as the Russian Arena active protection system are starting to be more common, with similar systems such as the Israeli Iron Fist active protection system. The tank may be on a comeback because of active defense systems, which attack missiles in mid-air. This may allow the tank to be competitive on the battlefield once again.

7 – 5 – Guns

Of the world's major armies, only the Soviet Red Army retained anti-tank guns in any significant quantity, mostly in 100 mm, 115 mm, and 125 mm calibers. The 125 mm anti-tank guns are extremely bulky and massive, and require large tractors to tow them for any significant distance. This is offset by their cheapness and potentially deadly effect, particularly now that they have been upgraded with laser rangefinders and depleted uranium ammunition .

7 – 6 – Mines

Owing to greater sophistication of the tank, and engineering support available to tank units to detect and negate minefields, a considerable effort was made to develop more effective anti-tank mine technology in the effort to deny tank-led formations maneuver space, or channel their movement into unsuitable avenues of approach.

7 – 7 – Infantry

Australian Army Land Rover Series 2 "gunbuggy" with a M40 recoilless rifle used in the anti-tank role.

The search for a more suitable, longer-range delivery system took up much of the immediate post-war era. The US invested in the recoilless rifle, delivering a widely used 75 mm design, and less common 90 mm and 106 mm designs (the latter was usually mounted rather than infantry-handled). The 106 mm formed the basis of a dedicated anti-tank vehicle, the Ontos tank, which mounted six 106 mm rifles. The Australian Army also fitted M40 recoilless rifles to Land Rover Series 2 vehicles for use in an anti-tank role. The Soviet Union also built recoilless rifles in various calibers intended to be used as anti-tank weapons, most commonly 73 mm, 82 mm, and 110 mm (only the 73 mm remains in service with the Russian military today, though the other two can be found all over the world due to

Soviet military aid during the Cold War). The British used a 120 mm (4.7 inch) design to equip infantry units, the BAT series, which served from the 1950s until replaced by MILAN, but it was generally too heavy for infantry use and had to be towed by, or mounted on, a vehicle for maneuverability.

The Soviets developed the RPG-2 from the German *Panzerfaust 150*. Further development led to the ubiquitous RPG-7. The RPG-7 is one of the most widely used Anti-tank weapons, favored most by soldiers of Irregular Militaries. The RPG-7 could fire a range of different warheads, from Thermobaric warheads to a single HEAT or Tandem-charge HEAT warheads against Explosive reactive armor equipped tanks. The RPG-7 has a long combat history, and has been used in most wars from the Vietnam war all the way to present day wars. In modern times, the RPG-7 is generally used in an Urban environment, which would enhance their effectiveness due to the close ranges involved. However, the aging RPG-7 has evolved to the even more potent RPG-29 which has proven its worth in conflicts in the Middle East, damaging the Merkava IV,[8] Challenger 2[9] and M1 Abrams[10] main battle tanks.

Soviet RPG-7

In the 1960s, the U.S. Army adopted the M72 LAW rocket, a lightweight, collapsible rocket launcher with the ability to penetrate moderate thicknesses of enemy armor. During Vietnam War, the weapon was used primarily against NVA and Viet Cong defensive works and emplacements, as there were few encounters against enemy armor. Overall, the LAW was regarded as a success, though its ignition system frequently suffered from misfires in the heat and humidity of Vietnamese jungles. The LAW has since been replaced by the AT4 (M136).

7 – 8 – Tactics

Changes in the anti-tank tactics since the Second World War mostly came from the appearance of new technologies, and increased firepower of the infantry mounted on fully armored vehicles. The most profound anti-tank technology has been the guided missile, which when coupled with a helicopter can mean that tanks can be engaged beyond ground line of sight (LOS), and at one of their most vulnerable aspect, the top armor.

8 – Effectiveness

The effect of anti-tank warfare is to prevent enemy tanks, and their supporting troops from maneuvering, which is the primary capability of the tanks. In the US Army the degree of effect by an anti-tank weapon on a vehicle is referred to as either "mobility kill", "firepower kill", and "catastrophic kill". In a mobility kill (M-kill), the vehicle loses its ability to move, for example, by breaking a tank track; the target is then immobile, but may retain full use of its weapons and still be able to fight to some extent. A firepower kill (F-kill) is some loss of the vehicle's ability to fire its weapons. M-kills and F-kills may be complete or partial, the latter corresponding to reductions in a target's ability to move or fire. A catastrophic kill (K-kill) removes the tank's ability to fight completely; this may entail complete destruction of the tank or disabling the crew.

8 – 1 – Future

Although the future of the tank was questioned in the 1960s due to the development of the anti-tank missiles, increases in thickness and composition of armor, and other improvements in tank design meant that infantry operated systems were no longer sufficiently effective by the 1970s, and the introduction of Chobham armor by the British Army and reactive armor by the Soviet Army forced the HEAT rounds to be increased in size, rendering them less portable.

Weapon systems like the RPG-29 and FGM-148 Javelin use a Tandem warhead where the first warhead disables reactive armor, while the second warhead defeats the shell armor by means of a HEAT or a shaped charge.

Today the anti-tank role is filled with a variety of weapons, such as portable "top attack" artillery ammunition and missiles, larger HEAT missiles fired from ground vehicles and helicopters, a variety of high velocity autocannon, and ever-larger and heavier tank guns.

One of the first lessons of the 2006 Israel-Lebanon conflict is the effectiveness of portable rocket propelled grenades, in particular, Russian-made RPG-29, and Metis-M, Kornet and European MILAN anti-tank missiles.

Anti - Tank Mine


A Russian TM-46 anti-tank blast mine.

Contents

1 - Introduction

An anti-tank mine, (abbreviated to "AT mine"), is a type of land mine designed to damage or destroy vehicles including tanks and armored fighting vehicles.

Compared to anti-personnel mines, anti-tank mines typically have a much larger explosive charge, and a fuze designed only to be triggered by vehicles or, in some cases, tampering with the mine.

2 – History

2 – 1 - US Civil War

While obviously the anti-tank mine as such did not pre-date the deployment of tanks in 1916, essentially identical devices were used earlier against locomotives. For example during the U.S. Civil War, Confederate forces created pressure-activated anti-railroad mines which destroyed at least two trains.

2 – 2 - First World War

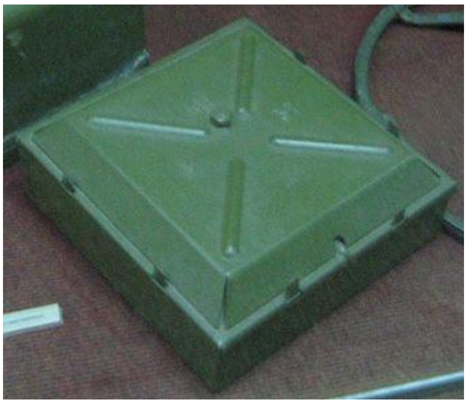
The first anti-tank mines were improvised during the First World War as a counter measure against the first tanks introduced by the British towards the end of the war. Initially they were nothing more than a buried high explosive shell or mortar bomb with its fuze upright. Later purpose built mines were developed, including the Flachmine 17, which was simply a wooden box packed with explosives and triggered either remotely or by a pressure fuze. By the end of the war, the Germans had developed row mining techniques, and mines accounted for 15 % of U.S. tank casualties during the Battle of Saint-Mihiel, Third Battle of the Aisne, Battle of Selle and Meuse-Argonne Offensive.

2 – 3 - Inter-War

The Soviet Union began developing mines in the early 1920s, and in 1924 produced its first anti-tank mine, the EZ mine. The mine, which was developed by Yegorov and Zelinskiy, had a 1 kg charge, which was enough to break the tracks of contemporary tanks. Meanwhile in Germany, defeat spurred the development of anti-tank mines, with the first truly modern mine, the Tellermine 29, entering service in 1929. It was a disc shaped device approximately 30 cm across filled with about 5 kg of high explosives. A second mine, the Tellermine 35 was developed in 1935. Anti-tank mines were used by both sides during the Spanish Civil War. Notably, Republican forces lifted mines placed by Nationalist forces and used them against the Nationalists. This spurred the development of anti-handling devices for anti-tank mines.

The Winter War between the Soviet Union and Finland also saw widespread use of anti-tank mines.

2 – 4 - Second World War

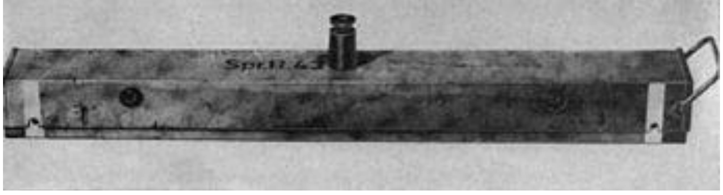


Soviet TM-35 mine at the Museum of Heroic Defense and Liberation of Sevastopol on Sapun Mountain, Sevastopol

The German Tellermine was a purpose-built anti-tank mine developed during the period between the First and Second World Wars, the first model being introduced in 1929. Some variants were of a rectangular shape, but in all cases the outer casing served only as container for the explosives and fuze, without being used to destructive effect (e.g. shrapnel).

Although other measures such as satchel charges, sticky bombs or bombs designed to magnetically adhere to tanks were developed, they do not fall within the category of land mines as they are not buried and detonated remotely or by pressure. The Hawkins mine was a British anti-tank device that could be employed as a mine laid on the road surface for a tank to run over setting off a crush fuze or thrown at the tank in which case a timer fuze was used.

Shaped charge devices like the Hohl-Sprung mine 4672 were also developed by Germany later in the war, although these did not see widespread use. The most advanced German anti-tank mine of the war was their minimal metal Topfmine.



German Riegel mine 43

In contrast to the "dinner plate" mines such as the German Tellermine were "bar mines" such as the German Riegel mine 43 and Italian B-2 mine. These were long mines designed to increase the probability of a vehicle triggering it, the B2 consisted of multiple small shaped-charge explosive charges along its length designed to ensure a mobility kill against enemy vehicles by destroying their tracks. This form of mine was the inspiration for the British L9 Bar Mine.

2 – 5 – Modern

Several advances have been made in the development of modern anti-tank mines, including :

more effective explosive payloads (different explosive compounds and shaped charge effects)

use of non-ferrous materials making them harder to detect

new methods of deployment (from aircraft or with artillery)

more sophisticated fuzes (triggered by seismic effects or combinations of effects)

sophisticated "anti-handling" devices to prevent or discourage tampering or removal.

3 – Design

More modern anti-tank mines are usually more advanced than simple containers full of explosives detonated by remote or the vehicles pressure. The biggest advances were made in the following areas:

Power of the explosives (explosives such as RDX).

Shaped charges to increase the armour piercing effect.

Advanced dispersal systems.

More advanced or specific detonation triggers.

Most modern mine bodies or casings are made of plastic material to avoid easy detection. They feature combinations of pressure or magnetically activated detonators to ensure that they are only triggered by vehicles.

4 - Dispersal systems

There are several systems for dispersing mines to quickly cover wide areas, as opposed to a soldier laying each one individually. These system can take the form of cluster bombs or be artillery fired. Cluster bombs contain several mines each, which could be a mixture of anti-personnel mines. When the cluster bomb reaches a preset altitude it disperses the mines over a wide area. Some anti-tank mines are designed to be fired by artillery, and arm themselves once they impact the target area.

5 – Off - route mines

Polish MPB mine.

Off-route mines are designed to be effective when detonated next to a vehicle instead of underneath the vehicle. They are useful in cases where the ground or surface is not suitable for burying or concealing a mine. They normally employ a shaped charge to focus the explosive effect in order to pierce armour. However the self forging projectile principle has been used for some French and Soviet off route mines and has earned infamy as an improvised explosive devices (IED) technique in Iraq.

One example of such a device is the US M24 that consists of a rocket launcher tube firing a HEAT rocket that is detonated by a pressure-sensitive tape switch laid across the road.

The term "off - route mine" refers to purpose designed and manufactured anti - tank mines, but most "home made" IEDs are employed in a similar manner.

6 – Countermeasures

The most effective countermeasure deployed against mine fields is mine clearing, using either explosive methods or mechanical methods. Explosive methods, such as the Giant Viper, involve laying explosives across a minefield, either by propelling the charges across the field with rockets, or by dropping them from aircraft, and then detonating the explosive, clearing a path. Mechanical methods include plowing and pressure-forced detonation and the deactivating RS36 Eggtron robot used during combat operations to protect vehicles. In plowing, a specially designed plow attached to the front end of a heavily armored tank is used to push aside the earth and any mines embedded in it, clearing a path as wide as the pushing tank. In pressure - forced detonation, a heavily armored tank pushes a heavy spherical or cylindrical solid metal roller ahead of it, causing mines to detonate.

Casspir Personnel Carrier

There are also several ways of making vehicles resistant to the effects of a mine detonation to reduce the chance of crew injury. In case of a mine's blast effect, this can be done by absorbing the blast energy, deflecting it away from the vehicle hull or increasing the distance between the crew and the points where wheels touch the ground - where any detonations are likely to center.

A simple, and highly effective, technique to protect the occupants of a wheeled vehicle is to fill the tires with water.[2] This will have the effect of absorbing and deflecting the mine's blast energy. Steel plates between the cabin and the wheels can absorb the energy and their effectiveness is enhanced if they can be angled to deflect it away from the cabin. Increasing the distance between the wheels and cabin, as is done on the South African Casspir personnel carrier, is an effective technique although there are mobility and ease of driving problems with such a vehicle.

Steel plates and armoured glass will protect the occupants from fragments. Mounting seats from the sides or roof of the vehicle, rather than the floor, will help protect occupants from shocks transmitted through the structure of the vehicle and a four-point seat harness will minimise the chance of injury if the vehicle is flung onto its side or its roof - a mine may throw a vehicle 5 – 10 m from the detonation point.

7 - Combat use

Anti-tank mines have played an important role in most wars fought since they were first used.

7 – 1 - Korean War

Anti-tank mines are still deployed along the demilitarized zones established and maintained between North Korea and South Korea since the signing of the armistice that ended the Korean War.

7 – 2 – Indo – China

During the Vietnam War, both 'regular' NVA and Viet Cong forces used AT mines. These were of Soviet, Chinese or local manufacture. Anti-tank mines were also used extensively in Cambodia and along the Thai border, planted by Pol Pot's Maoist guerrillas and the Vietnamese army, which invaded Cambodia in 1979 to topple the Khmer Rouge. Millions of these mines remain in the area, despite clearing efforts. It is estimated that they cause hundreds of deaths annually.

7 – 3 - Southern Africa

Conflict in southern Africa since the 1960s have often involved Soviet, US or South African supported irregular armies or fighters engaged in guerrilla warfare. What makes these conflicts significant to the study of anti-tank mines is that they featured the widespread use of these mines in situations other than conventional warfare (or static minefields) and also saw the development of effective mine resistant vehicles. As a result both Angola and Mozambique are littered with such devices to this day (as with Cambodia).

In the Angolan Civil War or South African Border War that covered vast sparsely populated area of southern Angola and northern Namibia, it was easy for small groups to infiltrate and lay their mines on roads before escaping again often undetected. The anti-tank mines were most often placed on public roads used by civilian and military vehicles and had a great psychological effect.

Mines were often laid in complex arrangements. One tactic was to lay multiple mines on top of each other to increase the blast effect. Another common tactic was to link together several mines placed within a few meters of each other, so that all would detonate when any one was triggered.

RG-31 Mine Protected Armored Personnel Carrier (MP APC) in service with the US Army in Iraq in 2006

It was because of this threat that some of the first successful mine protected vehicles were developed by South African military and police forces. Chief amongst these were the Buffel and Casspir armoured personnel carriers and Ratel armoured fighting vehicle.

They employed v-shaped hulls that deflected the blast force away from occupants. In most cases occupants survived anti-tank mine detonations with only minor injuries. The vehicles themselves could often be repaired by replacing the wheels or some drive train components that were designed to be modular and replaceable for exactly this reason.

Most countries involved in Middle Eastern peace keeping missions deploy modern developments of these vehicles like the RG-31 (Canada, United Arab Emirates, United States) and RG-32 (Sweden).

Anti - Tank Missile

	
The 9M133 Kornet Tripod-Mounted ATGM of the Russian Ground Forces	*FGM-148 Javelin anti-tank missile of the United States Army*

Contents

1 - Introduction

An anti-tank missile (ATM), anti-tank guided missile (ATGM), anti-tank guided weapon (ATGW) or anti-armor guided weapon, is a guided missile primarily designed to hit and destroy heavily armored military vehicles.

ATGMs range in size from shoulder-launched weapons, which can be transported by a single soldier, to larger tripod-mounted weapons, which require a squad or team to transport and fire, to vehicle and aircraft mounted missile systems.

The introduction to the modern battlefield of smaller, man-portable ATGMs with larger warheads has given infantry the ability to defeat light and medium tanks at great ranges, though main battle tanks using composite and reactive armors have proven to be resistant to smaller ATGMs . Earlier infantry anti-tank weapons , such as anti-tank rifles, anti-tank missiles and magnetic anti-tank mines, had limited armor-penetration abilities and / or required a soldier to approach the target closely.

2 – History

	
A closeup of the Indian Nag Missile head, with the Imaging Infrared (IIR) Seeker	*The RAF's Brimstone missile is a fire and forget anti-tank missile.*

The earliest guided anti-tank missile to see combat was the German Ruhrstahl X-7 ""Rotkäppchen""(little red riding hood) wire guided missile of World War II. The Rotkäppchen saw limited combat service during 1945 and consisted of a winged missile, resembling a large bird about to land with wingtip steering rocket jets. The warhead was from the standard German 150mm. *Hohlladung Hl/A.* HEAT shell and was capable of penetrating up to 205 mm of perpendicular rolled homogeneous armour plate. The missile was launched from an infantry deployable sled and was guided by a remote joystick control box some distance from the launching sled via wire spooled out during the missile's flight. A Rotkäppchen crew consisted of three members, the operator, the sled puller (with a missile ready to fire) and the spare missile carrier. Only two missiles were usually carried by a Rotkäppchen team. Accuracy at longer ranges was hampered by the human inability to use stereoscopic vision to judge relative distances after only a few hundred metres. Rotkäppchen operators simply could not tell if the missile was heading for the target or had already flown past it.

The SS.10 is the first anti-tank missile widely used. It entered service in the French Army in 1955. It was also the first anti-tank missile used by the US Army and Israeli Defense Forces.

The Malkara missile (from an Aboriginal word for "shield") was one of the earliest anti-tank guided missiles (ATGMs). It was jointly developed by Australia and the United Kingdom between 1951 and 1954, and was in service from 1958 until gradually replaced by the Swingfire missile in the late 1960s. It was intended to be light enough to deploy with airborne forces, yet powerful enough to knock out any tank then in service (it used a 26 kg HESH warhead).

First - generation manually command guided MCLOS missiles require input from an operator using a joystick or similar device to steer the missile to the target. The disadvantage is that the operator must keep the sight's cross hairs on the target and then steer the missile into the cross hairs—i.e. the *line-of-sight*. To do this, the operator must be well trained (spending hundreds of hours on a simulator) and must remain stationary and in view of the target during the flight time of the missile. Because of this, the operator is vulnerable while guiding the missile. The first system to become operational and to see combat was the French Nord SS.10 during the early 1950s.

Second-generation semi - automatically command guided SACLOS missiles require the operator to only keep the sights on the target until impact. Automatic guidance commands are sent to the missile through wires or radio, or the missile relies on laser marking or a TV camera view from the nose of the missile. Examples are the Russian 9M133 Kornet and the American Hellfire I missiles. Again, the operator must remain stationary during the missile's flight.

Third-generation guidance systems rely on a laser, electro-optical imager (IIR) seeker or a W band radar seeker in the nose of the missile. Once the target is identified, the missile needs no further guidance during flight; it is "fire-and-forget", and the missile operator is free to retreat. However, fire-and-forget missiles are more subject to electronic countermeasures than MCLOS and SACLOS missiles. Examples include the German PARS 3 LR, Israeli LAHAT and Spike and the Indian Nag.

Most modern ATGMs have shaped charge high explosive (HEAT) warheads, designed specifically for penetrating armor. Tandem-charge missiles attempt to defeat ERA protected armor. The small initial charge sets off the ERA while the follow-up main charge attempts to penetrate the main armor. Top - attack weapons such as the Indian Nag , American Javelin and the Swedish Bill are designed to focus the explosion down through an armored fighting vehicle's thinner turret - roof or upper-hull armor.

3 – Countermeasures

Spike (missile), capable of making a top attack flight profile.

Countermeasures against ATGMs include spaced, perforated, and composite armour, explosive reactive armour, jammers like the Russian Shtora, and active protection systems (APS) like the Israeli Trophy and the Russian Arena.

Armour systems have continued in development alongside ATGMs, and the most recent generations of armor are specifically tested to be effective against ATGM strikes, either by 'tricking' the missile into not detonating against the armor itself (such as in Slat armor) or using some form of reactive armor to 'attack' the missile upon impact, disrupting shaped charge that makes the warhead effective. Both come with the downside of significant weight and bulk. Reactive armor requires a vehicle be specifically designed with the system integrated and while developments continue to make armor lighter, any vehicle that includes such a system necessitates a powerful engine and will still be relatively slow. Slat armor is lighter and as such can be added to many vehicles after construction but still adds both bulk and weight. Particularly for vehicles that are designed to be transported by cargo aircraft, slat armor has to be fitted in field after deployment. Either approach can never offer complete coverage over the vehicle, leaving tracks or wheels particularly vulnerable to attack.

Jamming is potentially an effective countermeasure to specific missiles that are radar guided, however, as a general purpose defense, it is of no use against unguided anti-tank weapons, and as such it is almost never the only defense. If jamming is used continually, it can be extremely difficult for a missile to acquire the target, locking on to the much larger return from the jammer, with the operator unlikely noticing the difference without a radar screen to see the return. However, any missile that has a back up tracking system can defeat jamming.

Active protection systems show a great deal of promise, both in counteracting ATGMs and unguided weapons, but are not yet a proven technology. Compared to armor systems, they are very lightweight, can be fitted to almost any vehicle with the internal space for the control system and could, in the future, be a near-perfect defense against any missiles. The weakness of the systems include potential developments in missile design such as radar or IR decoys, which would drastically reduce their chance to intercept a missile, as well as technical challenges such as dealing with multiple missiles at once and designing a system that can cover a vehicle from any angle of attack. While these may be answered and allow for lightweight, highly maneuverable vehicles that are strongly defended against missiles and rockets that are extremely well suited for urban and guerrilla warfare. However, such a system is unlikely to be as effective against kinetic energy projectiles, making it a poor choice for fighting against tanks.

Traditionally, before "fire-and-forget" ATGMs were used, the most effective countermeasure was to open fire at the location where the missile was fired from, to either force the operator to take cover or kill him and thus making the missile go out of control and miss the target. While fire and forget missiles have definitive advantages in terms of guidance and operator safety, and include abilities such as top attack mode, older missiles continue in use, both in the front line armies of less developed countries, and in reserve service the world over, due to their lower cost or existing stockpiles of less advanced weapons

Antidote

Contents

1 - Introduction

An antidote is a substance which can counteract a form of poisoning . The term ultimately derives from the Greek *antididonai*, "given against".

The antidotes for some particular toxins are manufactured by injecting the toxin into an animal in small doses and extracting the resulting antibodies from the host animals' blood. This results in an antivenom that can be used to counteract poison produced by certain species of snakes, spiders, and other venomous animals. A number of venoms lack a viable antivenom, and a bite or sting from an animal producing such a toxin often results in death . Some animal venoms, especially those produced by arthropods (e.g. certain spiders, scorpions, bees, etc.) are only potentially lethal when they provoke allergic reactions and induce anaphylactic shock; as such, there is no "antidote" for these venoms because it is not a form of poisoning and anaphylactic shock can be treated (e.g., by the use of epinephrine).

Some other toxins have no known antidote. For example, the poison aconitine, a highly poisonous alkaloid derived from various aconite species has no antidote, and as a result is often fatal if it enters the human body in sufficient quantities.

3 - Mechanical approaches

Ingested poisons are frequently treated by the oral administration of activated charcoal, which adsorbs the poison and flushes it from the digestive tract, thereby removing a large part of the toxin. Poisons which are injected into the body (such as those from bites or stings from venomous animals) are usually treated by the use of a constriction band which limits the flow of lymph and / or blood to the area, thus slowing circulation of the poison around the body.

This should not be confuzed with use of a tourniquet which cuts off blood flow completely - often leading to the loss of the limb.

3 - List of antidotes

Agent	Indication
Activated charcoal with sorbitol	used for many oral toxins
Adenosine	Theophylline antidote for adenosine poisoning
Atropine	organophosphate and carbamate insecticides, nerve agents, some mushrooms
Beta blocker	theophylline
Calcium chloride	calcium channel blockers, black widow spider bites
Calcium gluconate	hydrofluoric acid
Chelators such as EDTA, dimercaprol (BAL), penicillamine, and 2,3-dimercaptosuccinic acid (DMSA, succimer)	heavy metal poisoning
Cyanide antidote (amyl nitrite, sodium nitrite, or thiosulfate)	cyanide poisoning
Cyproheptadine	serotonin syndrome
Deferoxamine mesylate	Iron poisoning
Digoxin Immune Fab antibody (Digibind and Digifab)	digoxin poisoning
Diphenhydramine hydrochloride and benztropine mesylate	Extrapyramidal reactions associated with antipsychotic
Ethanol or fomepizole	ethylene glycol poisoning and methanol poisoning
Flumazenil	benzodiazepine poisoning
Glucagon	beta blocker poisoning and calcium channel blocker poisoning
100 % oxygen or hyperbaric oxygen	carbon monoxide poisoning

therapy (HBOT)	and cyanide poisoning
Insulin with Glucagon	beta blocker poisoning and calcium channel blocker poisoning
Leucovorin	methotrexate and trimethoprim
Methylene blue	treatment of conditions that cause methemoglobinemia
Naloxone hydrochloride	opioid overdose
N-acetylcysteine	Paracetamol (acetaminophen) poisoning
Octreotide	oral hypoglycemic agents
Pralidoxime chloride (2-PAM)	organo phosphate insecticides, followed after atropine
Protamine sulfate	Heparin poisoning
Prussian blue	Thallium poisoning
Physostigmine sulfate	anti cholinergic poisoning
Pyridoxine	Isoniazid poisoning, ethylene glycol
Phytomenadione (vitamin K) and fresh frozen plasma	warfarin poisoning and indanedione
Sodium bicarbonate	ASA, TCAs with a wide QRS6

Antonov An-2

An-2R on skis allowing operations in the snow

Contents

1 - Introduction

The Antonov An-2 (Russian nickname: "*Annushka*" or "Annie") is a Soviet mass-produced single-engine biplane utility/agricultural (hence its other nickname *Kukuruznik*, literally *cropduster*, gained from its predecessor Po-2) aircraft designed and manufactured by the Antonov Design Bureau (now State Company) since 1946.[1] (USAF/DoD reporting name Type 22, NATO reporting name Colt.)

Role	Agricultural and utility aircraft
Manufacturer	Antonov Hongdu Aviation Industry Group WSK PZL-Mielec

	Shijiazhuang
Designer	Oleg Antonov
First flight	31 August 1947
Status	Series production may still continue in China as the Shijiazhuang Y-5;[3] engine refitting project underway[4]
Primary users	Soviet Union North Korea China Many others
Produced	1947 – 2002
Number built	18,000
Variants	Antonov An-3

2 - Design and development

The An-2 is used as a light utility transport, parachute drop aircraft, agricultural work and many other tasks suited to this large slow-flying biplane. Its slow flight and good field performance make it suited for short, unimproved fields, and some specialized variants have also been built for cold weather and other extreme environments. The *Guinness Book of World Records* states that the 45-year production run for the An-2 was for a time the longest ever, for any aircraft, but it was recently exceeded by the Lockheed C-130 Hercules.

The Antonov An-2 was designed to meet a 1947 Soviet Ministry of Forestry requirement for a replacement for the Polikarpov Po-2, which was used in large numbers in both agricultural and utility roles. Antonov designed a large single bay biplane of all-metal construction, with an enclosed cockpit and a cabin with room for seats accommodating twelve passengers. The first prototype, designated SKh-1, and powered by a Shvetsov ASh-21 radial engine, flew on 31 August 1947. The second prototype was fitted with a more powerful Shvetsov ASh-62 engine, which allowed the aircraft's payload to be significantly increased from 1,300 kg to 2,140 kg , and in this form it was ordered into production.

Initial Soviet production was at State Factory 473 in Kiev, Ukrainian SSR where the bulk of up to 5,000 units had been produced by 1960. Later Soviet production (after 1965, of model An-2M especially) was at State Factory 464 at Dolgoprudniy, Russian SFSR. After 1960, however, most An-2s were been built at Poland's WSK factory in Mielec, with over 13,000 made there before full production ended in 1991. Limited production from parts stocks, as well as spares and maintenance coverage continued until 2001, when four aircraft were produced for Vietnam.[8] China also builds the An-2 under license as the Shijiazhuang Y-5.[1] It has been occasionally and erroneously reported that there was East German production of the An-2. While An-2s were extensively refurbished in East Germany, there were no new aircraft built there .

The An-2 was designed as a utility aircraft for use in forestry and agriculture. However, the basic airframe is highly adaptable and numerous variants have been developed. These include hopper-equipped versions for crop-dusting, scientific versions for atmospheric sampling, water-bombers for fighting forest-fires, flying ambulances, float - equipped seaplane versions, and lightly armed combat versions for dropping paratroops . The most common version is the An-2T 12-seater passenger aircraft. All versions (other than the An-3) are powered by a 750 kW (1,000 hp) nine-cylinder Shvetsov ASh-62 radial engine, which was developed from the Wright R-1820. It uses 43 gallons of avgas per hour.

The An-2 has design features which make it suitable for operation in remote areas with unsurfaced airstrips:

It has a pneumatic brake system (similar to those used on heavy road vehicles) to stop on short runways.

It has an air line fitted to the compressor, so the pressure in the tires and shock absorbers can be adjusted without the need for special equipment.

The batteries are large and easy to remove, so the aircraft does not need a ground power unit to supply power.

There is no need for an external fuel pump to refuel the aircraft, as it has an onboard pump that allows the tanks to be filled from simple fuel drums.

It has a minimum of complex systems. The crucial wing leading edge slats that give the aircraft its slow flight ability are fully automatic, being held closed by the airflow over the wings. Once the airspeed drops below 64 km / h (40 mph), the slats will extend because they are on elastic rubber springs.

Take-off run: 170 m, landing run: 215 m (these numbers will of course vary depending on take-off/landing weight, outside air temperature, surface roughness, and headwind).

Antonov An-2 (An2-TP)

A note from the pilot's handbook reads: "If the engine quits in instrument conditions or at night, the pilot should pull the control column full aft and keep the wings level. The leading-edge slats will snap out at about 64 km/h (40 mph), and when the airplane slows to a forward speed of about 40 km/h (25 mph), the airplane will sink at about a parachute descent rate until the aircraft hits the ground." [1]

The An-2 indeed has no stall speed quoted in the operating handbook. Pilots of the An-2 say one can fly the aircraft in full control at 30 mph (as a contrast, a modern Cessna four-seater light aircraft has a stall speed of around 50 mph). This slow stall speed makes it possible for the aircraft to fly backwards (if the aircraft is pointed into a headwind of, say, 35 mph (56 km/h), it will travel backwards at 5 mph (8.0 km/h) whilst under full control). (This is also possible with almost any other true Short Take Off and Landing (STOL) aircraft, but the Antonov has the distinction of being able to do the trick in the mildest head wind.)

Since the collapse of the Soviet Union and the Eastern European communist states, most airlines in these areas have been withdrawing their An-2s from service, as some of these aircraft are now over 40 years old and the production of avgas had decreased. Private operators are still using the planes, as their stability, capacity and slow-flying ability make them very popular, for instance for skydiving.

In the early 1980s Antonov experimented with a development of the An-2 powered by a modern turboprop engine. The unit used was a 1,450 horse power (1,080 kW) Glushenkov engine, and aircraft fitted with this engine were fitted with a longer, more streamlined nose to accommodate it.

In 2013 Antonov announced that it had successfully flown for the first time a new version of the An-2 dubbed the An-2-100 fitted with a 3-blade reversible propeller and a 1500 shp Motor Sich MS-14 turboprop running on kerosene rather than Avgas which is no longer produced in CIS countries.

Whilst their high noise levels, increasing maintenance costs, high fuel consumption and unsophisticated nature (the pre-flight checks alone take between 30 and 40 minutes) make them obsolete for commercial service in Europe, the huge number of aircraft available means that prices are low (from as little as $30,000 for a serviceable example). This makes them ideal for the developing world, where their ability to carry large loads into short airstrips makes them assets to airlines on a budget. Many ex-Aeroflot An-2s work as regional airliners in Africa, Central and South America, Cuba and south east Asia.

North Korea has a number of the aircraft with[11] wooden propellers and canvas wings on their variants (the Y-5 version license-built in China) giving them a low radar cross-section, and therefore a limited degree of "stealth". In a war they could possibly be used to parachute or deliver special forces troops behind enemy lines for sabotage operations.

The An-2's ability, looks and flying characteristics, and its status as one of the world's biggest single-engined production biplanes, mean that demand for the An-2 is increasing in the United States and Western Europe, where they are prized by collectors of classic aircraft, making it an increasingly common sight at airshows However, nearly all western nations (the USA, Canada, the United Kingdom, France, etc.) prohibit the use of the An-2 commercially, despite its obvious potential as a bush plane and parachute aircraft. This is because the aircraft has not been certified by the relevant national aviation authorities, which limits its use. These restrictions vary by country, but all prevent the An-2 being used for any 'for profit' purpose, with the exception of the United States, where An-2s imported since 1993 are limited to experimental certification & Title 14 Code of Federal Regulations .

3 - Refitting project

In 2013, Antonov received orders for upgrading "hundreds" of the An-2 planes still in operation in Azerbaijan, Cuba and Russia to the An-2-100 upgrade version.

4 - Combat servic

The An-2 was used by combat services in the Korean War . During the 1960s an An-2 attempting to engage South Vietnamese naval units was shot down by an F-4 Phantom II under the control of an Air Intercept Controller (AIC) on the USS *Long Beach*.

On January 12, 1968, a clandestine TACAN site (call sign: *Laos Site 85* / Phou Pha Ti) installed by Special Forces (United States Army) in Northern Laos for directing USAF warplanes flying from Thailand to Vietnam was attacked by two North Vietnamese An-2s using machine guns fired from the cabin, rockets, and hand thrown grenades. A third An-2 orbited overhead. An Air America Bell UH-1B, XW-PHF, resupplying the site chased the two attacking aircraft. By using an AK - 47 the American crew (Ted Moore Captain, Glen Wood kicker) succeeded in shooting down one of the An-2s while the second aircraft was forced down by combined ground and air fire and crashed into a mountain. The surviving Antonov returned to its home base, Gia Lam, near Hanoi.

During the Croatian War of Independence in 1991, a few old Antonov An-2 biplanes used for crop-spraying were converted by the Croatian Air Force to drop makeshift bombs and were used in supply missions to the town of Vukovar and other besieged parts of Croatia.[14] The chief advantage for the An-2 was that they could take off and land in small or improvised airstrips. They were also used to drop supplies by parachute on isolated garrisons. At least one was shot down on 2 December 1991 over Vinkovci, eastern Slavonia, by Serbian SAM missiles, purportedly SA-6s.[15][16]

5 – Variants

5 – 1 - Soviet / Polish production

Izdeliye F – The in-house designation for the An-2NAK observation aircraft which was later re - designated An - 2K and / or An - 2F.

Izdeliye K – A prototype weather reconnaissance/research aircraft with an observers cockpit immediately forward of the fin above the rear fuzelage. First flown on 21 March 1948 'Izdeliye K' was found to be under-powered and unable to carry out its intended mission at high altitude, the aircraft was abandoned after a landing accident in October 1948. The concept was resurrected in 1954 as the 'An-2ZA' / 'An-6 Meteo'.

Izdeliye T – The original design concept originated at OKB-153 in Novosibirsk.

Izdeliye Sh – The in-house designation for the 'Izdeliye T' (presumably to confuze spies or infiltrators) design project at Novosibirsk.

5 – 2 - Ukrainian variants

An-2-100 is a 2013 Antonov upgrade version refitted with Motor Sich kerosene-fueled engine (instead of originally-installed avgas-consuming), most likely the MS-14 powerplant. Maiden flight on 10 July 2013 in Kiev.

6 – Operators

In addition to Aeroflot, the Soviet Air Force, and other Eastern Bloc military forces including Vietnam People's Air Force (VPAF), dozens of nations and airlines have employed the An-2 in civil and military roles. In recent years, it has also gained popularity in the USA and Canada as a bushplane.

As of 2013, there were thousands of An-2 still in operation around the world, including over 1,500 in Russia, 294 in Kazakhstan and 54 in Ukraine. Because of their reliability and robustness, several An-2 are also used in scheduled passenger service between airstrips in western countries with one example being the service between the North-Sea islands of Sylt and Wyk auf Föhr.

7 - Specifications (An-2)

Data from

General characteristics

Crew: 1–2

Capacity: 12 passengers

Length: 12.4 m (40 ft 8 in)

Wingspan:

Upper wing: 18.2 m (59 ft 8 in)

Lower wing: 14.2 m (46 ft 9 in))

Height: 4.1 m (13 ft)

Wing area: 71.52 m² (769.8 ft²)

Empty weight: 3,300 kg (7,300 lb)

Loaded weight: 5,500 kg (12,000 lb)

Useful load: 2,140 kg (4,700 lb)

Powerplant: 1 × Shvetsov ASh-62IR 9-cylinder supercharged radial engine, 750 kW (1,000 hp)

Performance

Maximum speed: 258 km / h (139 kn, 160 mph)
Cruise speed: 190 km/h (100 kn, 120 mph)
Stall speed: ~50 km/h (26 knots, 30 mph)
Range: 845 km (456 nmi, 525 mi)
Service ceiling: 4,500 m (14,750 ft)
Rate of climb: 3.5 m/s (700 ft/min)
Power/mass: 0.136 kW/kg (0.083 hp/lb)

9 – 8 – Accidents

As of April 2, 2013 there have been 411 hull-loss accidents of An-2, claiming a total of 391 human lives. One of the most recent accidents occurred around 4:10 in the afternoon on March 23, 2013 in Krasnoyarsk Krai where an Antonov An-2 was dusting crops and crashed into a pond after the engine lost power, killing one of the pilots.

Apache Helicopters
(Boeing AH- 64 Apache)

An AH-64 Apache from the U.S. Army's 101st Aviation Regiment in Iraq

Contents

1 Introduction

Role	Attack helicopter
National origin	United States
Manufacturer	Hughes Helicopters (1975 –1984) McDonnell Douglas (1984 –1997) Boeing Defense, Space & Security (1997–present)
Designer	Hughes Helicopters
First flight	30 September 1975
Introduction	April 1986
Status	In service
Primary users	United States Army Israel Air Force Egyptian Air Force Royal Netherlands Air Force
Produced	1983 – present
Number built	1,174 as of February 2010
Unit cost	AH-64A: $ 20 M (2007) AH-64D: $ 18 M (2007)
Variants	AgustaWestland Apache

The Boeing AH - 64 Apache is a four - blade, twin - engine attack helicopter with a tailwheel - type landing gear arrangement, and a tandem cockpit for a two - man crew. It features a nose-mounted sensor suite for target acquisition and night vision systems. It is armed with a 30 mm M230 Chain Gun carried between the main landing gear, under the aircraft's forward fuzelage. It has four hardpoints mounted on stub-wing pylons, typically carrying a mixture of AGM-114 Hellfire missiles and Hydra 70 rocket pods. The AH-64 has a large amount of systems redundancy to improve combat survivability.

The Apache originally started as the *Model 77* developed by Hughes Helicopters for the United States Army's Advanced Attack Helicopter program to replace the AH-1 Cobra. The prototype YAH-64 was first flown on 30 September 1975. The U.S. Army selected the YAH-64 over the Bell YAH-63 in 1976, and later approved full production in 1982. After purchasing Hughes Helicopters in 1984, McDonnell Douglas continued AH-64 production and development. The helicopter was introduced to U.S. Army service in April 1986. The first production AH-64D Apache Longbow, an upgraded Apache variant, was delivered to the Army in March 1997. Production has been continued by Boeing Defense, Space & Security; over 1,000 AH-64s have been produced to date.

The U.S. Army is the primary operator of the AH-64; it has also become the primary attack helicopter of multiple nations, including Greece, Japan, Israel, the Netherlands and Singapore; as well as being produced under license in the United Kingdom as the AgustaWestland Apache. U.S. AH-64s have served in conflicts in Panama, the Persian Gulf, Kosovo, Afghanistan, and Iraq. Israel used the Apache in its military conflicts in Lebanon and the Gaza Strip; British, Dutch and U.S. Apaches have seen deployments in Afghanistan and Iraq.

2 – Development

2 – 1 - Advanced Attack Helicopter

Following the cancellation of the AH-56 Cheyenne in 1972, in favor of U.S. Air Force and Marine Corps projects like the A-10 Thunderbolt II and Harrier, the United States Army sought an aircraft to fill an anti-armor attack role that would still be under Army command; the 1948 Key West Agreement forbade the Army from owning fixed-wing aircraft. The Army wanted an aircraft better than the AH-1 Cobra in firepower, performance and range. It would have the maneuverability for terrain following nap-of-the-earth (NoE) flying. To this end, the U.S. Army issued a Request For Proposals (RFP) for an Advanced Attack Helicopter (AAH) on 15 November 1972. As a sign of the importance of this project, in September 1973 the Army designated its five most important projects, the "Big Five" with AAH included.

A Hughes YAH-64A prototype

Proposals were submitted by Bell, Boeing Vertol/Grumman team, Hughes, Lockheed, and Sikorsky. In July 1973, the U.S. Department of Defense selected finalists Bell and Hughes Aircraft's Toolco Aircraft Division (later Hughes Helicopters). This began the phase 1 of the competition. Each company built prototype helicopters and went through a flight test program. Hughes' *Model 77/YAH-64A* prototype first flew on 30 September 1975, while Bell's Model 409/YAH-63A prototype first flew on 1 October 1975. After evaluating the test results, the Army selected Hughes' YAH-64A over Bell's YAH-63A in 1976. Reasons for selecting the YAH-64A included its more damage tolerant four-blade main rotor and the instability of the YAH-63's tricycle landing gear arrangement.

The AH-64A then entered phase 2 of the AAH program under which three pre-production AH-64s would be built, additionally, the two YAH-64A flight prototypes and the ground test unit were upgraded to the same standard . Weapons and sensor systems were integrated and tested during this time, including the laser-guided AGM-114 Hellfire missile . Development of the Hellfire missile had began in 1974, originally known by the name of *Helicopter*

Launched, Fire and Forget Missile ('Hellfire' being a shortened acronym), with the aim of arming helicopter platforms with an effective anti-tank missile.

2 – 2 - Into production

In 1981, three pre-production AH-64As were handed over to the U.S. Army for Operational Test II. The Army testing was successful, but afterward it was decided to upgrade to the more powerful T700-GE-701 version of engine, rated at 1,690 shp (1,260 kW). The AH-64 was named the *Apache* in late 1981, keeping with the Army's traditional use of American Indian tribal names for its helicopters and it was approved for full scale production in 1982. In 1983, the first production helicopter was rolled out at Hughes Helicopter's facility at Mesa, Arizona. Hughes Helicopters was purchased by McDonnell Douglas for $470 million in 1984. The helicopter unit later became part of The Boeing Company with the merger of Boeing and McDonnell Douglas in August 1997. In 1986, the incremental or flyaway cost for the AH-64A was $ 7 M and the average unit cost was approximately $13.9M based on total costs.

In the mid-1980s, McDonnell Douglas studied an improved "AH-64B" design with an updated cockpit, new fire control system and other upgrades. In 1988 funding was approved for a multi-stage upgrade program to improve sensor and weapon avionic systems and incorporate some digital systems.[21] However, rapidly improving technology led to the upgrade program being canceled in favor of more ambitious changes. Development of the more advanced AH-64D Apache Longbow was approved by the Defense Acquisition Board in August 1990. The first AH-64D prototype flew on 15 April 1992,[22] testing of the prototypes ended in April 1995. During the testing, six AH-64D helicopters were pitted against a numerically superior group of AH-64A helicopters; the results demonstrated that AH-64D has a seven times increase in survivability and four times increase in lethality compared to the AH-64A.[23][24][25] On 13 October 1995 full-scale production of the Apache Longbow was approved , and a $1.9-billion five-year contract was signed in August 1996 to upgrade and rebuild 232 existing AH-64A Apaches.[27] The first production AH-64D flew on 17 March 1997 and was delivered on 31 March. The cost of the AH-64D program totaled $11bn through 2007.

Some parts of the Apache are produced by international partners. AgustaWestland has been producing Apache components for the international market and for the AgustaWestland Apache.[30] Since 2004, Korea Aerospace Industries has been the sole manufacturer of the Apache's fuzelage . Prior to this, fuzelage production was handled by Teledyne Ryan Aeronautical throughout the 1980s and 1990s; a legal dispute between Teledyne Ryan and Boeing broke out over the eventual transfer of fuzelage production.

In April 2006, Boeing was awarded a $ 67.6M fixed-price contract for the remanufacture of several existing U.S. AH-64As to the AH-64D configuration; between May 2009 and July 2011, a further five contracts were issued to remanufacture batches of AH-64As to the upgraded D variant . Since 2008, nations operating the older AH-64A have been urged to undertake modernization programs to become AH-64Ds, as Boeing and the U.S. Army plans to terminate support for the A-variants in the near future . The Apache's effectiveness against ground forces and in urban warfare operations was bolstered by the addition of the AGM-114N – a Hellfire missile fitted with a thermobaric warhead; the AGM-114N was approved for full production in 2005 . The use of thermobaric "enhanced blast" weapons has been a point of controversy .

3 – Design

3 – 1 – Overview

Apache version	**Engine version**	**Engine power**
AH-64A	General Electric T700-701	1,696 shp (1,265 kW)
AH-64A+/D	General Electric T700-701C	1,890 shp (1,410 kW)
AH-64E	General Electric T700-701D	1,994 shp (1,487 kW)
WAH-64D	Rolls-Royce Turbomeca RTM322	2,100 shp (1,600 kW)

The AH-64 Apache has a four-blade main rotor and a four-blade tail rotor. The crew sits in tandem, with the pilot sitting behind and above the copilot / gunner. Both crew members are capable of flying the aircraft and performing methods of weapon engagements independently. The AH-64 is powered by two General Electric T700 turboshaft engines with high-mounted exhausts on either side of the fuzelage . Various models of engines have been used on the Apache; those in British service use engines from Rolls-Royce instead of General Electric. In 2004, General Electric Aviation began producing more powerful T700-GE-701D engines, rated at 2,000 shp (1,500 kW) for AH-64Ds.

The crew compartment has shielding between the cockpits, such that at least one crew member can survive hits. The compartment and the rotor blades are designed to sustain a hit from 23 mm rounds. The airframe includes some 1,100 kg of protection and has a self-sealing fuel system to protect against ballistic projectiles . The aircraft was designed to meet the crashworthiness requirements of MIL-STD-1290 which specifies minimum requirement for crash impact energy attenuation to minimize crew injuries and fatalities. This was achieved through incorporation of increased structural strength, crashworthy landing gear, seats and fuel system. Up to six AH-64 Apaches can be safely fitted inside the cargo hold of a USAF Lockheed C-5 Galaxy.

3 – 2– Avionics and targeting

AH-64 Apache in flight

One of the revolutionary features at the introduction of the Apache was its helmet mounted display, the Integrated Helmet and Display Sighting System (IHADSS) ; among other abilities the pilot or gunner can slave the helicopter's 30 mm automatic M230 Chain Gun to his helmet, making the gun track head movements to point at where he/she looks. The M230 E1 can be alternatively fixed to a locked forward firing position, or controlled via the Target Acquisition and Designation System (TADS) . The AH-64's standard of performance for aerial gunnery is to achieve at least 1 hit for every 30 shots fired at a wheeled vehicle at a range of 800 –1,200 m .

The AH-64 is designed to endure front-line environments and to operate during the day or night and in adverse weather via its avionics and onboard sensor suites.[57] These systems include the Target Acquisition and Designation System, Pilot Night Vision System (TADS/PNVS), passive infrared countermeasures , GPS, and the IHADSS . A newer system that is replacing TADS / PNVS is Arrowhead (MTADS); it is manufactured by Lockheed Martin, a contract was issued in February 2005 to begin equipping all U.S. Apaches.

In August 2012, 24 AH-64D were equipped with the Ground Fire Acquisition System (GFAS); intended to detect and target ground-based weapons fire sources. The GFAS consists of two small sensor pods which home in on muzzle flashes; working with the AH-64D's own sensors, an infrared camera precisely locates present ground-based threats and relevant distance. The GFAS has a 120° field of vision and is effective in all-light conditions.

3 – 3 – Armaments and configurations

Mission	Hellfire	30 mm rounds	Hydra 70	Maximum speed (knots)	Rate of climb (feet/min)	Endurance (hours)
Anti-Armor	16	1,200	0	148	990	2.5
Covering Force	8	1,200	38	150	860	2.5
Escort	0	1,200	76	153	800	2.5

The AH-64 is adaptable to numerous different roles within its context as Close Combat Attack (CCA), it has a customizable weapons loadout mounted on stub-wings for the role desired.[42] In addition to the 30 mm M 230 E1 Chain Gun, the Apache carries a range of external stores on its stub-wing pylons, typically a mixture of AGM-114 Hellfire anti-tank missiles, and Hydra 70 general-purpose unguided 70 mm rockets.

Starting in the late 1980s, the Stinger and AIM-9 Sidewinder air-to-air missiles and the AGM-122 Sidearm anti-radiation missile were evaluated for use upon the AH-64. The Stinger was initially selected over the AIM-9, but the U.S. Army is considering the Starstreak air-to-air missile instead. External fuel tanks can also be carried on the stub wings to increase range and mission time.[42] The stub-wing pylons have mounting points which make maintenance easier; these mountings can be used to secure personnel to the wings for transport for emergencies . Stinger missiles are more used by non-U.S. Apaches because foreign forces don't have as many other aircraft for air superiority to control the skies.

4 - Operational history

4 – 1 – United States Army

The U.S. Army formally accepted its first production AH-64A in January 1984 and training of the first pilots began later that year.[66][67] The first operational Apache unit, 7th Battalion, 17th Cavalry Brigade, began training on the AH-64A in April 1986 at Fort Hood, Texas . Two operational units with 68 AH-64s first deployed to Europe in September 1987 and took part in large military exercises there . The Apache was first used in combat in 1989, during Operation Just Cause, the invasion of Panama. The AH-64 participated in over 240 hours of combat attacking various targets, mostly at night . General Carl Stiner, commander of Operation Just Cause, praised the Apache for its precision: "You could fire that Hellfire missile through a window from four miles away at night".

As the Army began fielding the Apache, capabilities such as use of the FLIR for extensive night-flight operations made it clear that the

AH-64 was capable of traveling and fighting well beyond the forward line of own troops (FLOT) that previous attack helicopters were normally restricted to. In addition to deep-strike capabilities, it was discovered that the Apache had, not by any intention, been fitted with the same Have Quick UHF radio systems used by the U.S. Air Force; once this was recognized, inter-service coordination and joint operations such as the joint air attack teams (JAAT) were encouraged and inserted into standard training. The Apache operated extensively with close air support (CAS) aircraft such as the Fairchild Republic A-10 Thunderbolt II and the USMC's McDonnell Douglas AV-8B Harrier II, often acting as a target designator so the Apache could conserve its own munitions.

A soldier on top of an AH-64's stub-wing during an extraction exercise at Camp Bondsteel, Kosovo, 2007

A year after the Panama operation, close to half of all U.S. Apaches were deployed to Saudi Arabia in response to Iraq's invasion of Kuwait.[73] During Operation Desert Storm on 17 January 1991, eight AH-64As guided by four MH-53 Pave Low IIIs destroyed a portion of the Iraqi radar network ; the first attack of Desert Storm, an act to allow attack aircraft into Iraq without detection . The Apaches carried an asymmetric load of Hydra 70 flechette rockets, Hellfires, and one auxiliary fuel tank each . During the 100-hour ground war a total of 277 AH- 64s took part, destroying 278 tanks, numerous armored personnel carriers and other Iraqi vehicles. One AH-64 was lost in the war, to an RPG hit at close range, the Apache crashed but the crew survived . To maintain Apache operations with spare parts and equipment, during the Gulf War the U.S. Army unofficially grounded all other AH-64s world wide; additionally Apaches in the war zone flew only one-fifth of the flight-hours the Army had planned for.

The AH-64 played roles in the Balkans during separate conflicts in Bosnia and Kosovo in the 1990s . During Task Force Hawk, 24 Apaches were deployed to a land base in Albania in 1999 to participate in the Kosovo engagement; this required 26,000 tons of equipment to be transported and over 550 C-17 flights, at a cost of US$480 million . During these deployments, the AH-64 encountered problems such as deficiencies in training, night vision equipment, fuel tanks, and surviv ability . On 27 April 1999, an Apache crashed during training in Albania due to a failure with the tail rotor, causing the entire fleet in the Balkans to be grounded in December 2000.

Major General Dick Cody, then the commanding officer of the 101st Airborne, wrote a strongly worded memo to the U.S. Army Chief of Staff about the failures in training and equipment.[90] *The Washington Post* also dedicated a front-page article to the failures in Kosovo, commenting that: "The vaunted helicopters came to symbolise everything wrong with the Army as it enters the 21st century: Its inability to move quickly, its resistance to change, its obsession with casualties, its post-Cold War identity crisis". The Apache did not conduct any combat missions over Kosovo due to fears over the risk of casualties; in addition, none of the pilots were qualified to fly with night vision goggles, preventing nighttime operations.

U.S. Apaches have served in Operation Enduring Freedom in Afghanistan from 2001 . The Apache was the only platform capable of providing accurate CAS duties for Operation Anaconda; although they regularly took fire during the intense early fighting, they were kept operational by their ground crews . American AH-64Ds typically flew in Afghanistan and Iraq without the Longbow Radar as there were no armored threats remaining . On 21 December 2009, a pair of American Apaches attacked a British-held base in a friendly fire incident, killing one British soldier.

The AH-64 took part in invasion of Iraq in 2003 during Operation Iraqi Freedom . In one engagement on 24 March 2003, 31 Apaches were damaged, and one Apache was shot down and captured by Iraqi troops near Karbala . The intended attack against an armored brigade of the Iraqi Republican Guard's Medina Division was unsuccessful. The tank crews had set up a "flak trap" among terrain and employed their guns to good effect . Iraqi officials claimed a farmer with a Brno rifle shot down the Apache,[101] but the farmer denied involvement . The helicopter came down intact, and both the pilot and co-pilot were captured. The AH-64D was destroyed via air strike the following day.

AH-64D Apache flying over Baghdad, Iraq in 2007, on a reconnaissance mission

Most Apache helicopters that have taken heavy combat damage have been able to continue their missions and return safely . In 2006, an Apache helicopter was downed by a Soviet-made Strela 2 (SA-7) in Iraq. The Apache is typically able to avoid hits by such missiles but in this instance it did not . The coordination of Apaches in the war was discussed by Thomas Adams, who noted the helicopters tended to fight in small teams but had little autonomy to react to local threats and opportunities, requiring lengthy dialogue with command structures in an effort to centrally micromanage each unit.

By the end of U.S. military operations in Iraq in December 2011, several Apache helicopters had been shot down by enemy fire during the Iraq War, and others lost in accidents. In 2007, four Apache helicopters were destroyed on the ground by Iraqi insurgent mortar fire; the insurgents had made use of embedded coordinates in web-published photographs (geotagging) taken of the helicopters by soldiers . Several AH-64s have been lost to accidents in Afghanistan as of 2012.

According to Boeing, the U.S. Army Apache fleet has accumulated more than 3 million flight hours since the first prototype aircraft flew in 1975 . According to a DOD audit released in May 2011, Boeing had significantly overcharged the U.S. Army on multiple occasions, ranging from 33.3 percent to 177,475 percent for routine spare parts in helicopters like the Apache.

On 21 February 2013, the 1-229th Attack Reconnaissance Battalion at Joint Base Lewis-McChord became the first unit in the U.S. Army to field the AH-64E Apache Guardian. The battalion had received 8 helicopters since January, with a total of 24 to be received by April 2013.[114] The unit completed training with the AH-64E in May 2013 after over 6,000 flight hours. The Apache Guardian achieved initial operating capability (IOC) on 27 November 2013, making its ready for deployment.

In FY 2015 budgets, Army leaders are considering moving all Apaches from the Army Reserve and National Guard to the active Army to serve as scout helicopters. The OH-58 Kiowa has performed the role since 1968, but budget cuts have forced the service to rearrange its priorities. Upgrading the Kiowa fleet would cost $10 billion and developing or buying a new replacement helicopter would cost $ 16 billion. Both options are considered too expensive, so the plan is to retire the entire fleet over the next five years. With most Kiowas in active squadrons, Apaches from non-active units would be moved to active ones, upgraded to AH-64E standard, and control unmanned aerial vehicles like the MQ-1C Grey Eagle to perform aerial scouting missions. A 2010 study found that manned-unmanned teaming of Apaches and UAVs was the most cost-effective alternative to building a new scout helicopter. This teaming would meet 80% of reconnaissance requirements, compared to 20 % with the current Kiowa and 50 % with an upgraded Kiowa. The Apache redistribution plan has drawn intense criticism from Reserve and Guard units who would lose their attack helicopters, saying their specially-trained pilots would be lost and that they performed well when they deployed over the previous 12 years.

4 – 2 – Israel

The Israeli Air Force (IAF) first received AH-64As in 1990, for a total fleet of 42 . There was some controversy over the Air Force's choice to purchase Apaches over upgrading existing AH-1 Cobra attack helicopters . In 2000, Israel was interested in acquiring up to 48 Apache AH-64Ds, but U.S. reluctance to share the software source code complicated the prospect . In April 2005, Boeing delivered the first AH-64D to the IAF. In 2009, an arranged sale of six AH-64Ds was reportedly blocked by the Obama Administration (pending interagency review) over concerns the helicopters may pose a threat to civilian Palestinians in Gaza. Also, in February 2001 reports emerged the U.S. government was investigating alleged misuse of the Apache and other US military equipment against Palestinian leaders and facilities.

In IAF service, the AH-64A was named as the *Peten* (Hebrew: פתן, for Cobra), while the AH-64D was named *Saraph* (שרף, also as "Seraph", Hebrew for venomous / fiery winged serpent).

The AH-64A was used frequently during the 1990s to attack and destroy Hezbollah outposts in Lebanon , attacking in many weather conditions – day and night. On 13 April 1996, during Operation Grapes of Wrath, an Israeli Apache fired two Hellfire missiles at an ambulance in Lebanon, killing six civilians . During the al-Aqsa Intifada in 2000, the IAF used the AH-64 to kill senior Hamas figures, such as Ahmed Yassin and Adnan al-Ghoul, with guided missiles . On 24 May 2001, a privately owned Lebanese-registered Cessna 152 flew into Israeli airspace and was intercepted by two Israeli AH-64s, one of which shot down the Cessna with an AGM-114 Hellfire missile, killing the pilot.[133] On 22 March 2004, an Israeli AH-64 used a Hellfire missile to kill Hamas leader Ahmed Yassin, also killing both his bodyguards and nine bystanders . IAF Apaches played a prominent role in the 2006 Lebanon War, launching strikes into Lebanon targeting Hezbollah forces .

There have also been accidents involving the Apache helicopter in Israeli service. During the Lebanon War in 2006, two IAF AH-64A helicopters collided, killing one pilot and critically wounding three . In another incident in the conflict an IAF AH-64D crashed due to a malfunction in the main rotor, killing the two crew. In late 2007, the Israeli Air Force put further purchases and deliveries of AH-64Ds on hold during an investigation upon the aircraft's performance envelope However, Israeli officials have since praised the Apache for its role in Operation Cast Lead in 2008, against Hamas in Gaza .

In June 2010, Israel decided against upgrading its existing AH-64A to the -D configuration, due to budget restrictions . As of December 2010, the IAF was examining the adoption of a new missile system as a cheaper and lightweight complement to the Hellfire missile, either the American Hydra 70 or the Canadian CRV7. In recent years, Israeli Apaches have been used to patrol the skies over Gaza; strike operations against insurgents using these helicopters has become a frequent occurrence.

4 – 3 - United Kingdom

The UK operates a modified version of the Apache Longbow initially called the Westland WAH-64 Apache, and is designated Apache AH1 by the British Army. Westland built 67 WAH-64 Apaches under license from Boeing , following a competition between the Eurocopter Tiger and the Apache for the British Army's new Attack Helicopter in 1995 .,, Important deviations made by AgustaWestland from the U.S. Apache variants include changing to more powerful Rolls-Royce engines , and the addition of a folding blade assembly for use on naval ships .

4 – 4 - The Netherlands

The Dutch government initially showed an interest in acquiring Apache helicopters in the late 1980s, where it stated that it may purchase as many as 52 . A competition held in 1994 against the Eurocopter Tiger and the AH-1 Super Cobra led to the Royal Netherlands Air Force ordering 30 AH-64D Apaches in 1995. Construction for the order started in December 1997, deliveries began in 1999.[155][156] The Apaches of the RNLAF are equipped with the Apache Modular Aircraft Survivability Equipment (AMASE) system. The AMASE is an advanced Electronic Warfare self-protection system against Infra-Red (IR) missile threats.

The RNLAF Apaches' first deployment was in 2001 to Djibouti, Africa . They were also deployed alongside U.S. AH-64s in support of NATO peacekeeping forces in Bosnia and Herzegovina . In 2004, six Dutch AH-64s were deployed as part of the Netherlands contribution to Multinational force in Iraq to support the Dutch ground forces . The Apaches performed close combat support and display of force missions, along with providing reconnaissance information to ground forces. In February 2006, the Netherlands contribution to NATO forces in Afghanistan was increased from 600 to 1,400 troops and 6 AH-64s were sent in support.

Shortly after Apaches were deployed to Kabul airport as part of the Netherlands contribution to ISAF, on 10 April 2004 a pair of Dutch Apaches came under light gunfire close to the Afghan capital.[163] On 17 December 2007, a RNLAF Apache flew into powerlines during a night flying exercise in the Netherlands, forcing an emergency landing and causing a lengthy blackout in the region.

4 – 5 - Saudi Arabia

In the aftermath of the Gulf War of 1991, in which many U.S. Apaches operated from bases in Saudi territory, the government of Saudi Arabia purchased twelve AH-64As for its army. In the Middle East, Israel procured the Apache in response to the 1992 Saudi purchase.

In August 2006, the Saudi Arabian government began negotiations to spend as much as $400M on Apache upgrades, possibly remanufacturing them into the AH-64D Longbow configuration. In September 2008, the U.S. Government approved the purchase of 12 AH-64Ds requested by Saudi Arabia. In October 2010, Saudi Arabia requested a further 70 AH-64Ds as part of a possible, massive US-Saudi arms deal.

In November 2009, the Royal Saudi Air Force, as part of a military effort against insurgent intrusions of the kingdom's border, started using the Apache in Operation Scorched Earth; this involved launched air strikes against Houthi rebels operating inside neighboring Yemen as well. In January 2010 the rebels claimed to have shot down an Apache; this was denied by the Saudi military.[176] In late January 2010, the leader of the Shiite rebels announced their withdrawal from Saudi territory, this announcement followed a key battle on 12 January when Saudi forces reportedly took control of the border village of Al Jabiri.

4 – 6 – Egypt

In 1995, the Egyptian Air Force placed an order for 36 AH-64A helicopters. These Apaches were delivered with most of the advanced avionics used on the U.S. fleet at that time, with the exception of localized radio equipment. In 2000, Boeing announced that an order to remanufacture Egypt's existing Apache fleet to the AH-64D configuration. Notably, the AH-64D upgrade did not include the procurement of the Longbow radar, the supply of which had been refuzed by the U.S. government. Egypt requested a further 12 AH-64D Block II Apaches through a Foreign Military Sale in 2009.

In August 2012, the Egyptian Armed Forces undertook a large-scale military operation to regain control of the Sinai Peninsula from armed militants. Air cover throughout the operation was provided by the Egyptian Air Force's Apache helicopters; reportedly the Apaches destroyed three vehicles and killed at least 20 militants.

4 – 7 - Other users

The United Arab Emirates purchased 30 AH-64A helicopters in 1991 and 1994 , which they are now upgrading to AH-64D specification. In 2005, Kuwait purchased 16 Longbow helicopters.

In September 2003, Greece ordered 12 AH-64D in addition to existing fleet of 20 AH-64A+. By 1995 they had received 20 AH-64As; another 12 AH-64Ds were ordered in 2003. Singapore purchased 20 AH-64D Longbow Apache aircraft in two batches between 1999 and 2001 ; during October 2010 Apache training was suspended following the forced crash-landing of an Apache.

Japan ordered 50 AH-64Ds , which are being built under license by Fuji Heavy Industries, designated *AH-64DJP*. The first helicopter was delivered to the JGSDF in early 2006.

The Republic of China (Taiwan) reached an agreement with the U.S. to purchase 30 AH-64D Block III Apaches with weapons, and associated equipment in June 2011 . On 5 November 2013, Taiwan received the first 6 AH-64E Apaches. A second batch will arrive in December 2013, with all 30 to be delivered by the end of 2014.

4 – 8 - Future and possible users

In 2008, the Indian Air Force (IAF) released a tender for 22 attack helicopters; there were six contending submissions - Sikorsky's UH-60 Black Hawk, Boeing's AH-64D, Bell's AH-1 Super Cobra, Eurocopter's Tiger, Mil's Mi-28 and Augusta Westland's A129 Mangusta. Boeing and Bell initially backed out of the competition in October 2008 . In 2009, the competition was restarted and Boeing submitted a new Apache proposal . In December 2010, India requested the possible sale of 22 AH-64Ds and associated equipment. In October 2011, it was reported that the AH-64D had emerged as front-runner ahead of the Russian Mi-28N . On 5 October 2012, IAF Chief NAK Browne confirmed that the AH-64D Block III had been selected. In October 2012, the Indian government transferred control of most attack and armed helicopters from the Indian Air Force to the Army Aviation Corps. In spite of the transfer, the Indian Air Force sought to maintain control of the 22 proposed Apaches, wanting the type for air combat missions; the Indian Army arguing that the AH-64s would be better used supporting army operations. In April 2013, the Indian Ministry of Defence (MoD) decided that the 22 AH-64s would go to the Indian Air Force due to the procurement being an ongoing acquisition . In May 2013, the Indian Army requested an acquisition of 11 AH-64Es for the Army Aviation Corps.

South Korea showed interest in acquiring Apache attack helicopters .This move may be related to U.S. plans to withdraw many of its Apaches from South Korea . On 21 September 2012, the U.S. Congress was notified of the possible purchase of 36 AH-64D Block III Apaches, along with associated equipment and armament. The Apache was competing against the Bell AH-1Z Viper and the TAI / Agusta Westland T-129 for the order; a decision was expected in late 2012. In April 2013, it was announced that South Korea is to purchase 36 AH-64E helicopters . The Apaches are to be delivered from 2016 to 2018.

In February 2012, Indonesia's deputy minister of defense Sjafrie Sjamsoeddin stated that the Indonesian National Armed Forces plans to buy eight AH-64s . On 26 August 2013, the U.S. and Indonesia formalized a deal for 8 AH-64E Apaches worth $ 500 million . Qatar requested the sale of 24 AH-64D Apaches in July 2012, along with associated equipment and armament.

Iraq requested the sale of 24 AH-64s in April 2013;[218] a sale was cleared by Congress in January 2014. The sale is to consist of two parts: the helicopters and associated parts and maintenance, costing a combined $ 4.8 billion. Pilot training with six leased Apaches would also be included at a cost of $ 1.37 billion.

5 – Variants

5 – 1 - AH-64A

The AH-64A is the original production attack helicopter. The crew sit in tandem in an armored compartment. It is powered by two GE T700 turboshaft engines. The A-model was equipped with the −701 engine version until 1990 when the engines were switched to the more powerful −701C version.

U.S. Army AH-64As are being converted to AH-64Ds. The service's last AH-64A was taken out of service in July 2012 before conversion at Boeing's facility in Mesa, Arizona . On 25 September 2012, Boeing received a $136.8M contract to remanufacture the last 16 AH-64As into the AH-64D Block II version, to be completed by December 2013.

5 – 2 - AH-64B

In 1991 after Operation Desert Storm, the AH-64B was a proposed upgrade to 254 AH-64As. The upgrade would have included new rotor blades, a Global Positioning System (GPS), improved navigation systems and new radios. Congress approved $ 82 M to begin the Apache B upgrade. The B program was canceled in 1992. The radio, navigation, and GPS modifications, were later installed on most A-model Apaches through other upgrades.

5 – 3 - AH-64C

Additional funding from Congress in late 1991 resulted in a program to upgrade AH-64As to an AH-64B+ version. More funding changed the plan to upgrade to AH-64C. The C upgrade would include all changes to be included in the Longbow except for mast-mounted radar and newer −700C engine versions. However, the C designation was dropped after 1993 . With AH-64As receiving the newer engine from 1990, the only difference between the C model and the radar-equipped D model was the radar, which could be moved from one aircraft to another; thus the decision was made to simply designate both versions *AH-64D*.

5 – 4 - AH-64D

Israeli AH-64D

The *AH-64D Apache Longbow*, is equipped with an advanced sensor suite and a glass cockpit. The main improvement over the A-variant is the dome installed over the main rotor, housing the AN / APG-78 Longbow millimeter-wave fire-control radar (FCR) target acquisition system and the Radar Frequency Interferometer (RFI). The raised position of the radome enables the detection of targets and launching of missiles while the helicopter is behind obstacles (e.g. terrain, trees or buildings). The AN / APG-78 is capable of simultaneously tracking 128 targets and engaging the 16 most dangerous ones, and can initiate an attack within 30 seconds, while passing data on the other targets to other Longbow Apaches via data link . The data link is housed in a radio modem integrated with the sensor suite allows data to be shared with ground units and other D-models; allowing them to fire on targets detected by a single helicopter.

The aircraft is powered by a pair of uprated T700-GE-701C engines. The forward fuzelage was expanded to accommodate new systems to improve survivability, navigation, and 'tactical internet' communications capabilities. The first of the upgraded Block II Apaches was delivered to the U.S. Army in February 2003. Block II includes upgrades to the digital communications systems.

The Japanese Apache variant is based on the AH-64D. Japan's AH-64DJP can also be equipped with the AIM-92 Stinger air-to-air missiles for defense.

5 – 5 - AH-64E

Formerly known as AH-64D Block III, in October 2012 the type was redesignated *AH-64E* and received the name *Guardian*. The new designation represents the significantly increased capabilities of the upgrades featured. AH-64E includes the following upgrades: improved digital connectivity, the joint tactical radio system, more powerful T700-GE-701D engines, an upgraded transmission with new split-torque face gears to accommodate more power, capability to control Unmanned aerial vehicle (UAVs), new composite rotor blades, full IFR capability, and improved landing gear. The new blades, which successfully completed flight testing in May 2004, increase cruise speed, climb rate, and payload capability.[241] Deliveries began in November 2011 and full rate production was approved on 24 October 2012 . 634 AH-64Ds will be upgraded to AH-64E standard, and a production run of 56 new-build AH64E will start in 2019/20 . Changes in production lots 4 through 6 shall include a cognitive decision aiding system, new self-diagnostic abilities, Link-16 data-links, and radar improvements. The updated Longbow radar has an oversea capacity, potentially enabling naval strikes; an AESA radar is under consideration.

5 – 6 - Sea Apache

Naval versions of the AH-64A for the United States Marine Corps and Navy were examined from 1984 to 1987. Multiple concepts were studied with altered landing gear arrangements, improved avionics and weapons. Funding for the naval version was not provided, and the Marine Corps has continued to use the AH-1. The Canadian Forces Maritime Command also examined the prospect of using a modified Apache in naval service. The British Army's AgustaWestland Apache went through trials in 2004 onboard HMS *Ocean* to test its suitability for use. The U.S. expressed interest in these trials. The British Army made extensive use of its Apaches during the 2011 military intervention in Libya, operating directly from HMS *Ocean*, a Landing Platform Helicopter of the Royal Navy. In the summer of 2013, AH-64Ds of the U.S. 36th Combat Aviation Brigade were tested on a variety of U.S. Navy ships. There are no plans for full deployment at sea, though.

A U.S. Army AH-64A Apache aboard USS Nassau during Joint Shipboard Weapons and Ordnance training

5 – 7 - Export Apaches

Several models have been derived from both AH-64A and AH-64D for export. The British-built AgustaWestland Apache (assembled from kits purchased from Boeing) is based on the AH-64D Block I with several different systems, including more powerful engines, folding rotor blades, and other modifications for operation from Royal Navy vessels.

5 – 8 - Block modification

While a major change in design or role will cause the type designator suffix to change, for example from AH-64D to AH-64E the helicopters are also subject to Block modification. Block modification is the combining of equipment changes into blocks of modification work orders, the modifications in the block (sometimes called a block package) are all done to the helicopter at the same time.

6 – Operators

World map of military operators of the AH-64 Apache. Current operators in blue, potential operators in red.

Egypt
Egyptian Air Force (AH-64D)
Greece
Hellenic Army (AH-64A/D)
India
Indian Air Force (AH-64E 22 on order)
Indonesia
Indonesian Army (AH-64E 8 on order)
Israel
Israeli Air Force (AH-64A/D)
Japan
Japan Ground Self-Defense Force (AH-64D)
South Korea
Republic of Korea Army (AH-64E 36 on order)
Kuwait
Kuwait Air Force (AH-64D)
Netherlands
Defence Helicopter Command (AH-64D)
Saudi Arabia
Royal Saudi Land Forces (AH-64A / D / E)
Singapore
Republic of Singapore Air Force (AH-64D)
Taiwan (Republic of China)
Republic of China Army (AH-64E)
United Arab Emirates
United Arab Emirates Air Force (AH-64A/D)

United Kingdom
See AgustaWestland Apache
United States
United States Army (AH-64A / D)

7 - Specifications (AH-64A / D)

Weapon loadout of the AH-64 Apache
Data from Jane's Information Group, Bishop

General characteristics

Crew: 2 (pilot, and co-pilot/gunner)
Length: (17.73 m) (with both rotors turning)
Rotor diameter: (14.63 m)
Height: (3.87 m)
Disc area: (168.11 m²)
Empty weight: (5,165 kg)
Loaded weight: (8,000 kg)
Max. take off weight: (10,433 kg)
Fuzelage length: (15.06 m)
Maximum speed: 158 knots (182 mph, 293 km/h)

Armament

Guns: 1× 30 mm M230 Chain Gun with 1,200 rounds as part of the Area Weapon Subsystem

Hardpoints: Four pylon stations on the stub wings. Longbows also have a station on each wingtip for an AIM-92 Stinger twin missile pack.

Rockets: Hydra 70 70 mm, and CRV7 70 mm air-to-ground rockets

Missiles: Typically AGM-114 Hellfire variants; AIM-92 Stinger may also be carried.

Avionics

Lockheed Martin / Northrop Grumman AN/APG-78 *Longbow* fire-control radar (Note: can only be mounted on the AH-64D)

Accuracy International AWM
(Arctic Warfare Magnum)

German Army AWM-F, designated G22

Contents

Type	Sniper rifle
Place of origin	United Kingdom
Service history	
In service	1996 – present
Used by	See *Users*
Wars	Afghanistan War, Iraq War

Manufacturer	Accuracy International
Specifications	
Weight	6.5 kg (.300 Winchester Magnum) 6.9 kg (.338 Lapua Magnum) with stock, bipod and empty magazine
Length	1200 mm (.300 Win. Mag.) 1230 mm (.338 Lapua Magnum)
Barrel length	660 mm (.300 Win. Mag.) 686 mm (.338 Lapua Magnum)
Cartridge	.300 Winchester Magnum .338 Lapua Magnum
Action	Bolt-action
Effective firing range	1,100 m (*.300 Winchester Magnum*) 1,500 m (*.338 Lapua Magnum*)
Feed system	5-round detachable box magazine
Sights	detachable aperture type iron sights day or night optics

1 - Introduction

The Accuracy International AWM (Arctic Warfare Magnum) is a bolt-action sniper rifle manufactured by Accuracy International designed for magnum rifle cartridge chamberings. The Accuracy International AWM is also unofficially known as the AWSM (Arctic Warfare Super Magnum), which typically denotes AWM rifles chambered in .338 Lapua Magnum.

2 - Arctic Warfare Magnum system

The Accuracy International AWM rifle is a variant of the British Accuracy International Arctic Warfare (AW) rifle that was the basis of a family of sniper rifles using the Arctic Warfare name. As such the design details of the AWM variant are similar to the ones found in the basic AW rifle system. Compared to the AW, the AWM has a longer bolt to accommodate dimensionally larger magnum-length cartridges such as the .300 Winchester Magnum and the .338 Lapua Magnum. The bolt head, locking ring, and extractor and magazines were also revised to work with the increased size and operating pressures of magnum rifle cartridges.

The AWM features a detachable single stack removable box magazine which holds five rounds. The normal cartridges for this rifle, and the ones which have been accepted by NATO for use in AWM rifles, are .300 Winchester Magnum and .338 Lapua Magnum.

Muzzle brakes are fitted to reduce recoil, jump and flash and act as a base for optional iron sights and suppressors.

Normally, the AWMs are outfitted with a Schmidt & Bender PM II 10×42/MILITARY MK II 10×42 telescopic sight with 10× fixed power of magnification. However, a Schmidt & Bender PM II/MILITARY MK II with variable magnification of either 3–12×50, 4–16×50 or 5–25×56 can be used if the operator wants more flexibility to shoot at varying ranges, or when a wide field of view is required. Accuracy International actively promotes fitting the German made Schmidt & Bender PM II/MILITARY MK II product line as sighting components on their rifles, which is rare for a rifle manufacturer. The German and Russian Army preferred a telescopic sight made by Zeiss[2] over Accuracy International's preference.

The AWM rifle is normally supplied in a metal transit case together with a telescopic sight, mount, butt spacers, bipod, spare magazines, sling, cleaning and tool kits.

3 - Magnum chamberings

3 – 1 - .300 Winchester Magnum

The .300 Winchester Magnum (7.62 x 67mm) cartridge was designed as a magnum hunting cartridge and offers a flatter trajectory and a significant increase in muzzle velocity, wind resistance and supersonic range over the dimensionally smaller 7.62x51mm NATO cartridge. The ability of the .300 Winchester Magnum chambering to obtain fairly high muzzle velocities combined with for their diameter or caliber relatively heavy and long very-low-drag bullets significantly enhance the hit probability at longer ranges and hence the effective range compared to the 7.62x51mm NATO cartridge. For precision shooting, the Federal *Gold Medal Match* grade is the most commonly used ammunition .

The AWM chambered for the .300 Winchester Magnum is fitted with a fluted, stainless steel barrel that is 660 mm (26") long for optimum muzzle velocity and nominal weight. The .300 Winchester Magnum barrel features a non-traditional 279.4 mm (1:11 in) right-hand twist rate.

3 – 2 - .338 Lapua Magnum

A Dutch ISAF sniper team displaying their Accuracy International AWM .338 Lapua Magnum rifle and Leica/Vectronix VECTOR IV laser rangefinder binoculars.

The AWM in the .338 Lapua Magnum (8.6 x 70 mm) calibre was designed as a dedicated long range sniper rifle combining the maneuverability of rifles chambered in 7.62 x51 mm NATO with the greater power and range of the .50 BMG cartridge.

Compared to most .50 calibre rifles, the AWM offers considerably less rifle weight, recoil, muzzle flash, smoke and report. Although the .338 Lapua Magnum delivers less kinetic energy to the target compared with the .50 BMG, both cartridges have similar trajectories, resistance to wind drift and penetration, while the .338 Lapua Magnum unquestionably outperforms the 7.62 x 51 mm NATO and .300 Winchester Magnum, especially at ranges beyond 800 metres and 1,100 metres . AWM rifles in .338 Lapua Magnum can also be deployed against unarmoured hard targets, including armoured glass.

The AWM .338 Lapua Magnum is fitted with a stainless steel, fluted, 686 mm barrel, which research has found to be the best compromise between muzzle velocity on the one hand, and weight and length on the other. The rifle's barrel has an unconventional 279 mm right-hand twist rate, optimized for firing .338 - calibre very-low-drag bullets up to 16.85 g. When the AWM .338 Lapua Magnum was developed military issue cartridges were loaded with 16.2 g very-low-drag bullets. Longer, heavier very-low-drag bullets like the Sierra HPBT MatchKing .338 - calibre 19.44 g and the 21st century 19.44 gram .338 - calibre HPBT Scenar can be used, but require a 254 mm twist rate to stabilize them under high air density conditions as found on arctic coasts.

A limitation of AWM rifles is that .338 Lapua Magnum cartridges loaded to the Commission Internationale Permanente pour l'Epreuve des Armes à Feu Portatives (C.I.P.) maximum allowed overall length of 93.50 mm do not fit in the magazine due to a lack of internal magazine length. The reason for this limitation is that the AWM bolt action was initially developed for dimensionally smaller cartridges and then modified for the .338 Lapua Magnum chambering Ammunition manufacturers produce .338 Lapua Magnum military issue cartridges loaded with 16.2 g very-low-drag bullets (overall length ≤ 91.44 mm) that fit in the 91.50 mm long AWM magazines. As long as .338 Lapua Magnum cartridges that fit in the magazines are used, the AWM rifles can be used as repeating rifles instead of single shot rifles.

To address .338 Lapua Magnum ammunition length limitations of the AWM Accuracy International has since developed the AX338 long range rifle as the AWM successor model. Compared to the AWM, the bolt action of the AX338 is longer and wider and the internal magazine is lengthened, allowing the unimpaired use of .338 Lapua Magnum cartridges loaded to the C.I.P. (Permanent

International Commission for the Proof of Firearms Portable) maximum allowed overall length of 93.50 mm . Further the A X 338 has a 238 mm twist rate to adequately stabilize longer, heavier .338 caliber very-low-drag projectile designs that became more common in the 21 st century,

Ammunition types currently available for the .338 Lapua Magnum are FMJ, hollow point, Armor Piercing (AP) and Armor Piercing Incendiary (API).

3 – 3 - 1 - Longest confirmed sniper kill

A British sniper (center) carrying his L115A3 Long Range Rifle with attached suppressor.

In November 2009, British Army sniper Corporal of Horse (CoH) Craig Harrison, a member of the Household Cavalry, set what is still the record for longest recorded sniper kill by killing two Taliban machine gunners consecutively south of Musa Qala in Helmand Province in Afghanistan at a range of 2,475 m using a L115A3 Long Range Rifle . In the reports CoH Harrison mentions the environmental conditions were perfect for long range shooting: no wind, mild weather, clear visibility.

4 – Users

4 – 1 - Armed forces

Armenia: AX-338 – Anti sniper team.

Bangladesh: AWM – .338 Lapua Magnum (Bangladesh Army Sniper Team)

Czech Republic: AWM, AW50F and AW97 models are used by the 601st Special Operations Group.

Germany: AWM-F (Designated G22) – .300 Winchester Magnum

Indonesia: AWM is used by the *Komando Pasukan Katak* (Kopaska) tactical diver group and *Komando Pasukan Khusus* (Kopassus) special forces group

Italy: AWM – .338 Lapua Magnum is used by the 9th Parachute Assault Regiment "Col Moschin"

Republic of Korea: AWM – .338 Lapua Magnum.

Malaysia: AWM – .338 Lapua Magnum is used by the *Pasukan Gerakan Khas* (PGK) of the Royal Malaysia Police .

Ireland

Malta: AWM – .338 Lapua Magnum,

Netherlands: AWM and AWM-F – .338 Lapua Magnum.

Poland: AWM-F – .338 Lapua Magnum round; GROM ; 1 Pułk Specjalny Komandosów

Russia: AWM-F – .338 Lapua Magnum used by the Alpha Group counter-terrorism unit

United States of America: AWM – .338 Lapua Magnum used by all branches of USSOCOM

United Kingdom: AWM – .338 Lapua Magnum

4 – 2 - British Armed Forces

Schmidt & Bender 5- 25 x 56 PM II LP telescopic sight and its adjustment controls.

Royal Marines with L115A1 rifles.

The British Armed Forces adopted the AWM rifle chambered in .338 Lapua Magnum as the L115A1 Long Range Rifle. The British L115A1 rifles are outfitted with Schmidt & Bender 3-12 x 50 PM II/MILITARY MKII 3-12 x 50 0.1 MIL RAD telescopic sights. The

L115A1 is in service with the Royal Marines, British Army and RAF Regiment in Afghanistan and Iraq.

In November 2007 the British Ministry of Defence (MOD) announced that their snipers in the Army, Royal Marines and RAF Regiment were to get a new rifle. Accuracy International would supply 580 L115A3 Long Range Rifles with day telescopic sights. The L115A3 is being supplied as part of a broader Sniper System Improvement Programme (SSIP) program which also includes night sights, spotting scopes, laser range finders and tripods.[25] The L115A3 rifle was first deployed to Afghanistan in May 2008.[24] Some features of the improved L115A3 include:

Schmidt & Bender 5-25 x 56 PM II LP/MILITARY MKII 5-25x56 0.1 MIL RAD parallax, illumination, double turn telescopic sights;

Suppressors to reduce the flash and noise signature;

Folding stocks for better carrying in a backpack;

Adjustable cheek pieces for more comfort and better eye alignment with the telescopic sight;

Butt spikes (monopods) to aid stability during firing;

Adjustable bipods, which differ from the original Accuracy International bipod;

5 round box magazines.

The MOD claims a muzzle velocity of 936 m / s for the L115A3 This implies the British military are using a high pressure load to attain this muzzle velocity. A reverse engineering simulation with QuickLOAD internal ballistic software predicted that a typical military .338 Lapua Magnum load using 16.2 g Lapua LockBase B408 bullets at an overall cartridge length of 91.44 mm produces ≈ 460 MPa (66,833 psi) maximum piezo chamber pressure to achieve the claimed 936 m / s muzzle velocity.

4 – 3 - Dutch Armed Forces

The AWM-F chambered in .338 Lapua Magnum has been introduced from 1996 by the Dutch Army’s Korps Commandotroepen snipers and the AWM is used by all long range marksmen of the 11

Luchtmobiele Brigade (airborne infantry), mechanized infantry and reconnaissance units. Recently (2007) the snipers of the Netherlands Marine Corps also received this sniper rifle. The Dutch AWM(-F) rifles are outfitted with Schmidt & Bender 10 x 42 PM II and 3-12x50 PM II telescopic sights. The rifles are designated as *Accuracy, antipersoneel snipergeweer .338* (Accuracy anti personnel sniper rifle .338) and the Military of the Netherlands claim a maximum effective range of 1,400 m for their AWM (- F) rifles and have used these rifles in Afghanistan with great success.

4 – 4 - German Armed Forces

Since 1998 the Bundeswehr fields an AWM-F chambered in .300 Winchester Magnum (7.62 × 67 mm in Bundeswehr nomenclature), with a 3–12×56 SSG telescopic sight made by the German company Zeiss, under the designation of G22 (for *Gewehr 22*) or *Scharfschützengewehr 22* (*sniper rifle 22*). The German G22 rifles have folding stocks and emergency iron sights. For their G22 rifles the Bundeswehr claims an effective range of 1,100 m .

The German ammunition manufacturer Metallwerk Elisenhütte Nassau (MEN) has specially developed 7.62 × 67 mm ammunition for the G22.

The Carl Zeiss Optronics (previously branded as Hensoldt) telescopic sight has a mil-dot reticle and a scale that enables the operator to see the dialled in elevation setting through the rifle scopes ocular. The Bundeswehr 3–12×56 SSG telescopic sight differs somewhat from the further developed 3–12×56 SSG-P telescopic sight. The Bundeswehr telescopic sight has no parallax setting option and the range scale has a setting range from 0 to 10 instead of 0 to 11 symbolizing the 11.2 milliradian elevation adjustment range shown in the current Carl Zeiss Optronics 3–12×56 SSG-P telescopic sight brochure.

4 – 5 - Royal Malaysia Police

The 69 Commandos of the *Pasukan Gerakan Khas* (PGK) snipers from Royal Malaysia Police using the AWM, chambered in

.338 Lapua Magnum alongside the 7.62mm Accuracy International Arctic Warfare.

4 – 6 - Norwegian Special Forces

The snipers in Marinejegerkommandoen and Forsvarets Spesialkommando are currently using the AWM primary weapon .338 Lapua Magnum, with Schmidt & Bender scopes.

4 – 7 - Russian Alpha Group

The snipers of the Russian Alpha Group counter-terrorism unit are using the AWM-F chambered in .338 Lapua Magnum with Zeiss 3–12×56 SSG series telescopic sights.

4 – 8 - Singapore Army

The snipers of the Singapore Army use the AWM alongside the Accuracy International Arctic Warfare .

4 – 8 - South Korean Special Forces

The 707th Special Mission BN from ROK Army and the Republic of Korea Naval Special Warfare Brigade from ROK Navy use AWM series sniper rifles chambered in .338 Lapua Magnum outfitted with Schmidt & Bender 3-12 x 50 PM II telescopic sights.

4 – 10 - United States Special Operations Command

This sniper rifle is currently being issued to most special forces under the United States Special Operations Command such as DEVGRU and U.S. Army personnel stationed in Alaska.

Area Denial Weapon

Caltrop used in Vietnam.

Contents

1 - Introduction

An area denial weapon is a device used to prevent an adversary from occupying or traversing an area of land. The specific method used does not have to be totally effective in preventing passage (and sometimes is not) as long as it is sufficient to severely restrict, slow down, or endanger the opponent. Most area denial weapons pose long-lasting risks to anyone entering the area, specifically to civilians, and thus are often controversial.

2 - Historical methods

In the 18th century, Spanish bayonet (probably the locally-common species *Yucca aloifolia*) was planted around the fortifications of St. Augustine, Florida to discourage penetration by both man and beast.

2 – 1 – Anti – cavalry

In medieval warfare, sharp and sturdy stakes were buried at the bottom of long lines of ditches, pointed end up diagonally, in order to prevent cavalry charges in a given area. Even if the stakes were spotted, soldiers would be forced to dismount and effectively give up their purpose as cavalry as well as becoming easier targets. The correct layout of these extensive lines of ditches and the quality control of stake size, form and placement was part of the craft of war.

A more modern version, allowing quicker dispersal and providing the advantage of being hidden easier, are caltrops, though items bearing close similarity (small balls with spikes) had been in use for most of antiquity. Many variants were also used, such as boards with metal hooks, as described during battles of Julius Caesar.

Passive fortification—ditches and obstacles such as dragon's teeth, Czech hedgehogs and Toblerones — were used as anti-tank (the modern 'cavalry') measures during World War II.

2 – 2 – Anti - infantry

Simple rows or clusters of sharpened sticks (nowadays also known as punji sticks), and the use of small caltrops have been a feature of anti-infantry warfare for a long time. However, due to the difficulty of mass - producing them in the pre - modern age, they were rarely used except in the defense of limited areas or chokepoints, especially during sieges, where they were used to help seal breaches. Increasing ease of production still did not prevent these methods from slowly falling out of favor from the late Middle Ages onward.

Caltrops are still sometimes used in modern conflicts, such as during the Korean War, where Chinese troops, often wearing only light shoes, were particularly vulnerable. In modern times, special caltrops are also sometimes used against wheeled vehicles with pneumatic tires. Some South American urban guerrillas as the Tupamaros and Montoneros called them "miguelitos" and used these as a tactic to avoid pursuit after ambushes.

3 - Modern methods

3 – 1 – Explosives

Anti-personnel landmines.

The most common are land mines of various types, planted by hand or dispersed by artillery. Some modern prototypes experiment with automatic guns or artillery- delivered ammunitions that are fired only after remote sensing detects enemies.

Booby traps or improvised explosive devices in sufficient concentration also qualify as area denial weapons, though they are much easier to clear and usually pose less long-term danger.

During an armed conflict there are several methods of countering land mines. These include using armoured vehicles to negate the effects of anti-personnel land mines. Land mines can also be cleared either by hand, or by using specialised equipment such as tanks equipped with flails. Explosives can also be used to clear mine fields, either by artillery bombardment, or with specialised charges such as Bangalore torpedos, the Antipersonnel Obstacle Breaching System and the Python Minefield Breaching System.

156 states are parties to the Ottawa Treaty under which they have agreed not to use, stockpile, produce or transfer anti-personnel mines.

Anti - ship missiles are a modern method of stopping a potential adversary from attacking by sea. China, North Korea, Syria and Iran all have developed or imported such weapons in an effort to develop a modern anti - access or A2 / AD strategy to counter modern United States weaponry.

3 – 2 - NBC agents

Various NBC (nuclear, biological, chemical) weapons can be used for area denial, as long as the agent is long-lasting. Fallout from nuclear weapons might be used in such a role. While never actually employed in this form, its use had been suggested by Douglas MacArthur during the Korean War.

Anthrax spores can contaminate the ground for long periods of time, thus providing a form of area denial.[6] However, the short-term (tactical) effects are likely to be low - the psychological effects on an opponent would likely be more significant.

The massive use of defoliants such as Agent Orange can be used as an interdiction measure because they leave areas empty of any form of vegetation cover. In the desert-like terrain that ensues, it is impossible for an adversary to travel without being seen, and there is little cover in case of an attack, especially from the air.

Many chemical weapons also produce toxic effects on any personnel in an affected area. However, this usually has no tactical value, as the effects of indirect exposure do not develop fast or substantially enough - though again, the psychological effect upon an enemy aware of the chemical usage may be considerable. There are however some chemical agents that are by design non-degrading, such as the nerve agent VX. Sulfur mustard was extensively used by both German and allied forces on the west front in World War I as an effective area-denial weapon, usually through contaminating large land stripes by extensive shelling with HD/Gelbkreuz ordnance. Since sulfur mustard is very persistent, involatile, hard-to-decontaminate and highly effective in inflicting debilitating casualties at even low doses, this tactic proved to be very effective.

3 – 3 – Targeted

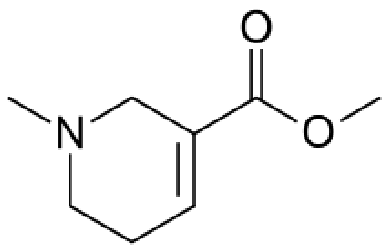
To address some of the problems with land-mines (see 'Draw backs'), weapons manufacturers are now experimenting with area-denial weapons which need human command to operate. Such systems are usually envisioned as a combination of either explosives, pre-targeted artillery shelling or smartguns with remote sensing equipment (sound, vibration, sight/thermal). By not posing a long-term risk, and by having some level of IFF capability (automatic or human-decision-based), these systems aim to achieve compliance with the Ottawa Treaty, as for example the Metal Storm ADWS (Area Denial Weapons System).

4 – Drawbacks

As area denial weapons do not discriminate between friend and foe (or civilians) they make the affected zone hazardous for all trying to enter. Concepts for area denial weapons which do discriminate (by active sensing) have often been proposed, but have not yet reached a stage of general usefulness, due to their high complexity (and cost) and the risk of misidentification.

Explosive - based area - denial weapons (mines) may be intentionally equipped with detonators which degrade over time, either exploding them or rendering them (relatively) harmless. Even in these cases, unexploded munitions often pose significant risk.

Arecoline



Contents

1 - Introduction

Arecoline is a natural product, an alkaloid found in the areca nut the fruit of the areca palm (*Areca catechu*) . It is an odourless oily liquid.

Systematic (IUPAC) name	
Methyl 1-methyl-1,2,5,6-tetra hydro pyridine-3-carboxylate	
Clinical data	
Legal status	Uncontrolled
Formula	$C_8H_{13}NO_2$
Mol. mass	155 g / mol
Density	1.0495 g/cm³
Boiling point	209 °C (408 °F)

2 – Chemistry

Arecoline is a strong base, with pK_a ~ 6.8 . Arecoline is volatile in steam, miscible with most organic solvents and water, but extractable from the latter by ether in presence of dissolved salts. Being basic, arecoline forms salts with acids. The salts are crystalline, but usually deliquescent: the hydrochloride , arecoline • HCl, forms needles, m.p. 158°C ; the hydrobromide , arecoline • HBr, forms slender prisms, mp. 177-179 °C from hot alcohol; the aurichloride, arecoline•$HAuCl_4$, is an oil, but the platinichloride, $arecoline_2$•H_2PtCl_6, mp. 176 °C, crystallizes from water in orange-red rhombohedrons. The methiodide forms glancing prisms, mp. 173-174 °C.

3 - Biological Action

In many Asian cultures, the areca nut is chewed along with betel leaf to obtain a stimulating effect.[3] Arecoline is the primary active ingredient responsible for the central nervous system effects of the areca nut. Arecoline has been compared to nicotine; however, nicotine acts primarily on the nicotinic acetylcholine receptor. Arecoline is known to be a partial agonist of muscarinic acetylcholine M_1, M_2, M_3 receptors and M_4, which is believed to be the primary cause of its parasympathetic effects (such as pupillary constriction, bronchial constriction, etc.).

LD_{50}: 100 mg / kg, administered subcutaneously in mouse.

4 – Uses

Owing to its muscarinic and nicotinic agonist properties, arecoline has shown improvement in the learning ability of healthy volunteers. Since one of the hallmarks of Alzheimer's disease is a cognitive decline, arecoline was suggested as a treatment to slow down this process and arecoline administered intravenously did indeed show modest verbal and spatial memory improvement in Alzheimer's patients, though due to arecoline's possible carcinogenic properties , it is not the first drug of choice for this degenerative disease.

Arecoline has also been used medicinally as an antihelmintic (a drug against parasitic worms).

ARGES Mine

Contents

1 - Introduction

ARGES is an off-route anti-tank mine, developed by an international consortium to meet the needs of the British, French and German armed forces. The system consists of a rocket and launch tube, a tripod and a sensor package.

The sensor package has an acoustic sensor that detects the approach of a suitable target and activates the passive infrared and laser sensors which trigger the launch of the rocket when the target passes in front of it.

The rocket uses a modified version of the motor from the LAW 80 anti-tank rocket, and has a tandem HEAT warhead, enabling it to penetrate the side armour of all main battle tanks, including those protected with reactive armour. The rocket has a range of between two and ninety meters, with the hit probability at ninety meters being 97 % .

The mine is highly programmable with an active window of between three hours and forty days, to choose a specific target in a convoy, as well as the ability to be re-programmed. The system can also be command initiated.

2 - Specifications

Weight: 18 to 22 kg quoted.
Length: 1.02 m
Height: from 230 mm to 700 mm
Range: 2 to 97 m
Traverse: - 45 degrees to + 45 degrees

Argon Flash

Argon flash, also known as argon bomb, argon flash bomb, argon candle, and argon light source, is a single-use source of very short and extremely bright flashes of light. The light is generated by a shock wave in argon or, less commonly, other noble gas. The shock wave is usually produced by an explosion. Argon flash devices are almost exclusively used for photographing explosions and shock waves.

Although krypton and xenon can be also used; argon is favorable because of its low cost.

The light generated by an explosion is produced primarily by compression heating of the surrounding air. Replacement of the air with a noble gas considerably increases the light output; with molecular gases, the energy is consumed partially by dissociation and other processes, while noble gases are monatomic and can only undergo ionization; the ionized gas then produces the light. The low specific heat capacity of noble gases allows heating to higher temperatures, yielding brighter emission. Flashtubes are filled with noble gases for the same reason.

Typical argon flash devices consist of an argon-filled cardboard or plastic tube with a transparent window on one end and an explosive charge on the other end. Many explosives can be used; Composition B, PETN, RDX, and plastic bonded explosives are just a few examples.

The device consists of a vessel filled with argon and a solid explosive charge. The explosion generates a shock wave, which heats the gas to very high temperature (over 10^4 K; published values vary between 15,000 K to 30,000 K with the best values around 25,000 K) The gas becomes incandescent and emits a flash of intense visible and ultraviolet black body radiation. The emission for the temperature range is highest between 97–193 nm, but usually only the visible and near-ultraviolet ranges are exploited.

To achieve emission, the layer of at least one or two optical depths of the gas has to be compressed to sufficient temperature. The light intensity rises to full magnitude in about 0.1 microsecond. For about 0.5 microsecond the shock wave front instabilities are sufficient to create significant striations in the produced light; this effect diminishes as the thickness of the compressed layer increases. Only about 75 micrometers thick layer of the gas is responsible for the light emission. The shock wave reflects after reaching the window at the end of the tube; this yields a short increase of light intensity. The intensity then fades

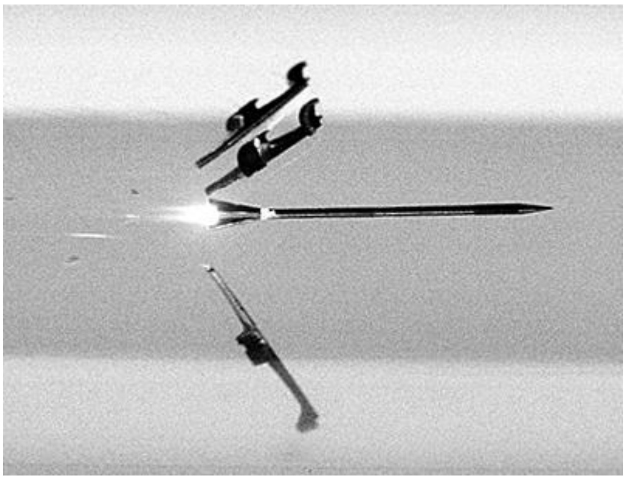
The amount of explosive can control the intensity of the shock wave and therefore of the flash. The intensity of the flash can be increased and its duration decreased by reflecting the shock wave by a suitable obstacle; a foil or a curved glass can be used.[2] The duration of the flash is about as long as the explosion itself, depending on the construction of the lamp, between 0.1 and 100 microseconds.[3] The duration is dependent on the length of the shockwave path through the gas, which is propoportional to the length of the tube; it was shown that each centimeter of the path of shock wave through the argon medium is equivalent to 2 microseconds.

Argon flash is a standard procedure for high speed photography, especially for photographing explosions,[5] or less commonly for use in high altitude test vehicles . The photography of explosions and shock waves is made easy by the fact that the detonation of the argon flash lamp charge can be accurately timed relative to the test specimen explosion and the light intensity can overpower the light generated by the explosion itself. The formation of shock waves during explosions of shaped charges can be imaged this way.

As the amount of released radiant energy is fairly high, significant heating of the illuminated object can occur. Especially in case of high explosives this has to be taken into account.

Super Radiant Light (SRL) sources are an alternative to argon flash. An electron beam source delivers brief and intense pulse of electrons to suitable crystals (e.g. cadmium sulfide). Flash times in nanosecond to picosecond range are achievable. Pulsed lasers are another alternative.

Armour - Piercing Discarding Sabot



A modern APFSDS projectile shortly after muzzle exit, as the sabot petals are separating from the penetrator

Contents

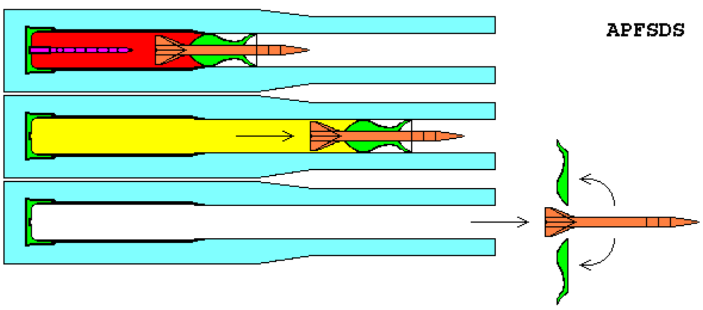
1 - Introduction

Armour-piercing discarding sabot (APDS) is a type of kinetic energy projectile fired from a gun to attack armoured targets. APDS rounds are sabot rounds and were commonly used in large calibre tank guns, but have now been superseded by armour-piercing fin-stabilized discarding sabot (APFSDS) projectiles in such guns. However, APDS rounds are still commonly used in small or medium calibre weapon systems. For a given calibre, this type of ammunition can effectively double the armour penetration of a gun, compared to those firing armour - piercing (AP), AP - capped (APC), or APC + ballistic cap (APCBC) projectiles.

2 - History and development

APDS was developed by engineers working for the French Edgar Brandt company, and was fielded in two calibers (75 mm / 57 mm for the Mle1897 / 33 75 mm anti-tank cannon, 37 mm / 25 mm for several 37 mm gun types) just before the French-German armistice of 1940 . The Edgar Brandt engineers, having been evacuated to the United Kingdom, joined ongoing APDS development efforts there, culminating in significant improvements to the concept and its realization .The APDS projectile type was further developed in the United Kingdom between 1941–1944 by Permutter and Coppock, two designers with the Armaments Research Department. In mid-1944 the APDS projectile was first introduced into service for the UK's QF 6 pdr anti - tank gun and later in September 1944 for the 17 pdr anti - tank gun.

The reason for the development of the APDS was the search for anti-tank projectiles with increased penetrating performance. It was known that high impact (terminal) velocity, or a larger diameter projectile would be required to improve penetration. A larger projectile would require a completely new weapon system and may have been too heavy to retrofit onto existing armoured fighting vehicles. Increasing the velocity of the current projectiles was also a problem due to the impact velocity limitations of steel armour-piercing (AP) projectiles, which would shatter at velocities above ~850 m/s when uncapped.



A diagram of a fin stabilized discarding sabot showing its operation.

To allow increased impact velocity, a stronger penetrator material was required. The chosen new penetrator material was tungsten carbide (WC), due to its greater hardness and its ability to withstand the greater shock and pressure generated during a higher velocity impact. As the density of WC (≈15.7 g / cm^3) is twice that of steel (≈7.86 g / cm^3), such a shot was too heavy at full bore to be accelerated to a sufficient muzzle velocity. To overcome this, a lightweight full diameter carrier shell was developed to sheathe the inner high density core. The name given to this projectile type was the Armor-Piercing Composite Rigid (APCR). The APCR projectile was about half the weight of a standard AP shot, but of the same diameter. Due to the large surface area for the gases to impinge upon the lightweight APCR projectile, it experienced a higher average acceleration in the gun barrel, in turn imparting a higher muzzle velocity. Unfortunately the low sectional density of the APCR resulted in poor carrying power (high aerodynamic drag), losing velocity and penetration rapidly over distance.

To over come these limitations the British devised a way for the outer sheath to be discarded after leaving the bore. The name given to the discarded outer sheath was the sabot (a French word for a wooden shoe). For APDS projectiles the sabot is also known as a pot, as the sabot resembles a flower pot in shape. The APDS has the advantages of the lightweight projectile with regards to bore acceleration and high muzzle velocity, but does not suffer from the high drag of the APCR in flight.

3 - Sabot construction

The sabot of a large calibre APDS consists of a light high strength alloy full diameter pot and base unit, which is screwed together. The front part of the pot has 3 - 4 petals (sabots) which are covered with a centering band (often a nylon derivative). The rear half has a rubber obturator and driving band (again nylon) held in place by the screw-in base unit. The base unit, if a tracer element is attached to the sub-projectile, has a hole located at the center. Before firing, the sub-projectile and sabot are locked together. Due to the high setback forces, friction between the pot and sub-projectile allows spin to be transferred, so stabilizing the sub - projectile. Small / medium calibre APDS use a lightweight high strength alloy base pot and three or more plastic petals. To transfer the spin to the core in small/medium calibre weapons, the core tends to have a notch at its base. Under bore acceleration, which can be higher than 100,000 g, the uneven base is forced into the softer pot material, locking the sub - projectile to the pot and imparting spin. Not all small/medium calibre APDS rely on this technique, another method for spin coupling is by using the forward plastic petals. The petals are of a slightly larger diameter than the lands in the rifled bore. This forces the petals tightly against the core, increasing the friction between them and allowing the spin to be transferred.

4 – Sub - projectile construction

The sub-projectile consists of a high density core with a penetrating cap, enclosed within a high strength sheath (steel) with a lightweight alloy (aluminum-magnesium alloy) ballistic cap. For modern small/medium calibre APDS projectiles, the core is not sheathed and the ballistic and penetrating caps are combined. A tracer element may be added to the APDS sub-projectile, for large calibre weapons this is part of the outer sheath, for small / medium calibre weapons it is contained within a hollow cavity in, or attached to, the base of the core. Most modern APDS projectiles used high strength shock resistant tungsten alloys. The main constituent is tungsten, alloyed or sintered with / to cobalt, copper, iron or nickel. Very few APDS use depleted uranium (DU) titanium alloy for the penetrator material, though the retired 20 mm MK149-2 Phalanx round did use DU.

5 - Sabot discard

When a large calibre APDS is fired and while still within the bore, the setback forces shear the forward petals, partly unlocking the sub-projectile from the sabot, but still holding it rigidly within the pot. Gas pressure is used to delay the unlocking of the pins holding the rear part of the sub - projectile by gyroscopic forces. Once outside the barrel, the pins, centering band and forward petals are released or discarded by projectile spin, the aerodynamic drag removes the pot/base unit. As an APDS sub - projectile does not require driving bands and the core is supported at the base and ogive region, a far more aero dynamic projectile shape can be chosen. This, in combination with the sub - projectiles' higher sectional density, gives the resulting sub-projectile vastly reduced aerodynamic drag in comparison to the APCR. Both the higher initial velocity and the reduced drag result in high terminal velocity at impact. This also lowers flight time and improves accuracy. Accuracy can suffer if there are unwanted sabot / sub - projectile interactions during discard.

6 - Impact example

The sequence upon impact of the APDS projectile, for example the 120 mm L11, as used on the Chieftain tank, fired L15 APDS [3] (muzzle velocity 1370 m / s), goes as follows: the lightweight ballistic cap is crushed, the penetrating cap then strikes the armour, distributing the shock across the whole surface of the core's nose, reducing the initial shock experienced by the core. The steel sheath surrounding the core peels away, and the core goes on to penetrate the armour. The penetration of the L15 APDS is approximately 355 mm of rolled homogeneous armour at 1000 m.

7 – FAPDS

Many newer medium calibre APDS cores use a frangible high density alloy, the resulting projectiles are called Frangible Armour Piercing Discarding Sabot (FAPDS) for APDS types, or FRAP (Frangible Armour Piercing) for full calibre projectiles. During penetration, a frangible projectile's core fragments into many high velocity pieces. The effect of a frangible projectile on a lightly armoured target is much the same as a high explosive incendiary round, but with a cloud of dense, high velocity fragments penetrating deeper into the target's interior. Upon striking heavy armour the effect of FAPDS is more akin to a standard APDS, albeit with higher fragmentation of the core, and hence lethality if the armour is perforated.

FAPDS is also known as a Penetrator with Enhanced Lateral Effect (PELE).

Armoured Fighting Vehicle

	
An MRAP Cougar HE in testing with land mines set off around it	*A M1128 Mobile Gun System firing its 105 mm cannon*

Contents

1 - Introduction

An **armoured fighting vehicle** (or **armored fighting vehicle** – see spelling differences) **AFV** is a combat vehicle, protected by strong armour and armed with weapons, which combines operational mobility, tactical offensive, and defensive capabilities. AFVs can be wheeled or tracked. It is not uncommon for AFVs to be simply referred to as "armour".

Armoured fighting vehicles are classified according to their intended role on the battlefield and characteristics. This classification is not absolute; at different times different countries will classify the same vehicle in different roles. For example, armoured personnel carriers were generally replaced by infantry fighting vehicles in a similar role, but the latter has some capabilities lacking in the former. There may also be hybrid vehicles, such as the Stryker family of AFVs; the M1128 Mobile Gun System, an armoured car which mounts a large 105 mm gun normally used in tank destroyers, but can theoretically be reconfigured to the M1126 Infantry Carrier Vehicle.

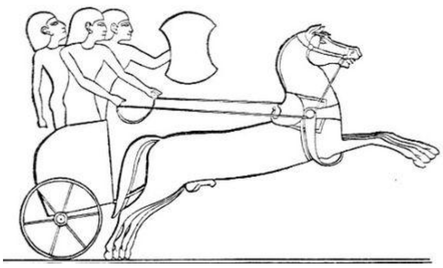
Successful general-purpose armoured fighting vehicles often also serve as the base of a whole family of specialized vehicles, for example, the M113 and MT-LB tracked carriers, and the MOWAG Piranha wheeled AFV.

2 - Evolution of AFVs
2 – 1 – History
2 – 1 – 1 – Conception

Model of a vehicle sketched by Leonardo da Vinci

Prior to the invention of the internal combustion engine and the advent of armoured warfare in the 20th century, the AFV classification did not exist. However, war machines with rudimentary armour have been used in battle for millennia. These designs historically struggled between the paradox of exposed-mobility, effective-firepower and cumbersome - protection. Siege engines, such as battering rams, would often be armoured in order to protect the crews from the defenders.

The idea of a vehicle with a tortoise like cover has been known since antiquity. Frequently cited is Leonardo da Vinci's 15th century sketch of a mobile, protected gun platform; the drawings show a conical, wooden shelter with apertures for cannons around the circumference. The machine was to be mounted on four wheels which would be turned by the crew through a system of hand cranks and cage (or "lantern") gears. Leonardo quoted "*I will build armored wagons which will be safe and invulnerable to enemy attacks. There will be no obstacle which it cannot overcome.*" However, modern replicas have demonstrated that the human crew would have been able to move it over only short distances.

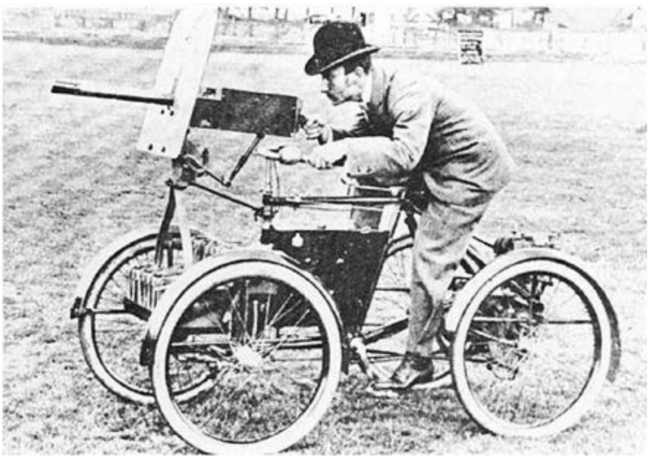


Hittite chariot (drawing of an Egyptian relief)

The chariot was used as a mobile archery platform and as a "battle taxi". The original chariot was a fast, light, open, two-wheeled conveyance drawn by two or more horses hitched side by side. It was used for ancient warfare during the bronze and the iron ages. The war wagon were medieval weapon-platforms development during the Hussite Wars around 1420 by Hussite forces rebelling in Bohemia. These heavy wagon were given protective sides with firing slits and heavy firepower from either a cannon or a force of hand - gunners and crossbowmen, supported by infantry using pikes and flails.

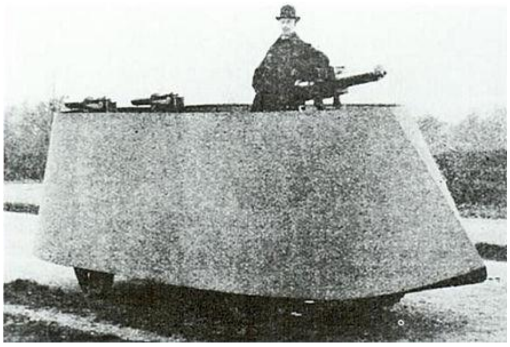
2 – 1 – 2 - Modern AFVs

2 – 1 – 2 - 1 - Armoured car



F.R. Simms' Motor Scout, built in 1898 as an armed car.

The first modern AFVs were armoured cars, dating back virtually to the invention of the motor car. The Motor Scout was designed and built by British inventor F.R. Simms in 1898. It was the first armed petrol engine powered vehicle ever built. The vehicle was a De Dion - Bouton quadricycle with a mounted Maxim machine gun on the front bar. An iron shield in front of the car protected the driver.



F.R. Simms' 1902 Motor War Car, the first armoured car to be built.

The first armoured car was the Simms' Motor War Car, designed by Simms and built by Vickers, Sons & Maxim in1899 . The vehicle had Vickers armour 6 mm thick and was powered by a four- cylinder 3.3 - litre 16 hp Cannstatt Daimler engine giving it a maximum speed of around 9 miles per hour (14 kilometers per hour). The armament, consisting of two Maxim guns, was carried in two turrets with 360° traverse.

Another early armoured car of the period was the French Charron , Girardot et Voigt 1902, presented at the *Salon de l'Automobile et du cycle* in Brussels, on 8 March 1902 . The vehicle was equipped with a Hotchkiss machine gun, and with 7 mm armour for the gunner. Armoured cars were first used in large numbers on both sides during World War I as scouting vehicles which offered armoured protection to the crew.

2 – 1 – 2 - 2 – Tank

British World War I Mark V tank.*

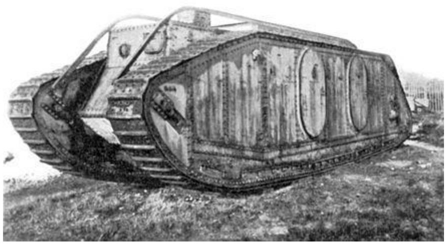
The development of the AFV took a great leap forward during World War I, when the tracked tank was developed by Britain and

France to break the stalemate on the Western Front. The tank was envisioned as an armoured machine that could cross ground under fire from machine guns and respond with fire from mounted guns. It was to move on caterpillar tracks to enable it to cross ground broken up by shellfire and trenches.

In Great Britain, the Landships Committee was formed by the First Lord of the Admiralty, Winston Churchill[9] on 20 February 1915. The Director of Naval Construction for the Royal Navy, Eustace Tennyson d'Eyncourt, was appointed to head the Committee in view of his experience with the engineering methods it was felt might be required. The first design, Little Willie, ran for the first time in September 1915 and served to develop the form of the track but an improved design, better able to cross trenches, swiftly followed and in January 1916 the prototype, nicknamed "Mother", was adopted as the design for future tanks. Production models of "Male" tanks (armed with naval cannon and machine guns) and "Females" (carrying only machine-guns) would go on to fight in history's first tank action at the Somme in September 1916 . Great Britain produced about 2,600 tanks of various types during the war.

In 1916, the French pioneered the use of a full 360° rotation turret in a tank for the first time, with the creation of the Renault FT light tank, with the turret containing the tank's main armament. In addition to the traversable turret, another innovative feature of the FT was its engine located at the rear. This pattern, with the gun located in a mounted turret and the engine at the back, became the standard for most succeeding tanks across the world . The FT was the most numerous tank of the War; over 3,000 were made by late 1918.

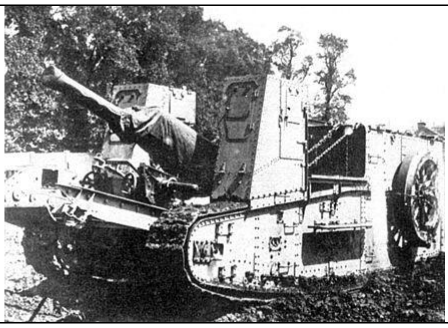
2 – 1 – 2 - 3 - Other AFVs



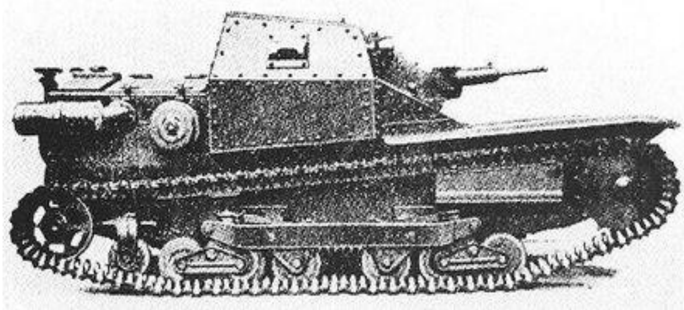
The Mark IX tank, the first armoured personnel carrier.

The tank proved highly successful, and as technology improved it became a weapon that could cross large distances at much higher speeds than supporting infantry and artillery. The need to provide the units that would fight alongside the tank led to the development of a wide range of specialized AFVs, especially during the Second World War.

The Armoured personnel carrier, designed to transport infantry troops to the frontline, emerged towards the end of WWI. During the first actions with tanks it had become clear that often infantry could not keep up with the tanks; they could not be transported in the tank, due to the poor atmosphere quality. In 1917, Lieutenant G.R. Rackham was ordered to design an armoured vehicle specifically for troop transport. The Mark IX tank was built by Armstrong, Whitworth & Co., although just three vehicles were finished at the time of the Armistice and only 34 were built in total.



British Gun Carrier Mark I



An Italian L3 / 33 tankette.

Different tank classifications emerged in the interwar period. The tankette was conceived as a mobile, two-man model, mainly intended for reconnaissance. In 1925 Sir John Carden and Vivian Loyd produced the first such design – the Carden Loyd tankette. Tankettes saw use in the Italian Royal Army during the Italian invasion of Ethiopia, the Spanish Civil War, and almost every place Italian soldiers fought during World War II. The Imperial Japanese Army also used them for jungle warfare.

The British Gun Carrier Mark I was the first Self - propelled artillery and was fielded in 1917. It was based on the first tank, the British Mark I and carried a heavy field gun. The next major advance was the Birch gun developed for the motorised warfare experimental brigade (the Experimental Mechanized Force). This mounted a field gun, capable of the usual artillery trajectories, on a tank style chassis.

During WWII, most nations developed self-propelled artillery vehicles. These had mounted guns on a tracked chassis (often that of an obsolete or superseded tank) and provide an armoured superstructure to protect the gun and its crew. The first British design, "Bishop", carried the 25 p dr gun - howitzer, but in a mounting that severely limited the gun's performance. It was replaced by the more effective Sexton. The Germans created many examples of lightly armored self-propelled anti-tank guns using captured French equipment (example Marder I), their own obsolete light tank chassis (Marder II), or ex-Czech chassis (Marder III) . These led to better protected tank destroyers, built on medium tank chassis such as the Jagdpanzer IV and Jagdpanther.

The Self - propelled anti - aircraft weapon debuted in WWI. The German 77 mm anti - aircraft gun, was truck - mounted and used to great effect against British tanks, and the British QF 3 inch 20 cwt was mounted on trucks for use on the Western Front. Although the Birch gun was a general purpose artillery piece on an armoured tracked chassis, it was capable of being elevated for anti-aircraft use. Vickers Armstrong developed one of the first SPAAGs based on the chassis of the Mk.E 6-ton light tank/Dragon Medium Mark IV tractor, mounting a Vickers QF-1 "Pom-Pom" gun of 40 mm. The Germans fielded the SdKfz 10 / 4 and 6/2, cargo halftracks mounting single 20 mm or 37 mm AA guns (respectively) by the start of the War.

By the end of World War II, most modern armies had vehicles to carry infantry, artillery and anti-aircraft weaponry . Most modern AFVs are superficially similar in design to their World War II counterparts, but with significantly better armour, weapons, engines and suspension. The increase in the capacity of transport aircraft has allowed AFVs to be practically transported by air. Many armies are replacing some or all of their traditional heavy vehicles with lighter airmobile versions, often with wheels instead of tracks.

2 – 2 – Design

2 – 2 – 1 – Armour

The level of armour protection between AFVs varies greatly – a main battle tank will normally be designed to take hits from other tank guns and anti-tank missiles, whilst light reconnaissance vehicles are often only armoured "just in case". Whilst heavier armour provides better protection, it makes vehicles less mobile (for a given engine power), limits its air-transportability, increases cost, uses more fuel and may limit the places it can go – for example, many bridges may be unable to support the weight of a main battle tank. A trend toward composite armour is taking place in place of steel – composites are stronger for a given weight, allowing the tank to be lighter for the same protection as steel armour, or better protected for the same weight. Armour is being supplemented with active protection systems on a number of vehicles, allowing the AFV to protect itself from incoming projectiles.

The level of protection also usually varies considerably throughout the individual vehicle too, depending on the role of the vehicle and the likely direction of attack. For example, a main battle tank will usually have the heaviest armour on the hull front and the turret, lighter armour on the sides of the hull and the thinnest armour on the top and bottom of the tank. Other vehicles – such as the MRAP family – may be primarily armoured against the threat from IEDs and so will have heavy, sloped armour on the bottom of the hull.

2 – 2 – 2 – Weaponry

Weaponry varies by a very wide degree between AFVs – lighter vehicles for infantry carrying, reconnaissance or specialist roles may have only a machine gun for self-defence (or no armament at all), whereas heavy self propelled artillery will carry large guns, mortars or rocket launchers. These weapons may be mounted on a pintle, affixed directly to the vehicle or placed in a turret or cupola.

The greater the recoil a weapon on an AFV is, the larger the turret ring needs to be. A larger turret ring necessitates a larger vehicle. To avoid listing to the side, turrets are usually located at the centre of the vehicle on vehicles that are capable of amphibious operations.

Grenade launchers provide a versatile launch platform for a plethora of munitions including, smoke, phosphorus, tear gas, illumination, anti - personnel, infrared and radar-jamming rounds.

Turret stabilization is an important capability because it enables firing on the move and prevents crew fatigue.

2 – 2 – 3 – Engine

Modern AFVs have primarily used either petrol (gasoline) or diesel piston engines. More recently gas turbines have been used. Most early AFVs used petrol engines, as they offer a good power-to-weight ratio. However, they fell out of favour during World War Two due to the flammability of the fuel.

Most current AFVs are powered by a diesel engine; modern technology including the use of turbo - charging help to overcome the lower power-to-weight ratio of diesel engines compared to petrol.

Gas turbine (turbo shaft) engines offer a very high power-to-weight ratio and were starting to find favour in the late 20th century – however they offer very poor fuel consumption and as such some armies are switching from gas turbines back to diesel engines (i.e. the Russian T- 80 used a gas turbine engine, whereas the later T-90 does not). The US M1 Abrams is a notable example of a gas turbine powered tank.

3 - Modern classification by type and role

Notable armoured fighting vehicles extending from post-World War I to today.

3 – 1 – Tank

The tank is an all terrain AFV designed primarily to engage enemy forces by the use of direct fire in the frontal assault role. Though several configurations have been tried, particularly in the early experimental days of tank development, a standard, mature design configuration has since emerged to a generally accepted pattern. This features a main artillery gun, mounted in a fully rotating turret atop a tracked automotive hull, with various additional machine guns throughout.

Philosophically, the tank is, by its very nature, an offensive weapon. Being a protective encasement with at least one gun position, it is essentially a pillbox or small fortress (though these are static fortifications of a purely defensive nature) that can move toward the enemy – hence its offensive utility.

Historically, tanks are divided into three categories:

Light tanks – small, thinly armoured, weakly gunned; superior tactical/strategic mobility tanks intended for the airborne divisions and the armoured reconnaissance role.

Medium tanks – mid-sized, adequately armoured, respectably gunned, fairly mobile tanks; intended to provide an optimum balance of characteristics for manoeuvre combat; primarily used against hostile tanks and other AFV's.

Heavy tanks – large, thickly armoured, powerfully gunned, but barely mobile "Siegeworks" tanks; intended for the assault-breakthrough role against fortified lines, particularly in support of infantry formations.

Cavalry tank, cruiser tank, infantry tank, and assault-breakthrough tank have been used by various countries to classify tanks by operational role. Tankette is used to describe particularly small one or two-man vehicles, typically armed with a machine gun and/or anti - air weapons.

In modern use, the heavy tank has fallen out of favour, being supplanted by more heavily-armed and armoured descendent of the medium tanks – the main battle tank. The light tank has in many militaries lost favour to cheaper, faster, lighter armoured cars and tank destroyers; however, light tanks (or similar vehicles with other names) are still in service with a number of forces as reconnaissance vehicles, most notably the Russian Marines with the PT-76, the British Army with the Scimitar, and the Chinese Army with the Type 63.

3 – 1 – 1 - Main battle tank

Indian T-90 Bhisma with appliqué reactive armor and standard 125 mm main gun

Modern main battle tanks incorporates recent advances in automotive, artillery, and armour technology to combine the best characteristics of the historic medium and heavy tanks into a single, all around type. They are also the most expensive to mass-produce. It is distinguished by its high level of firepower, mobility and armour protection relative to other vehicles of its era. It can cross comparatively rough terrain at high speeds, but its heavy-dependency on fuel, maintenance, and ammunition makes it logistically demanding. It has the heaviest armour of any IFV on the battlefield, and carries a powerful precision-guided munition weapon systems that may be able to engage a wide variety of both ground targets and air targets. It is among the most versatile and fearsome land-based weapon-systems of the 21st-century, valued for its shock action against other troops and high survivability, although it is still vulnerable to anti-tank warfare.

3 – 1 – 2 – Tankette

A tankette is a tracked armed and armoured vehicle[16] resembling a small "ultra - light tank" roughly the size of a car, mainly intended for light infantry support or scouting . They were one or two-man vehicles armed with a machine gun. Colloquially it may also simply mean a "small tank".

Tankettes were designed and built by several nations between the 1920s and 1940s. They were very popular with smaller countries. Some saw some combat (with limited success) in World War II. However, the vulnerability of their light armour eventually caused the concept to be abandoned.

3 – 1 – 3 – *Super* - heavy tank

The term "super-heavy tank" has been used to describe armoured fighting vehicles of extreme size, generally over 75 tonnes. Programs have been initiated on several occasions with the aim of creating an invincible siege works / breakthrough vehicle for penetrating enemy formations and fortifications without fear of being destroyed in combat. Examples were designed in World War I and World War II, along with a few in the Cold War. However, few working prototypes were ever been built and there are no clear evidence any of these vehicles saw combat, as their immense size would have made most designs impracticable.

3 – 1 – 4 - Flame tank

Churchill Crocodile flame tank

A **flame tank** is a tank equipped with a flamethrower, most commonly used to supplement combined arms attacks against fortifications, confined spaces, or other obstacles. The type only reached significant use in the Second World War, during which the United States, Soviet Union, Germany, Italy, Japan and the United Kingdom (including members of the British Commonwealth) all produced flamethrower - equipped tanks.

A number of production methods were used. The flamethrowers used were either modified versions of existing infantry flame weapons (Flammpanzer I and II) or specially designed (Flamm panzer III). They were mounted externally (Flamm panzer II), replaced existing machine gun mounts, or replaced the tank's main armament (Flamm panzer III). Fuel for the flame weapon was either carried inside the tank, in armoured external storage, or in some cases in a special trailer behind the tank (Churchill Crocodile).

Flame tanks have been superseded by thermobaric weapons such as the Russian TOS-1.

3 – 1 – 5 - Infantry tank

A British Matilda tank displaying a captured Italian flag

The idea for this tank was developed during World War I by the British and French. The infantry tank was designed to work in concert with infantry in the assault, moving mostly at a walking pace, which required it to carry heavy armour to survive defensive fire. Its main purpose would have been to clear the battlefield of obstacles, suppress or destroy defenders, and protect the infantry on their advance into and through enemy lines by giving mobile overwatch and cover.

The British came back to the concept in the pre-Second World War era. The infantry tank did not need to be fast so it could carry more armour. One of the best-known infantry tanks was the Matilda II of World War II.

3 – 1 – 6 - Cruiser tank

Cromwell tank.

A cruiser tank, or cavalry tank, was designed to move fast and exploit penetrations of the enemy front. The idea originated in "Plan 1919", a British plan to break the trench deadlock of World War I in part via the use of high-speed tanks. This concept was later implemented in the "fast tanks" pioneered by Walter Christie.

They were used by the United Kingdom during World War II. Cruiser tanks were designed to complement infantry tanks, exploiting gains made by the latter to attack and disrupt the enemy rear areas. In order to give them the required speed, cruiser designs sacrificed armour compared to the infantry tanks.

The Soviet fast tank (*bistrokhodniy tank*, or BT tank) classification also came out of the infantry/cavalry concept of armoured warfare and formed the basis for the British cruisers after 1936. The T-34 was a development of this line of tanks as well, though their armament, armour, and all-round capability places them firmly in the medium tank category.

3 – 2 - Armoured car

The armoured car is a wheeled, often lightly armoured, vehicle adapted as a fighting machine. Its earliest form consisted of a motorised ironside chassis fitted with firing ports. By World War I, this had evolved into a mobile fortress equipped with command equipment, searchlights, and machine guns for self defence. It was soon proposed that the requirements for the armament and layout of armoured cars be somewhat similar to those on naval craft, resulting in turreted vehicles. The first example carried a single revolving cupola with a Vickers gun; modern armoured cars may boast heavier armament – ranging from twin machine guns to large calibre cannon.

Eland Mk7 armoured car.

Some multi-axled wheeled fighting vehicles can be quite heavy, and superior to older or smaller tanks in terms of armour and armament. They usually do not have attached weaponry. Others are often used in military marches and processions, or for the escorting of important figures. Under peacetime conditions, they form an essential part of most standing armies. Armoured car units can move without the assistance of transporters and cover great distances with fewer logistical problems than tracked vehicles.

During World War II, armoured cars were used for reconnaissance alongside scout cars. Their guns were suitable for some defence if they encountered enemy armoured vehicles, but they were not intended to engage enemy tanks. Armoured cars have since been used in the offensive role against tanks with varying degrees of success, most notably during the South African Border War, Toyota War, the Invasion of Kuwait, and other lower-intensity conflicts.

3 – 2 – 1 – Aerosani

An *aerosani* (Russian: аэросани, literally "aerosled") is a type of propeller - driven snowmobile, running on skis, used for communications, mail deliveries, medical aid, emergency recovery and border patrolling in northern Russia, as well as for recreation.

Aerosanis were used by the Soviet Red Army during the Winter War and World War II.

The first aerosanis may have been built by young Igor Sikorsky in 1909 – 10, before he built multi-engine airplanes and helicopters. They were very light plywood vehicles on skis, propelled by old airplane engines and propellers.

3 – 2 – 2 - Scout car

A **scout car** is military armored reconnaissance vehicle, capable of off-road mobility and often carrying mounted weapons such as machine guns for offensive capabilities and crew protection. They often only carry an operational crew aboard, which differentiates them from wheeled armored personnel carriers (APCs) and Infantry Mobility Vehicles (IMVs), but early scout cars, such as the open-topped US M3 Scout Car could carry a crew of seven. The term is often used synonymously with the more general term armored car, which also includes armored civilian vehicles. They are also differentiated by being designed and built for purpose, as opposed to improved technicals which might serve in the same role.

3 – 2 – 3 - Internal security vehicle

An internal security vehicle (ISV), also known as an armoured security vehicle (ASV), is a combat vehicle used for supporting contingency operations. Security vehicles are typically armed with a turreted heavy machine gun and auxiliary medium machine gun. The vehicle is designed to minimize firepower dead space and the vehicles weapons can be depressed to a maximum of 12°. Non-lethal water cannons and tear gas cannons can provide suppressive fire in lieu of unnecessary deadly fire.

The vehicle must be protected against weapons typical of riots. Protection from incendiary devices is achieved though coverage of the air intake and exhaust ports as well as a strong locking mechanism on the fuel opening. Turret and door locks prevent access to the interior of the vehicle by rioters. Vision blocks, ballistic glass and window shutters and outside surveillance cameras allow protected observation from within the vehicle. Wheeled 4 x 4 and 6x6 configurations are typical of security vehicles. Tracked security vehicles are often cumbersome and leave negative political connotations for being perceived as an imperial invading force.

3 – 2 – 4 - Improvised fighting vehicle

An improvised fighting vehicle is a combat vehicle resulting from modifications to a civilian or military non-combat vehicle in order to give it a fighting capability. Such modifications usually consist of the grafting of armour plating and weapon systems. Various militaries have procured such vehicles, ever since the introduction of the first automobiles into military service.

During the early days, the absence of a doctrine for the military use of automobiles or of an industry dedicated to producing them, lead to much improvisation in the creation of early armoured cars, and other such vehicles. Later, despite the advent of arms industries in many countries, several armies still resorted to using ad hoc contraptions, often in response to unexpected military situations, or as a result of the development of new tactics for which no available vehicle was suitable. The construction of improvised fighting vehicles may also reflect a lack of means for the force that uses them. This is especially true in developing countries, where various armies and guerrilla forces have used them, as they are more affordable than military-grade combat vehicles.

		
A ZU-23-2 technical used by the forces of the National Transitional Council during the Libyan civil war , in October 2011.	*A Gun Truck of the type used in Iraq, based on an M939 five-ton truck*	*A U.S. Marine Corps High Mobility Multipurpose Wheeled Vehicle traversing difficult terrain in Afghanistan*

Modern examples include **military gun truck** used by units of regular armies or other official government armed forces, based on a conventional cargo truck, that is able to carry a large weight of weapons and armour. They have mainly been used by regular armies to escort military convoys in regions subject to ambush by guerrilla forces. "Narco tanks", used by Mexican drug cartels in the Mexican Drug War, are built from such trucks, which combines operational mobility, tactical offensive, and defensive capabilities.

3 – 3 - Troop carriers

Troop - carrying AFVs are divided into three main types – armoured personnel carriers (APCs), infantry fighting vehicles (IFVs) and infantry mobility vehicles (IMV). The main difference between the three is their intended role – the APC is designed purely to transport troops and is armed for self - defence only – whereas the IFV is designed to provide fire support to the infantry it carries. IMV is a wheeled armored personnel carrier serving as a military patrol, reconnaissance or security vehicle.

3 – 3 – 1 - Armoured personnel carrier

Slovak APC Tatrapan.

Armoured personnel carriers are intended to carry infantry quickly and relatively safely to point where they are deployed. In 1918, the British Mk V* (Mark Five Star) tank carried a small number of troops as an experiment, but the men were debilitated by the conditions inside the vehicle. The first purpose-built APC was the British Mk IX (Mark Nine). In the US the term "Infantry Carrier Vehicle (ICV)" is used. In 1944, the Canadian general Guy Simonds ordered the conversion of redundant armoured vehicles to carry troops (generically named "Kangaroos"). This proved highly successful, even without training, and the concept was widely used in the 21st Army Group. Post-war, specialised designs were built, such as the Soviet BTR-60 and US M113.

3 – 3 – 2 - Infantry fighting vehicl

An **infantry fighting vehicle** (**IFV**) , also known as a **mechanized infantry combat vehicle** (**MICV**) , is a type of armoured fighting vehicle used to carry infantry into battle and provide direct fire support.[24] The first example of an IFV was the West German Schützenpanzer Lang HS.30 which served in the Bundeswehr from 1958 until the early 1980s.

The German Puma is one of the best protected infantry fighting vehicles

IFVs are similar to armoured personnel carriers (APCs) and infantry carrier vehicles (ICVs), designed to transport a section or squad of infantry (generally between five and ten men) and their equipment. They are differentiated from APCs— which are purely "troop-transport" vehicles armed only for self-defense— because they are designed to give direct fire support to the dismounted infantry and so usually have significantly enhanced armament. IFVs also often have improved armour and some have firing ports (allowing the infantry to fire personal weapons while mounted).

They are typically armed with an auto cannon of 20 to 40 mm calibre, 7.62mm machine guns, anti - tank missiles (ATGMs) and/or surface-to-air missiles (SAMs). IFVs are usually tracked, but some wheeled vehicles fall into this category. IFVs are generally less heavily armed and armoured than main battle tanks. They sometimes carry anti-tank missiles to protect and support infantry against armoured threats, such as the NATO TOW missile and Soviet Bastion, which offer a significant threat to tanks. Specially-equipped IFVs have taken on some of the roles of light tanks; they are used by reconnaissance organizations, and light IFVs are used by airborne units which must be able to fight without the heavy firepower of tanks.

3 – 3 – 3 - Infantry mobility vehicle

An infantry mobility vehicle (IMV) or protected patrol vehicle (PPV) is a wheeled armored personnel carrier (APC) serving as a military patrol, reconnaissance or security vehicle. Examples include the ATF Dingo, AMZ Dzik, AMZ Tur, Mungo ESK, and Bushmaster IMV. This term also applies to the vehicles currently being fielded as part of the MRAP program.

IMVs were developed in response to the threats of modern counter insurgency warfare, with an emphasis on Ambush Protection and Mine-Resistance. Similar vehicles existed long before the term IMV was coined, such as the French VAB and South African Buffel. The term is coming more into use to differentiate light 4x4 wheeled APCs from the traditional 8x8 wheeled APCs. It is a neologism for what might have been classified in the past as an armoured scout car, such as the BRDM, but the IMV is distinguished by having a requirement to carry dismountable infantry. The up - armoured M1114 Humvee variant can be seen as an adaptation of the unarmoured Humvee to serve in the IMV role.

	
A CV-9035 demonstrator infantry fighting vehicle for the U.S. Army.	*Polish AMZ Tur*

	
The ATF Dingo of the German Army is a mine-resistant/ambush protected infantry mobility vehicle used by several European armed forces	*The M113, one of the most common tracked APCs, on duty during the Iraq War.*


United States Army National Guard M1117 Armored Security Vehicles.

3 – 4 - Amphibious vehicles

	
Two U.S. Marine Corps Assault Amphibious Vehicles emerge from the surf onto the sand of Freshwater Beach, Australia.	*BTR-70s coming ashore, engine snorkels and waterjet deployed.*

Many modern military vehicles, ranging from light wheeled command and reconnaissance, through armoured personnel carriers and tanks, are manufactured with amphibious capabilities. Contemporary wheeled armoured amphibians include the French Véhicule de l'Avant Blindé and Véhicule Blindé Léger. The latter is a small, lightly armoured 4 x 4 all-terrain vehicle that is fully amphibious and can swim at 5.4 km / h. The VAB (*Véhicule de l'Avant Blindé* - "Armoured Vanguard Vehicle") is a fully amphibious armoured personnel carrier powered in the water by two water jets, that entered service in 1976 and produced in numerous configurations, ranging from basic personnel carrier, anti - tank missile platform.

During the Cold War the Soviet bloc states developed a number of amphibious APCs, fighting vehicles and tanks, both wheeled and tracked. Most of the vehicles the Soviets designed were amphibious, or could ford deep water. Wheeled examples are the BRDM - 1 and BRDM - 2 4 x 4 armoured scout cars, as well as the BTR - 60, BTR-70, BTR - 80 and BTR - 94 8 x 8 armoured personnel carriers and the BTR - 90 infantry fighting vehicle.

The United States started developing a long line of Landing Vehicle Tracked (LVT) designs from ca. 1940. The US Marine Corps currently uses the AAV7 - A1 Assault Amphibious Vehicle, which was to be succeeded by the Expeditionary Fighting Vehicle, which was capable of planing on water and can achieve water speeds of 37 – 46 km / h. The EFV project has been cancelled.

A significant amount of tracked armoured vehicles that are primarily intended for land - use, have some amphibious cability, tactically useful inland, reducing dependence on bridges. They use their tracks, sometimes with added propeller or water jets for propulsion. As long as the banks have a shallow enough slopes to enter or leave the water they can cross rivers and water obstacles.

Some heavy tanks can operate amphibiously with a fabric skirt to add buoyancy. The Sherman DD tank used in the Normandy landings had this setup. When in water the waterproof float screen was raised and propellers deployed. Some modern vehicles use a similar skirt.

3 – 5 - Armoured engineering vehicle

Typically based on the platform of a main battle tank, these vehicles go by different names depending upon the country of use or manufacture. In the US the term "combat engineer vehicle (CEV)" is used, in the UK the term "Armoured Vehicle Royal Engineers (AVRE)" is used, while in Canada and other commonwealth nations the term "armoured engineer vehicle (AEV)" is used. There is no set template for what such a vehicle will look like, yet likely features include a large dozer blade or mine ploughs, a large calibre demolition cannon, augers, winches, excavator arms and cranes, or lifting booms.

These vehicles are designed to directly conduct obstacle breaching operations and to conduct other earth-moving and engineering work on the battlefield. Good examples of this type of vehicle include the UK Trojan AVRE, the Russian IMR, and the US M728 Combat Engineer Vehicle.

It should be noted that while the term "armoured engineer vehicle" is used specifically to describe these multi-purpose tank-based engineering vehicles, that term is also used more generically in British and Commonwealth militaries to describe all heavy tank-based engineering vehicles used in the support of mechanized forces. Thus, "armoured engineer vehicle" used generically would refer to AEV, AVLB, Assault Breachers, and so on.

3 – 5 – 1 - Assault breacher vehicle

An **assault breacher vehicle (ABV)** , also known as a **explosive ordnance disposal vehicle (EODV)** , or simply **Breacher**, is especially designed to clear pathways for troops and other vehicles through minefields and along roadside bombs and Improvised Explosive Devices. These vehicles are based on a tank-chassis with 1,500 + horsepower engines, but fitted with a 50-caliber machine gun and a front - mounted 5 – meter - wide plow, supported by metallic skis that glide on the dirt and typically equipped with at least 3,200 kilograms of Mine Clearing Line Charges: rockets carrying C - 4 explosives up to 100 – 150 meters forward, detonating hidden bombs at a safe distance, so that troops and vehicles can pass through safely . They were called *"the answer"* to the deadliest threat facing NATO troops in modern asymmetrical conflict.

3 – 5 – 2 - Armoured bulldozer

The **armored bulldozer** is a basic tool of combat engineering. These combat engineering vehicles combine the earth moving capabilities of the bulldozer with armor which protects the vehicle and its operator in or near combat. Most are civilian bulldozers modified by addition of vehicle armor/military equipment, but some are tanks stripped of armament and fitted with a dozer blade. Some tanks have bulldozer blades while retaining their armament, but this does not make them armored bulldozers as such, because combat remains the primary role – earth moving is a secondary task.

3 – 5 – 3 - Armoured recovery vehicle

An **armoured recovery vehicle** (**ARV**) is a type of vehicle recovery armoured fighting vehicle used to repair battle - or mine-damaged as well as broken-down armoured vehicles during combat, or to tow them out of the danger zone for more extensive repairs. To this end the term *"Armoured Repair and Recovery Vehicle" (ARRV)* is also used.

ARVs are normally built on the chassis of a main battle tank (MBT), but some are also constructed on the basis of other armoured fighting vehicles, mostly armoured personnel carriers (APCs). ARVs are usually built on the basis of a vehicle in the same class as they are supposed to recover; a tank-based ARV is used to recover tanks, while an APC- based one recovers APCs, but does not have the power to tow a much heavier tank.

3 – 5 – 4 - Armoured vehicle-launched bridge

An **armoured vehicle-launched bridge** (**AVLB**) is a combat support vehicle, sometimes regarded as a subtype of combat engineering vehicle, designed to assist militaries in rapidly deploying tanks and other armoured fighting vehicles across rivers. The AVLB is usually a tracked vehicle converted from a tank chassis to carry a folding metal bridge instead of weapons. The AVLB's job is to allow armoured or infantry units to cross water, when a river too deep for vehicles to wade through is reached, and no bridge is conveniently located (or sufficiently sturdy, a substantial concern when moving 60-ton tanks).

The bridge layer unfolds and launches its cargo, providing a ready-made bridge across the obstacle in only minutes. Once the span has been put in place, the AVLB vehicle detaches from the bridge, and moves aside to allow traffic to pass. Once all of the vehicles have crossed, it crosses the bridge itself and reattaches to the bridge on the other side. It then retracts the span ready to move off again. A similar procedure can be employed to allow crossings of small chasms or similar obstructions. AVLBs can carry bridges of 60 feet (18 metres) or greater in length. By using a tank chassis, the bridge layer is able to cover the same terrain as main battle tanks, and the provision of armour allows them to operate even in the face of enemy fire. However, this is not a universal attribute: some exceptionally sturdy 6x6 or 8x8 truck chassis have lent themselves to bridge-layer applications.

3 – 5 – 5 - Combat engineer section carriers

The **combat engineer section carriers** are used to transport sappers (combat engineers) and can be fitted with a bulldozer's blade and other mine-breaching devices. They are often used as APCs because of their carrying ability and heavy protection. They are usually armed with machine guns and grenade launchers and usually tracked to provide enough tractive force to push blades and rakes. Some examples are the U.S. M113 APC, IDF Puma, Nagmachon, Husky, and U.S. M1132 ESV (a Stryker variant).

	
Marines with 2nd Combat Engineer Battalion launch a M58 MICLIC from an Assault Breacher Vehicle.	*A remotely controlled Panther armored mine clearing vehicle leads a column down a road in Bosnia and Herzegovina , 1996.*
	
BPz3 "Büffel", German Army.	*An armored IDF Caterpillar **D9**R bulldozer, nicknamed "דובי" (Teddy bear) in Israel. Its armor allows it to work under heavy fire.*
	
M1132 Engineer Squad Vehicle (ESV) issued to combat engineer squads in the US Army Stryker brigade combat teams.	*An M60A1 Armored Vehicle Launched Bridge (AVLB), deploying its scissors-type bridge.*

3 – 6 - Air defense vehicles

Flakpanzer Gepard, Germany

An anti-aircraft vehicle, also known as a self-propelled anti-aircraft weapon (SPAA) or self-propelled air defense system (SPAD), is a mobile vehicle with a dedicated anti-aircraft capability. The Russian equivalent of SPAAG is ZSU (from *zenitnaya samokhodnaya ustanovka* – "anti-aircraft self-propelled mount"). Specific weapon systems used include machine guns, autocannons, larger guns, or missiles, and some mount both guns and longer-ranged missiles. Platforms used include both trucks and heavier combat vehicles such as APCs and tanks, which add protection from aircraft, artillery, and small arms fire for front line deployment. Anti-aircraft guns are usually mounted in a quickly-traversing turret with a high rate of elevation, for tracking fast-moving aircraft. They are often in dual or quadruple mounts, allowing a high rate of fire. Today, missiles (generally mounted on similar turrets) have largely supplanted anti-aircraft guns.

3 – 7 - Self - propelled artillery

Self-propelled artillery vehicles give mobility to artillery. Within the term are covered self-propelled guns (or howitzers) and rocket artillery. They are highly mobile, usually based on tracked chassis carrying either a large howitzer or other field gun or alternatively a mortar or some form of rocket or missile launcher. They are usually used for long-range indirect bombardment support on the battlefield.

In the past, self - propelled artillery has included direct-fire "Gun Motor Carriage" vehicles such as assault guns and tank destroyers (also known as self - propelled anti - tank guns). These have been heavily armoured vehicles, the former providing danger - close fire -support for infantry and the latter acting as specialized anti-tank vehicles.

Modern self - propelled artillery vehicles may superficially resemble tanks, but they are generally lightly armoured, too lightly to survive in direct-fire combat. However, they protect their crews against shrapnel and small arms and are therefore usually included as armoured fighting vehicles. Many are equipped with machine guns for defence against enemy infantry.

The key advantage of self - propelled over towed artillery is that it can be brought into action much faster. Before the towed artillery can be used, it has to stop, unlimber and set up the guns. To move position, the guns must be limbered up again and brought — usually towed — to the new location. By comparison self-propelled artillery in combination with modern communications can stop at a chosen location and begin firing almost immediately, then quickly move on to a new position. This ability is very useful in a mobile conflict and particularly on the advance.

Conversely, towed artillery was and remains cheaper to build and maintain. It is also lighter and can be taken to places that self-propelled guns cannot reach, so despite the advantages of the self-propelled artillery, towed guns remain in the arsenals of many modern armies.

3 – 7 – 1 - Assault gun

The Soviet SU - 76 was easily constructed in small factories incapable of producing proper tanks.

An assault gun is a gun or howitzer mounted on a motor vehicle or armoured chassis, designed for use in the direct fire role in support of infantry when attacking other infantry or fortified positions.

Historically the custom-built fully armored assault guns usually mounted the gun or howitzer in a fully enclosed casemate on a tank chassis. The use of a casemate instead of a gun turret limited these weapons field of fire, but allowed a larger gun to be fitted relative to the chassis, more armour to be fitted for the same weight, and provided a cheaper construction. In most cases, these turretless vehicles also presented a lower profile as a target for the enemy.

3 – 7 – 2 - Mortar carrier

An American M1129 Mortar Carrier

A mortar carrier is a self - propelled artillery vehicle carrying a mortar as its primary weapon. Mortar carriers cannot be fired while on the move and some must be dismounted to fire. In U.S. Army doctrine, mortar carriers provide close and immediate indirect fire support for maneuver units while allowing for rapid displacement and quick reaction to the tactical situation. The ability to relocate not only allows fire support to be provided where it is needed faster but also allows these units to avoid counter-battery fire. Mortar carriers have traditionally avoided direct contact with the enemy. Many units report never using secondary weapons in combat.

Prior to the Iraq War, American 120 mm mortar platoons reorganized from six M1064 mortar carriers and two M577 fire direction centers (FDC) to four M1064 and one FDC.[26] The urban environment of Iraq made it difficult to utilize mortars. New technologies such as mortar ballistic computers and communication equipment and are being integrated. Modern era combat is becoming more reliant on direct fire support from mortar carrier machine guns.

3 – 7 – 3 - Multiple rocket launcher

BM-30 Smerch 300 mm rocket launcher in raised position

A multiple rocket launcher is a type of unguided rocket artillery system. Like other rocket artillery, multiple rocket launchers are less accurate and have a much lower (sustained) rate of fire than batteries of traditional artillery guns. However, they have the capability of simultaneously dropping many hundreds of kilograms of explosive, with devastating effect.

The Korean Hwacha is an example of an early weapon system with a resemblance to the modern-day multiple rocket launcher.The first modern multiple rocket launcher was the German *Nebelwerfer* of the 1930s, a small towed artillery piece. Only later in World War II did the Allies deploy similar weapons in the form of the Land Mattress.

The first self - propelled multiple rocket launchers – and arguably the most famous – were the Soviet BM-13 Katyushas, first used during World War II and exported to Soviet allies afterwards. They were simple systems in which a rack of launch rails was mounted on the back of a truck. This set the template for modern multiple rocket launchers. The Americans mounted tubular launchers atop M4 Sherman tanks to create the T34 Calliope rocket launching tank, only used in small numbers, as their closest equivalent to the Katyusha.

3 – 7 – 4 - Tank destroyer

A Norwegian anti - tank platoon equipped with NM142 TOW missile launchers

Tank destroyers and tank hunters are armed with an anti-tank gun or missile launcher, and are designed specifically to engage enemy armoured vehicles. Many have been based on a tracked tank chassis, while others are wheeled. Since World War II, main battle tanks have largely replaced gun-armed tank destroyers; although lightly armoured anti tank guided missile (ATGM) carriers are commonly used for supplementary long-range anti-tank engagements.

In post - Cold War conflict, the resurgence of expeditionary warfare has seen the emergence of gun-armed wheeled vehicles, sometimes called "protected gun systems", which may bear a superficial resemblance to tank destroyers, but are employed as direct fire support units typically providing support in low intensity operations such as Iraq and Afghanistan. These have the advantage of easier deployment, as only the largest air transports can carry a main battle tank, and their smaller size makes them more effective in urban combat.

Many forces' IFVs carry anti-tank missiles in every infantry platoon, and attack helicopters have also added anti-tank capability to the modern battlefield. But there are still dedicated anti-tank vehicles with very heavy long-range missiles, or intended for airborne use. There have also been dedicated anti-tank vehicles built on ordinary armoured personnel carrier or armoured car chassis. Examples include the U.S. M901 ITV (Improved TOW Vehicle) and the Norwegian NM142, both on an M113 chassis, several Soviet ATGM launchers based on the BRDM reconnaissance car, the British FV438 Swingfire and FV102 Striker and the German Raketenjagdpanzer series built on the chassis of the HS 30 and Marder IFV.

	
A preserved Sherman M4(105) Assault Gun carriage	*British AS - 90s firing in Basra, Iraq, 2006*

3 – 8 - Armoured train

Replica of the 'Hurban' Armoured train located in Zvolen, Slovakia.

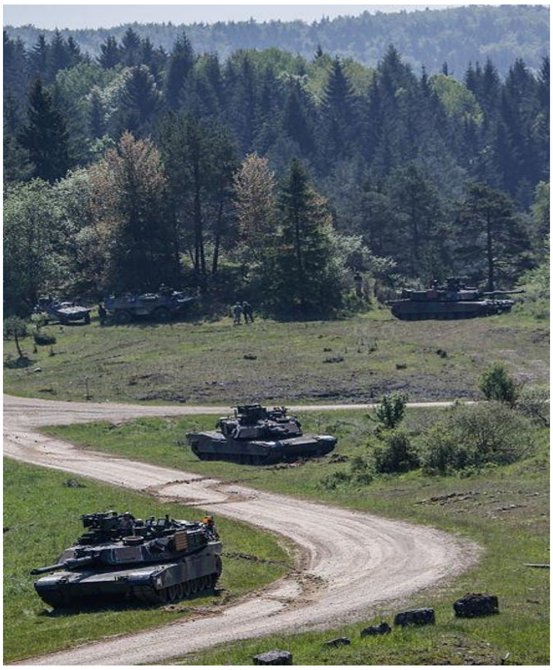
An **armoured train** is a railway train protected with armour. They are usually equipped with railroad cars armed with artillery and machine guns. They were mostly used during the late 19th and early 20th century, when they offered an innovative way to quickly move large amounts of firepower. Their use was discontinued in most countries when road vehicles became much more powerful and offered more flexibility, and because armoured trains were too vulnerable to track sabotage as well as attacks from the air. However, the Russian Federation used improvised armoured trains in the Second Chechen War in the late 1990s and 2000s.

The railroad cars on an armoured train were designed for many tasks such as carrying guns and machine guns, infantry units, anti-aircraft guns. During World War II, the Germans would sometimes put a *Fremdgerät* (such as a captured French Somua S-35 or Czech PzKpfw 38 (t) light tank, or Panzer II light tank) on a flatbed car which could be quickly offloaded by means of a ramp and used away from the range of the main railway line to chase down enemy partisans.

Different types of armour were used to protect from attack by tanks. In addition to various metal plates, concrete and sandbags were used in some cases for improvised armoured trains.

Armoured trains were sometimes escorted by a kind of rail-tank called a draisine. One such example was the 'Littorina' armoured trolley which had a cab in the front and rear, each with a control set so it could be driven down the tracks in either direction. Littorina mounted two dual 7.92mm MG13 machine gun turrets from Panzer I light tanks.

Armoured Warfare



Modern American armoured vehicles during an exercise

Contents

1 - Introduction

Armoured warfare or **tank warfare** is the use of armoured fighting vehicles in modern warfare. It is a major component of modern methods of war. The premise of armoured warfare rests on the ability of troops to penetrate conventional defensive lines through use of manoeuvre by armoured units.

Much of the application of armoured warfare depends on the use of tanks and related vehicles used by other supporting arms such as infantry fighting vehicles and self-propelled artillery, as well as mounted combat engineers and other support units. The doctrine of armoured warfare was developed to break the static nature of World War I trench warfare on the Western Front, and return to the 19th century school of thought that advocated manoeuvre and "decisive battle" outcomes in military strategy.

2 - World War I

Prior to World War I, horse - mounted cavalry performed what is now the role of tanks; manoeuvring and breaking through enemy infantry to attack army lines of communication in the rear. The entry of machine guns on the battlefield, and the increased occupation of the flanks of armies, leading to closed fronts, made cavalry too vulnerable for this task.

Modern armoured warfare began with the need to break the tactical, operational and strategic stalemates forced on commanders on the Western Front by the effectiveness of entrenched defensive infantry armed with machine guns — known as trench warfare. Under these conditions, any sort of advance was impossibly slow and occasioned massive casualties. The development of the tank was motivated by the need to return manoeuvre to warfare, and the only way to do so was to protect soldiers from small arms (rifle, machine gun) fire as they were moving.

Strategic use of tanks was slow to develop during and immediately after World War I, partly due to technical limitations but also due to the prestige role traditionally accorded to horse-mounted cavalry.

Tanks were first developed in Britain and France, as a way of navigating the barbed wire and other obstacles of no-man's land while remaining protected from machine-gun fire. The manoeuvrability of the tank would at least in theory regain armies the ability to flank enemy lines. In practice, tank warfare during most of World War I was hampered by mechanical failure, limited numbers, and general under utilization.

British Mark I tanks first went to action at the Somme, on September 15, 1916,[1] but did not manage to break the deadlock of trench warfare. In the Battle of Cambrai (1917) British tanks were more successful, and broke a German trenchline system, the Hindenburg Line.

The German Empire produced only a few tanks, late in the war. Twenty German A7V tanks were produced during the war, compared to almost 4,000 French and over 2,500 British tanks of various kinds. Nonetheless, World War I saw the first tank – versus - tank battle in military history, in April 1918 during the Second Battle of Villers - Bretonneux, when a group of three German A7V tanks engaged a group of three British Mark IV tanks.

After the disastrous final German offensive; in the summer of 1918 the lack of tanks on the German side, coupled with the Allied tactics that involved a combination of hundreds of their own tanks, cannon equipped (aka "males"), as also machine guns equipped ("females"), with rotating turrets (like the French Renault FT) or not (like the British tanks), greatly contributed to the success of 1918

Allied counter - offensives (as e.g. the Battles of Soissons and Amiens), which ended the stalemate imposed by trench warfare on the Western Front, and thus effectively ending the war. Following the First World War, the technical and doctrinal aspects of armoured warfare became more sophisticated and diverged into multiple schools of doctrinal thought.

3 - Interwar period

During the 1920s, various British and French commanders who had been associated with the development of the tank were involved in developing the new ideas. The significant split in philosophy can be said to be French and British in schools of thought.

The French school proposed the armoured forces to be largely an infantry-supporting arm, demanding heavily armoured tanks armed with infantry support guns, as well as 'cavalry' tanks operating en masse to break through the enemy defensive lines. Although seen as retrograding and reminiscent of WW1 tank use, it advocated a doctrine that included a desire to introduce an element of manoeuvre without expecting collapse of the enemy infantry's defence.

The British school leaned more towards more mobile and lighter designs supported by equally - mobile units of infantry, artillery and sappers to replace horse - mounted cavalry. These self - contained motorised detachments would depend on the tank only to provide a way to penetrate the main enemy defensive lines, and would seek to bring about defeat of the enemy by severing the lines of communication and supply as had been done during the previous century.

Both doctrines were faced with the reality during the 1920s that the armoured vehicles (as early road transport in general) were extremely unreliable, and could not be used in sustained operations.

In Britain Liddell Hart wrote extensively on tank warfare and the theories of Colonel Fuller. The British War Office sanctioned the creation of the Experimental Mechanized Force which was formed on

May 1, 1927, under Colonel R. J. Collins. The units were entirely mobile and consisted of reconnaissance tankettes and armoured cars, a battalion of 48 Vickers medium tanks, a motorised machine gun battalion, a mechanized artillery regiment, which had one battery of fully tracked self- propelled guns capable of acting as conventional or anti-aircraft artillery (Birch guns), and a motorized company of field engineers. The unit carried out operations on Salisbury Plain and was observed by the other major nations, the United States, Germany, and the Soviet Union. Although its performance was recognised, it was disbanded in 1928.

All European states (with the exception of Germany), the USA, and Japan, would create their own experimental mechanized forces during the late 1920s, many using either French or British vehicle designs or even directly purchased vehicles, but largely borrowing from both to develop their own doctrines. Early in the 1930s after the rise to power of the Nazi Party in Germany, German officers were sent to observe and participate in development of armoured doctrine in the USSR.

In the 1930s the British Army began the conversion of its cavalry from horse to tanks. Although there were differences on where British military strength should be developed, with the Royal Air Force and Royal Navy being favoured by some in power, all but a few regiments were fully converted by 1939.

In the Soviet Union during the early 1930s Red Army and German officers collaborated in developing use of tanks based on second generation vehicles using turreted main weapons, and experimenting with different chassis configurations and drive trains. One important acquisition for the Red Army turned out to be the purchase of a T3 chassis from an inspired US designer J.W. Christie which served as the basis of the Soviet BT series of fast tanks.[3] The Red Army in particular was much influenced by the theoretical works of Marshal Tukhachevsky who advocated "large scale tank warfare" in the early 1930s His theories died with him with his execution in 1937, but were revived with General Georgy Zhukov's mass tank, artillery, and air attacks at the battles of Khalkhin Gol (Nomonhan) in 1939, during the Soviet's undeclared war with Japan . These tactics would be repeated on a larger scale a week later by the German army during their invasion of Poland in September 1939. This development led to the intent by the Red Army to form a massive tank force of thousands of vehicles.

As Europe neared another conflict, doctrinal development of armoured warfare was still in development, opinion split between proponents of infantry as the primary combat arm, and those arguing that infantry was to become the supporting arm of the more mobile armoured forces. Use of armoured warfare was most prominently tested during the Soviet - Japanese Border Wars conflict in 1938.

4 - Second World War

Modern armour warfare doctrine developed during the years immediately preceding World War II, in most cases with the tank seen as an infantry support weapon in the breakthrough of defence lines role. A fundamental key to conventional warfare is the concentration of force at a particular point on the enemy's defence line seen as either weak or offering other tactical, operational or strategic advantages.

Concentration of force increases the chance of victory in a particular engagement through application of one of the Principles of War—mass. This point, if correctly chosen and exploited, assures a greater chance of success in a given tactical engagement or a small number of operational engagements which are often sufficient to win a strategically decisive battle. The German term that later came to define the building of such a concentration at a given point is *Schwerpunktbildung*, which translates as center of gravity-creation, meaning a "development of a centre of effort".

This can be visualized when looking at two opposing defensive lines, each composed of two infantry and two armoured divisions, distributed consistently along the length of a line. A numerically equivalent attacker can win by concentrating his two armoured divisions at one point of the line with his two infantry divisions holding the rest of the line, thus increasing the chance of breaching the enemy defences, then passing through, turning the flank of the severed two halves of the defensive line, and further exploiting the numerical superiority against the smaller number of defenders on the flank to force them to retreat onto the intact part of the line, therefore widening the breach.

The defensive line could attempt to counterattack, but it is not strong at any point and although the combined infantry and armour attack of the defenders is stronger than an infantry only attack, it is not very much stronger (since the divisions are spread out along the entire line) and it is in general much easier to defend than attack due to the factor of field entrenchment and field engineering in preparation for such counterattacks.

A major aspect of all warfare is the simple formula, known as the *Lanchester's Square Law*, that the relative combat power of a combat unit in contact with each other to the relative combat power of an enemy of a given size, all other factors being equal, is the square of the number of members of that unit:

One tank obviously has the combat power of one tank. ($1^2 = 1$)
Two tanks have four times the relative combat power of a single tank. ($2^2 = 4$)

From this it is derived that twice as many tanks will quadruple the relative firepower — relative that is, to the amount of firepower the enemy has per member of the friendly unit; one could also express this by saying that their relative punishment from enemy action is reduced four times, which is the same thing — as not only their own absolute number is doubled, but the number of enemy tanks relative to each of their own, is thereby halved also.

Thus, concentrating two divisions into one point and attacking generates a far greater force than is achieved by spreading two divisions into a line and pushing forward on a broad front.

Concentration of force requires mobility to prevent the enemy detecting the point of attack in time to reinforce the section of the defence, and concentration of firepower to be effective in combat once concentrated. The tank embodies these two properties, and so constitutes the primary weapon in armoured warfare.

Forces of all participating powers during WW2 were composed predominantly of the Infantry and other combat supporting Arms (artillery, reconnaissance troops, engineers and logistics and service troops). With the possible exceptions of the United Kingdom and the United States (which both had fully mechanized by the war's end), the infantry units were still highly dependent on horse-drawn vehicles, as was the artillery on horse-towed guns when operating in the field. Strategic movement was provided by the rail transport networks.

4 – 1 - British and French

4 – 1 – 1 – Pre – war

In the UK and in France, armour was accepted into the Army, but using a division of labour: some as infantry support weapons, others as cavalry replacements. As such, the UK and French infantry tanks were heavily armoured, and as a consequence slow, whereas British cavalry ("cruiser") tanks were swift, and as a result poorly armoured. Only some of the German tanks were designed for independent mobile operations and as all-around tanks: lighter, considerably more mobile, but more weakly armed and armoured than the infantry tanks. Tanks were not yet seen to be a primary anti-tank weapon.

When the German tanks actually had to fight the UK infantry tanks in 1940, they were severely discomfited, but recovered to drive the British army out of continental Europe. At the start of the German invasion, France possessed more tanks and, in one-to-one terms, better tanks, than the Germans. However, what mattered was how the tanks were used, and French command distributed half of its tanks among independent *Bataillons de Chars de Combat* (battle tank battalions) for infantry support, rendering them tied to decision-making of the local army commanders. In 1940 the German command concentrated its tanks into Panzer divisions and used them for strategic envelopment, smashing their way through the French defensive line, and driving towards The Channel, threatening to sever communications and supply lines with the national centres of logistic support.

To counter such attacks, a mobile anti-tank force must be held in reserve and moved to meet the attack. The French had no strategic reserve at all, let alone a highly mobile reserve; their three Cavalry armoured divisions (*Divisions Légères Mécaniques* or Mechanised Light Divisions) — the only armoured units organised on the lines of the German armoured divisions — had already been committed in the Low Countries. This factor was crucial in the French failure to counteract the German penetration, as the four French Infantry armoured divisions, the *Divisions cuirassées*, lacked sufficient strategic mobility and squandered their power in actions of limited scope such as the Battle of Montcornet and the Battle of Abbeville (in which the 4th DCr, under Colonel De Gaulle, obtained some success against the German 57th Infantry Division). Later in the campaign, the French applied a new defensive tactic called the hedgehog, which proved highly resistant against tank attacks. However, due to the losses already sustained, the French could never counterattack on a large scale, and the hedgehogs were eventually by-passed by the German troops.

4 – 1 – 2 - North African theatre

In the deserts of North Africa, the British developed the alternative approach of combining the armoured, infantry and artillery together to form a 'balanced, combined arms team'. The 10th Italian Army of Maresciallo (Marshal) Rodolfo Graziani, being ill-armed and inadequately led, soon gave way to this approach by the Commonwealth troops of the 8th Army.

The arrival of the German *Afrika Korps* under command of General der Infanterie Erwin Rommel highlighted the weaknesses of the British approach: the small number of infantry and artillery in each armoured division was sufficient when attacking the immobile and uncoordinated Italian troops, but against the highly mobile, well-coordinated German units, the undermanned Commonwealth formations were proving inadequate.

Between 1941 - 42, the Allies struggled in armoured battles in the North African desert due to improper tactics; in particular, running armoured formations into opposing anti-tank positions; however, they achieved some notable successes at Crusader, 1st Alamein and under Montgomery finally achieved decisive victories, in particular at the Second Battle of El Alamein against even the mighty 8.8 cm flak guns. In the later years of the war, with the invasion of the European mainland, Allied Armies become effective armoured forces, but increasingly larger and more powerful German tanks, such as the Panther, Tiger and King Tiger easily outclassed most Allied tanks on a tactical level, with the Churchill & Cavalier/Cromwell being the closest match the British could offer. Nonetheless, the overwhelming numbers of Shermans combined with their average capabilities ensured Allied Victory.

4 – 2 – Red Army

4 – 2 – 1 – Pre - war

Much of the Red Army development in tank use was based on the theoretical work carried out by such officers as Tukhachevsky and Triandafillov in the mid to late 1930s. This was as part of the two-directioned concepts, one being infantry- centred "broad front" and the other being a "shock army".

While the infantry based part of the doctrine demanded "powerful tanks" (heavy tanks armed with infantry guns and machineguns) and "tankettes" (light, often amphibious tanks with machineguns), the shock Army demanded "manoeuvre tanks" (fast tanks with medium guns) used in conjunction with motorized forces and "mechanized cavalry" that would operate in depth as "strategic cavalry" combined with nascent airborne troops. These ideas culminated in the "PU-36" or the 1936 Field Service Regulations.

4 – 2 – 2 - Red Army wartime

A T-34 - 85 tank on display at Musée des Blindés in April 2007.

At the start of the Second World War much of the Red Army, including its armoured forces, was in transition and recovering from the 1937 repression of the officer corps. The Red Army ignored the lessons from Nomonhan, which had been successfully conducted by General Zhukov, and relied instead on lessons from politically selected officers who were veterans of the Spanish Civil War. The result was a poor showing during the Soviet-Finnish War of 1939. The Red Army tank fleet was extremely large, consisting of some 24,000 vehicles, but many were obsolete or unfit for service due to difficulties with supplying spare parts and lack of qualified support staff. Almost half of the tank fleet was lost in the first month of the war.

The Red Army's initial strategic withdrawal relegated the armoured forces to a secondary role. However, one important development took place shortly before the war, which influenced Soviet armoured doctrine and tank design for a decade: the creation of the T-34. Developed on the Christie suspension chassis and using sloped armour for the first time, the T-34 proved a shock to the German forces with its excellent combination of mobility, protection and firepower. Using wide tracks, the T-34 was also able to negotiate terrain in difficult weather conditions, something that persistently dogged the German designs.

Assessing the success of the German Blitzkrieg strategy, operational methods and tactics, the Red Army concluded that it should return to the use of operational methods developed before the war, so the Tank Armies were eventually created. To complement the T-34, heavy tanks, self-propelled artillery, and tank destroyers were also designed. Much of the use of Red Army's armoured forces were used in concentrations during all strategic operations of the Red Army in World War II, initiated under strict secrecy and using the Principle of Surprise.

4 – 3 – Germany

4 – 3 – 1 - Pre and early war

Guderian (right edge) guides armoured force in Poland

By the time of World War II, the German armoured forces had developed a much more profound and more flexible doctrine than that of the Allies on the tactical and operational level. No such doctrine existed on the strategic level but their concentrated Panzer divisions in 1940 in the Battle of France nevertheless strategically exploited breaches in the allied defensive lines to great effect.

This development, largely under the influence of Heinz Guderian's *Achtung–Panzer!*, was facilitated by the fact that for political reasons a Tank Arm had been formed, the *Panzertruppe* or *Panzerwaffe*, distinct from the Infantry and Cavalry. The *Panzertruppe* however was until 1940 overshadowed by the much more influential Infantry, as exemplified by the low priority given to tank production and the fact tanks were between 1936 and 1939 also divided among the Infantry and Cavalry.

Guderian, with the help of others, established the armoured combined arms team, distinct from a purely infantry or cavalry formation. The panzer divisions were not solely composed of tanks, but integrated the other arms in it as well — most notably, mechanized infantry (riding in halftracks to be protected from small-arms fire while being transported) and self-propelled artillery (howitzers fitted on a tank chassis). This allowed the panzer division to become a complete and independent combat force, and overcome the problems that tanks had in attaining a breakthrough against strong opposition by entrenched enemy infantry equipped with large numbers of antitank-guns, which would be very costly without direct infantry support. Infantry had always had problems keeping up with the speedy tanks; now they could simply drive along with them. However, this development was hampered until 1941 by the lack of half-tracks vehicles to equip the mechanized infantry.

The in - depth research through theoretical approaches, wargaming and exercises developed a confidence within the *Panzertruppe* itself (and political support by Hitler) in the armoured formation as the key battlefield formation — although this view was before 1940 not shared by the other Arms of Service. A key part of this doctrine was improved communications by having radios in all tanks — and again this ideal suffered from technical limitations as most tanks had receiver sets only. The superior tactical and operational doctrine combined with an appropriate strategic implementation enabled the Germans in 1940 to defeat forces quantitatively superior in armour, infantry and artillery during their campaign in France; but just when Blitzkrieg was made a deliberate doctrine, in 1941, it ultimately failed on the eastern front, though attaining at first spectacular successes.

4 – 3 – 2 - Late war

Later in World War II, the Germans were on the defensive. The Panther and heavy Tiger tanks had impressive firepower and armour in tank to tank battles. It could take four to five Shermans to knock out a single Tiger tank by manoeuvring to its weaker flank or rear armour. But the onslaught of Allied armour was much superior in numbers. Besides using tanks in dug-in positions, the Germans made use of older types by turning them into tank destroyers, basically turretless tanks with heavier guns and sometimes heavy armour plating.

These vehicles, like the Sturmgeschütz III, outnumbered the German tanks and destroyed numerous Allied tanks on the battlefields of Europe. They were part of very effective general anti-tank tactics that included the use of anti-tank teams armed with *Panzerfäuste* (small recoilless rifles), anti-tank guns and extensive anti-tank minefields. However, they made a successful use of Blitzkrieg tactics very difficult.

4 – 4 - United States

Though the U.S. had established the Tank Corps in WWI using French Renault FT (and *Six Ton Model 1917* tanks, copies of Renault FTs) and British MK tanks , and some officers like Dwight D. Eisenhower and George S. Patton, Jr. emerged from that war initially as avid proponents of continuing and developing an American armored force, the rapid reduction of the forces and apathy and even antipathy towards funding and maintaining armed forces in the inter-war years led to relative stagnation of armored doctrine in the United States. Adna R. Chaffee, Jr., virtually alone, advocated for the future of armored warfare and the development of appropriate training, equipment and doctrine during the late 1920s through the 1930s.

The United States Army had always regarded the French Army as the best army in Europe , and consequently the US Army frequently copied French uniforms (the US Civil War), airplanes, and armour (Renault FT tank). Only when France was rapidly overrun in 1940 did the US Army become "shocked" into re-thinking the influences by the perceived actions of German tanks in the 1939 Polish Campaign. Its Armored Combat Arm was not created until 1940 when The Armored Force was born on July 10, 1940, with the Headquarters, Armor Force and the Headquarters, I Armored Corps established at Fort Knox. On July 15, 1940, the 7th Cavalry Brigade (Mechanized) became the 1st Armored Division; the 7th Provisional

Tank Brigade, an infantry tank unit at Fort Benning, became the 2nd Armored Division"[1]. The Tank Battalion was established at Fort Meade, Md., and a small Armored Force School was also established.

The popular conception in the US was that tanks had been used boldly as part of a new system of war called Blitzkrieg. Under General Jacob L. Devers, Chief of the Armored Force, doctrine evolved into a combined arms operational force consisting of primarily infantry, artillery, and tanks with tanks being the major maneuver component. Under this doctrine, US tank crews of both armored divisions and GHQ tank battalions were taught to fight tanks in tank on tank engagements. Armored Force personnel during and after the war criticized the infantry for using the GHQ tank battalions assigned to infantry divisions strictly as infantry support.

The US Combined Arms team included air support, artillery, engineers, and a tank component supplemented by the Tank Destroyer concept. The latter is most closely identified with the Chief of Army Ground Forces, General Leslie McNair. Having studied the early German successes McNair came under the belief that US forces would be faced with fast moving enemy forces who would seek to bypass, isolate and reduce US forces in a replay of the Fall of France. To counter the enemy blitzkrieg McNair sought to improve the organic anti-tank strength of the US infantry divisions by attaching towed AT guns and equipping the infantry with hand-held Bazookas. To stem the flood of marauding panzers, fast moving powerfully armed Tank destroyer battalions were created to be held back and used in the counterattack.

It was believed that conventional tanks that could take on the enemy Panthers and Tigers toe to toe would not have the speed and mobility to avoid being flanked and bypassed and therefore would not have the chance to fight. It was also calculated that US interests would be better served by large numbers of **reliable** (*battleworthiness*) medium tanks rather than a smaller number of **un-reliable** heavy tanks. It was decided therefore to slow the production of the US heavy tank designs such as the M26 Pershing and concentrate resources on mass - producing the M4 Sherman and tank destroyers such as the M18 Hellcat. Since the Sherman medium tank would be inferior to the enemy heavy tanks they would have to avoid tank - vs - tank combat as much as possible, leaving enemy tanks to the tank destroyers.

To be able get into position to counterattack, the tank destroyers had to be fast. To achieve the desired mobility and agility from the engines available the armor protection was sacrificed, a measure of protection coming from being nimble and hopefully from being able to knock out the enemy before they could get a shot in. Although they had guns of around about 76 mm, the tank destroyer units were issued with the ancestor of the modern Armour-piercing discarding sabot, rounds which made their guns much more powerful than a simple comparison of calibres would suggest.

In actual combat however the Germans were unable and unwilling to fight in the fast, free flowing manner to which the US forces had been tuned to counter. Against the defensive and ambush tactics that the Germans actually used, McNair's doctrine led to US tanks having weaker guns and less armour protection than their German counterparts, and in the narrow confines of much of the terrain in Normandy, they could not avoid one-on-one encounters with German tanks.

4 – 5 – Japanese

The Japanese doctrine was mainly French in concept but with some purely Japanese elements. Due to Japan's naval priorities in warship construction and inter - service feuds (the marine branch of the IJN favoured all - around protective armour) IJA tanks were lightly armoured. As with most armour during the 1930s, the main guns were small in caliber: 37 mm for their Type 95 light tanks and 47 mm for the Type 97 medium tank, but this was sometimes compensated by a high muzzle velocity. The IJA's use of tanks in China exemplifies its doctrine: light tanks were used for scouting or acted as mobile infantry support, while medium tanks supported the infantry and assaulted deeper objectives, but did not fight en masse.

In 1939, the Japanese Army engaged Soviet armour at Nomonhan. During the three month long war, Japanese armour had shown their weakness against Soviet tanks; and the resulting Japanese defeat prompted a series of complaints by the Imperial Army to incorporate improvements in future Japanese armour. This is the primary reason IJA tanks were not as successful while being used with IJA tactics. The tank forces of the US Army consisted of the M2A4 and M3 Stuart light tanks up until 1941,[15] although these vehicles were five years *newer* than the 1935 built Type 95's, the IJA and US light tanks were comparable to each other, and seemingly performed well for their respective forces during jungle combat operations; during their phase of WWII.

As with all armour, maintenance was a continuous challenge; especially in tropical environments. When IJA and SNLF (Imperial marines) tanks did clash with the enemy they were quickly destroyed by concealed anti - tank guns or overwhelming numbers of hostile tanks. Japan was a naval power, and concentrated its production on warships, thus placing a low priority on armoured vehicle development , its tanks becoming quickly obsolete during the later years of the war. A number of designs that were equal to heavier foreign types were on the drawing board at the beginning of the war, but would only be built in small numbers towards the end, being placed in reserve, to be deployed for the defence of Japan itself.

4 – 6 – Chinese

The Republic of China's National Revolutionary Army's 200th Division was the country's only mechanized division during the war. The 200th used pre-war tanks acquired from Italy, Germany, and the Soviet Union .

5 - Cold War

5 – 1 – Arab - Israeli wars

The conflict between Islamic nations in the East Mediterranean region and Israel in particular would serve to become a testing ground for development in armoured warfare during the decades of the Cold War. Both sides in the Arab-Israeli series of conflicts made heavy use of tanks and other armoured vehicles. Up until the 1973 Yom Kippur War, Israeli armoured units typically had the advantage, mainly due to good tactics and unit cohesion.

However without tanks and infantry working together, problems can arise.

During the Yom Kippur War, Israeli tanks operating alone in large numbers were decimated by Egyptian infantry with anti-tank guided missiles. This is an extreme example but exemplifies what has been fairly thoroughly documented since the Second World War: tanks and infantry work best by taking advantage of each other's strengths and combining to minimize the weaknesses.

In many conflicts, it was usual to see infantry riding on the back of tanks, ready to jump off and provide support when necessary. Unfortunately, the design of many modern tanks makes this a dangerous practice. The M1 Abrams, for example, has such hot exhaust gas that nearby infantry have to be careful where they stand. Tanks can also be very vulnerable to well aimed artillery; well-coordinated air support and counter-battery artillery units can help overcome this.

5 – 1 – 1 - The guided missile

While attempts to defeat the tank were made before and during the Second World War, through the use of conventional high velocity anti-tank artillery, this proved increasingly difficult in the post-war period due to increased armour protection and mobility of tanks. The Soviet Union, the country with the largest armoured fleet in the world, strove to incorporate some anti-tank capability into almost every infantry weapon, and in the 1960s designed and deployed portable anti-tank guided missiles. These new weapons could be either carried by infantry, or fired from the newly developed BMP-1 infantry fighting vehicle.

In 1973, the Israel Army failed to anticipate the importance of these new weapon systems. Hundreds of AT-3 Sagger man - portable anti-tank guided missiles (ATGMs), supplied to Egypt by the Soviet Union and could be operated by infantry without having extensive training, inflicted heavy losses on the Israeli armoured formations. Since then, ATGMs have played an important role within the Israeli Army, having developed advanced domestic-made versions (*see* Spike / Gil missile), which have been widely - exported throughout the world.

In the recent 2006 conflict with Hezbollah, while Israeli infantry were able to easily defeat opposing ATGM teams, tanks operating on their own suffered several hits from the latest advanced Russian tandem-warhead types (such as the Kornet). This highlighted that tanks operating solely, in the era of ATGMs, are extremely vulnerable.

Responding to the serious tank losses suffered against Hezbollah, Rafael Advanced Defense Systems in cooperation with Israel Aircraft Industries developed a missile defence system for tanks, called Trophy, to intercept and destroy anti tank missiles.[17][18] The system was successfully deployed in combat on March 1, 2011, when it intercepted an anti tank missile during an engagement on the Gaza border.

5 – 2 – NATO

During the Cold War, NATO assumed armoured warfare to be a dominant aspect of conventional ground warfare in Europe. Although the use of light tanks was largely discontinued, and heavy tanks were also mostly abandoned, the medium tank design evolved into heavier models due to increase in armour and larger sized main weapon resulting in the main battle tank (MBT) which came into existence, combining most of the different types of tanks during World War II.

For the most part the NATO armoured doctrine remained defensive, and dominated by use of nuclear weapons as deterrence. Although most NATO nations began the Cold War period with a large number of US-designed tanks in their fleets, there was a considerable degree of disagreement on the design of future MBTs among the

NATO major nations. Both the US and Germany experimented with, but abandoned the missile - armed MBT-70. The M26 Pershing basic design of the United States would evolve until the M60 main battle tank was replaced with the gas-turbine powered M1 Abrams in the 1980s. The British Army also retained a WWII tank design, the Centurion, which proved to be highly successful and was not fully replaced until the 1970s.

The West German Bundeswehr decided to develop their own tank in the 1960s, and in the 1970s produced the Leopard I, which was a somewhat lighter design, conforming to German doctrine that emphasized speed over protection. The French series of AMX tanks also emphasized manoeuvre over protection. By the 21st century, most advanced western main battle tanks were built around powerful engines, large 120 mm guns and composite armour.

5 – 3 – Warsaw Pact

Warsaw Pact "Big Seven" threats

The Warsaw Pact armoured doctrine was substantially influenced by the developments in the Soviet Army which sought to adopt its existing doctrine evolved during WW2 to the nuclear battlefield. In the early 1960s this led to a number of important developments in the armoured forces and their supporting Arms. One important development was the transition of the Second World War use of Cavalry - Mechanized Group (CMG) into the Cold War Operational Manoeuvre Group (OMG) that was designed to exploit breakthroughs to penetrate NATO's defences in depth. This was a culmination of the Deep Battle theory dating to the 1930s.

In 1964 a significant breakthrough in tank design was achieved in the Soviet Union when the T - 64 was produced which for the first time used an automatic loader, reducing the crew of the tank to three crewmen. Subsequently this model, and the later T-72 and T-80 tanks introduced further innovations that influenced armoured warfare by introducing guided missiles into the tank ammunition mix, allowing ATGW fire from standard tank guns. The Soviet Union is also one of the countries that use two Main Battle Tanks: The high-quality T-80s and lower quality T-72s. Modern Soviet tanks, like the ones mentioned, are typically armed with 125mm smooth bore guns. Advancements in Soviet tanks include improved Fire Control Systems, strong armour protected by ERA, and defensive countermeasures (such as Shtora-1 and Arena). The most advanced Soviet tank, up until the end of the Cold War, was the T-80U, which shared similar characteristics with the M1A1(Turbine engine, advanced Fire Control Systems, strong armour, and fire power)

Infantry fighting vehicles were first developed in the 1960s with the Soviet Union's BMP-1, for the first time allowing supporting infantry to accompany tanks on a battlefield when nuclear weapon use was expected.

The T - 64s and BMP-1s were also joined by the self - propelled guns and more importantly Mi -24 Rotary - wing aircraft capable of firing anti-tank missiles entering production in 1970 which were built and theorized as "flying tanks".

The Soviet tank troops, as they were known in the USSR, included armoured units, armoured training regiments and other formations and units.

5 – 4 – Vietnam War

M113 armoured personnel carriers proved effective in the terrain of Vietnam against enemy forces which, until 1968, rarely deployed their armour . Though they were soon countered with mines and RPGs, M-113's continued service during the war, primarily evolving into infantry fighting vehicles, known as the *ACAV*[23] (Armored Cavalry Assault Vehicle); and functioning as a "light tank."

More heavily armed infantry fighting vehicles such as the M2/M3 Bradley Fighting Vehicle would be based on experience with the M113. Gun trucks were also introduced as M35 trucks fitted with armour and guns to protect convoys. In 1968, Communist forces primarily deployed the Soviet built PT-76 light tank.

By 1971, the larger T-54 medium tanks were fielded, proving themselves susceptible to the M-72 LAW rocket, ARVN M41 Walker Bulldog light tanks, as well as the larger M48A3 Pattons. In January 1969, US Armored Cavalry units began exchanging their M48A3 Patton tanks for the M551 Sheridan Armored Airborne Reconnaissance Assault Vehicles; by 1970 over 200 Sheridan tanks were operating in Vietnam.

6 – Present

	
A Leclerc tank in a hull - down position. Note the observation periscope which would allow the commander to observe in turret-down position.	*A combined force of M1 Abrams tanks, Bradley IFVs and a logistical convoy advancing during the Gulf War*

Tanks rarely work alone; the usual minimum unit size is a platoon (platoon is the smallest US Army/Marine unit led by an officer, and a component of a company or troop) of three to five tanks. The tanks of the platoon work together providing mutual support: two might advance while covered by the others then stop and provide cover for the remainder to move ahead.

Normally, multiple platoons coordinate with mechanized infantry and utilize their mobility and firepower to penetrate weak points in enemy lines. This is where the powerful engines, tracks and turrets come into play. The ability to rotate the turret by a full 360° allows coordinated movement within and between platoons, while defending against attacks from multiple directions and engaging troops and vehicles without stopping or slowing down.

When on the defensive, they wait in prepared positions or use any natural terrain elements (such as small hills) for cover. A tank sitting just behind a hill crest ("hull - down") exposes only the top of its turret, with the gun and sensors, to the enemy, leaving the smallest possible target while allowing it to engage the enemy on the other side of the hill. Tanks are usually able to depress the main gun below the horizontal since modern kinetic energy (KE) rounds have nearly flat trajectories. Without this they would be unable to exploit such positions. However, upon cresting a hill, the tank may expose its thinly armoured underside to enemy weapons.

The deposition of armour around a tank is not uniform; the front is typically better armoured than the sides or rear. Accordingly, normal practice is to keep the front towards the enemy at all times; the tank retreats by reversing instead of turning around. Driving backwards away from an enemy is even safer than driving forwards towards them since driving forwards over a bump can throw the front of the tank up in the air, exposing the thin armour of the underside and taking the gun off the target due to its limited angle of depression.

The tracks, wheels and suspension of a tank are outside the armoured hull and are some of the most vulnerable spots. The easiest way to disable a tank (other than a direct hit in a vulnerable area with a full - power anti-tank weapon) is to target the tracks for a "mobility kill" (*m-kill*), or target all external visual aids with rubbery cohesive substances such as melted rubber or blackened high viscosity epoxy resins. Once a tank is disabled it is easier to destroy. This is why side-skirts are an important feature; they can deflect heavy machine-gun bullets and trigger the detonation of HEAT rounds before they strike the running gear. Other vulnerable parts of a typical tank include the engine deck (with air intakes, radiators, etc.) and the turret ring, where the turret joins the hull.

When used defensively, tanks are often sunk into trenches or placed behind earth berms for increased protection. The tanks can fire off a few shots from their defensive position, then retreat (reversing) to another prepared position further back and drive behind the berms or into the trenches there. These positions can be constructed by the tank crews, but preparations are better and quicker if carried out by combat engineers with bulldozers. Over head protection, even if it is fairly thin, can also be very useful since it can help pre-detonate artillery shells and avoid direct hits from above which can be deadly to tanks, by striking them at their thinnest armour. In short, tank crews find as many ways as possible to augment the armour on their vehicles.

Tanks usually go into battle with a round in the gun, ready to fire, to minimize reaction time when encountering an enemy. The US doctrine calls for this round to be a kinetic energy (KE) round, as the reaction time is most important when meeting enemy tanks, to get the first shot (and possibly the first kill). If troops or light vehicles are encountered, the usual response is to fire this round at them, despite it not being ideal — it is difficult and time - consuming to remove a round which is already in the breech. In this case, after the KE round is fired, a HEAT round would normally be loaded next to continue the engagement.

Tanks can be decisive in city fighting, with the ability to demolish walls and fire medium and heavy machine guns in several directions simultaneously. However, tanks are especially vulnerable in urban combat. It is much easier for enemy infantry to sneak up behind a tank or fire at its sides, where it is most vulnerable. In addition, firing down from multi-story buildings allows shots at the soft upper turret armour and even basic weapons like Molotov cocktails, if aimed at the engine air intakes, can disable a tank. Because of these limitations, tanks are difficult to use in city conflicts where civilians or friendly forces might be nearby, since their firepower can't be used effectively.

6 – 1 - Airborne threats

The Tunguska gun-missile Anti-Aircraft system employs two 2A38M 30 mm auto cannons and eight 9M311 SAMs for low altitude air defence.

Tanks and other armoured vehicles are vulnerable to attack from the air for several reasons. One is that they are easily detectable—the metal they are made of shows up well on radar, and is especially obvious if they are moving in formation. A moving tank also produces a lot of heat, noise and dust. The heat makes seeing them on a forward-looking infra - red system easy and the dust is a good visual clue during the day.

The other major reason is that most armoured vehicles have thinner armour on the roof of the turret and on the engine deck, so an anti-tank guided missile (from an attack helicopter or ground-attack jet) hitting them from the top can be deadly even if it has a small warhead. Even a small automatic cannon is powerful enough to penetrate the rear and top sections of the engine compartment of a tank.

Certain aircraft have been developed to attack armoured vehicles. Most notable is the purpose - built Fairchild - Republic A-10 Thunderbolt II, affectionately known as the "Warthog" because of its shape (in contrast to more aesthetically pleasing military aircraft). The 'Hog' may be blunt but is exceptionally effective in its purpose: hunt and kill enemy armour and vehicles and its reputation as an effective "Tank buster" is not unfounded.

Although able to carry a number of different missiles and bombs (including anti-tank ordnance such as the AGM-65 Maverick), its main weapon is the 30 mm GAU - 8 / A Avenger Gatling gun which is capable of firing 3,900 depleted uranium armour - piercing rounds per minute (a popular belief is that the plane was actually built around the gun and not vice – versa). Capable of low- speed, low - altitude flight, the A-10 is itself an airborne armoured vehicle with a titanium enclosure about the pilot, an airframe that can survive direct hits from armour-piercing and high-explosive projectiles up to 23 mm and triple redundancy in its flight systems, with mechanical systems to back up double-redundant hydraulics. The Soviet equivalent is the SU-25.

Similarly, a number of helicopter gun ships have been designed mainly to engage enemy armoured vehicles. The AH-1Z Viper, AH-64 Apache, Denel Rooivalk, Euro copter Tiger, Ka-50 Black Shark, Mi-28 Havoc, A129 Mangusta and Westland Lynx are examples. Helicopters are very effective against armoured vehicles for many reasons. The AH - 64D Longbow Apache, for example, is equipped with an improved sensor suite and weapon systems and the AN / APG - 78 Longbow Fire Control Radar dome installed over the main rotor. Helicopters however have proved highly vulnerable to small arms ground fire, and so in American service, most missions that would have originally fallen under the domain of the attack helicopter are instead being executed by the much more heavily armoured A-10.

Airborne threats can be countered in several ways. One is air supremacy. This is what the United States relies on most, which is demonstrated by their distinct lack of effective short-range, mobile air defence vehicles to accompany armoured units. Most other countries accompany their armoured forces with highly mobile self-propelled anti-aircraft guns such as the German Gepard or the Soviet 9K22 Tunguska, short and medium-range surface – to - air missile systems such as the SA-6, SA-8 and SA-11, or combine both on the same vehicle (the Tunguska for example can also host SA-19 SAM missiles). The usage of anti - aircraft rounds fired from the main gun of a tank has been increasing over the years. An example is the HE-FRAG round from the T-90 which can be detonated at a set distance as determined by its laser range finder.

7 – Support

Armoured warfare is mechanically and logistically intensive and requires extensive support mechanisms. Armoured Fighting Vehicles require *armoured* vehicles capable of working in the same terrain to support them. These are operated by the appropriate branches of the army, e.g. recovery and maintenance vehicles by the REME and combat engineering vehicles by the RE in the British Army. These include :

Armoured recovery vehicles (ARV) — many of these are based on the chassis for the vehicle they support. E.g. the ARV for the UK Challenger tank is a Challenger hull onto which a winch is added.

Armoured supply vehicles

(armoured) Combat Engineering Vehicles (CEV), e.g. bulldozers

For transporting tracked AFVs over highways, heavy transporters are used, since AFVs are prone to malfunction and their tracks also ruin the highways.

8 - Light tanks and tank destroyers

French AMX-10RC
during the Operation Desert Shield phase of the Gulf War

While tanks are integral to armoured warfare, when power projection is required, the inability to perform rapid deployment has always been a limitation of heavy main battle tanks.

It takes a few weeks to transfer tanks and their supporting equipment by air or sea . Some tanks and armoured vehicles can be dropped by parachute, or carried by cargo airplanes or helicopters. The largest transports can only carry one or two main battle tanks. Smaller transports can only carry or air drop light tanks and APCs such as the M113.

The desire to create air-portable armoured vehicles that can still take on conventional MBTs has usually resulted in ATGM-armed light vehicles or in self - propelled gun style vehicles. The lack of armour protection is offset by the provision of a first-look/first-hit/first-kill capability through the mating of a powerful gun to superior targeting electronics, a concept similar to that of the US tank destroyers of WWII.

Vehicles which have put such considerations into practice include the Stingray light tank, AMX 10 RC and B1 Centauro. Most such US projects to create such vehicles have been abortive, e.g. the M8 Armored Gun System. The most common was the flawed M551 Sheridan light tank. This was an air-portable tank capable of destroying heavier tanks using the revolutionary (for the time) 152 mm CLGP launcher. The combat effectiveness of this tank was limited by the unreliable MGM-51 missile. The latest iteration of the mobile anti-tank gun platform in American service is the M1134 Anti-Tank Guided Missile Vehicle, a Stryker variant equipped with TOW Missiles; most modern militaries operate comparable vehicles.

Though limited conflicts (such as the insurgency in Iraq) rarely involve direct combat between armoured vehicles, the need to defend against insurgent attacks and IEDs has resulted in the application of armour to light vehicles and the continued use of armoured transports, fighting vehicles and tanks.

Armstrong's mixture

Contents

1 - Introduction

Armstrong's mixture is a highly sensitive primary explosive. Its primary ingredients are red phosphorus and strong oxidizer, such as potassium chlorate and potassium perchlorate. Sulfur and calcium carbonate might be present in small amounts, though other additives are also used. Commercially, Armstrong's mixture is used in extremely small quantities on the paper caps in toy cap guns . It has also been considered a suitable mixture for the primer used in guns after boron carbide has been added.

2 - Safety considerations

Because of its sensitivity to shock, friction and flame, Armstrong's mixture is an extremely dangerous explosive. Only about 10 mg of it is used per item of consumer fire works. Depending on composition, conditions and quantity, Armstrong's mixture can explode violently in an enclosed space.

Army Engineering Maintenance

Contents

1 - Introduction

Army engineering maintenance consists of those engineers, technicians, and military organizations responsible for the expert repair and maintenance of army vehicles, weapon systems, and other equipment.

Army engineering maintenance should not be confused with military engineering which is distinctly separate and analogous to civil engineering while the former analogous to mechanical engineering and electrical engineering.

2 - Operational and tactical level focus

At the operational and tactical levels, army engineering maintenance is focused on the repair and scheduled maintenance work required to keep army equipment fleets operational.

3 - Strategic level focus

At the strategic level, army engineering maintenance is closely linked to military logistics. At this level, it includes work such as the design, development, and testing of new vehicles and weapon systems. It also includes lifecycle management activities once new systems become operational.

DEMSS Kineton

Army School of Ammunition.

Contents

1 - Introduction

Defense Explosive Ordnance Disposal , Munitions and Search School Kineton or **DEMSS Kineton** is the main training school for Ammunition Technicians and Ammunition Technical Officers in the British Army and is based at MoD Kineton near Kineton, Warwickshire, England.

The school teaches students conventional land munitions, Explosive Ordnance Disposal (EOD) and Improvised Explosive Device Disposal (IEDD).

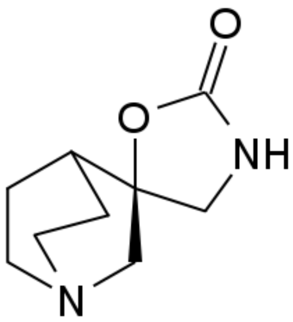
2 - History

The school is split into two schools at different location the first at MoD Kineton and the second at DEMSS Bicester and the Headquarters are based at Kineton.

The school was formally known as Army School of Ammunition before being renamed the Defense Explosive Ordnance Disposal, Munitions and Search School (DEMSS North) in 2009, then DEMSS Kineton the same year.

The Felix Centre is part of this school responsible for teaching students from around the world IEDD techniques.

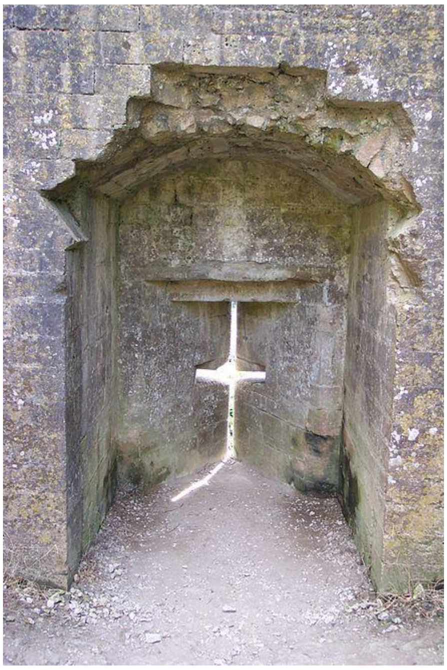
AR - R17779



IUPAC name :	
(2*S*)-2′*H*-spiro [4-azabicyclo [2.2.2] octane-2,5'- [1,3] oxazolidin] -2'- one	
Molecular formula	$C_9 H_{14} N_2 O_2$
Molar mass	182 g mol^{-1}

AR-R17779 is a drug that acts as a potent and selective full agonist for the α7 subtype of neural nicotinic acetylcholine receptors. It has nootropic effects in animal studies , but its effects do not substitute for those of nicotine . It has also recently been studied as a potential novel treatment for arthritis.

Arrow Slit



An arrow slit at Corfe Castle. This shows the inside - where the archer would have stood.

Contents

1 - Introduction

An **arrow slit** (often also referred to as an **arrow loop**, **loophole** or **loop hole**, and sometimes a **balistraria**) is a thin vertical aperture in a fortification through which an archer can launch arrows.

The interior walls behind an arrow loop are often cut away at an oblique angle so that the archer has a wide field of view and field of fire. Arrow slits come in a remarkable variety. A common and recognizable form is the cross. The thin vertical aperture permits the archer large degrees of freedom to vary the elevation and direction of his bowshot but makes it difficult for attackers to harm the archer since there is only a small target to aim at.,

Balistraria can often be found in the curtain walls of medieval battlements beneath the crenellations.

2 – History

The invention of the arrow slit is attributed to Archimedes during the siege of Syracuse in 214 – 212 BC. Slits "of the height of a man and about a palm's width on the outside" allowed defenders to shoot bows and scorpions (an ancient siege engine) from within the city walls . Although used in late Greek and Roman defences, arrow slits were not present in early Norman castles. They are only reintroduced to military architecture towards the end of the 12th century, with the castles of Dover and Framlingham in England, and Richard the Lionheart's Château Gaillard in France. In these early examples, arrow slits were positioned to protect sections of the castle wall, rather than all sides of the castle. In the 13 th century, it became common for arrow slits to be placed all around a castle's defences.[1]

3 – Design

In its simplest form, an arrow slit was a thin vertical opening; however, the different weapons used by defenders sometimes dictated the form of arrow slits. For example, openings for long bowmen were usually tall and high to allow the user to shoot standing up and make use of the 1.8 m bow, while those for crossbowmen were usually lower down as it was easier for the user to shoot whilst kneeling to support the weight of the weapon. It was common for arrow slits to widen to a triangle at the bottom, called a fishtail, to allow defenders a clearer view of the base of the wall . Immediately behind the slit there was a recess called an embrasure; this allowed a defender to get close to the slit without being too cramped . The width of the slit dictated the field of fire, but the field of vision could be enhanced by the addition of horizontal openings; they allowed defenders to view the target before it entered range.

Usually, the horizontal slits were level, which created a cross shape, but less common was to have the slits off - set (called displaced traverse slots) as demonstrated in the remains of White Castle in Wales. This has been characterized as an advance in design as it provided attackers with a smaller target;[4] however, it has also been suggested that it was to allow the defenders of White Castle to keep attackers in their sights for longer because of the steep moat surrounding the castle.

When an embrasure linked to more than one arrowslit (in the case of Dover Castle, defenders from three embrasures can shoot through the same arrow slit) it is called a "multiple arrowslit".[5] Some arrowslits, such as those at Corfe Castle, had lockers nearby to store spare arrows and bolts; these were usually located on the right hand side of the slit for ease of access and to allow a rapid rate of fire.[2]

Arsenic

Contents

1 - Introduction

Arsenic is a chemical element with symbol **As** and atomic number 33. Arsenic occurs in many minerals, usually in conjunction with sulfur and metals, and also as a pure elemental crystal. Arsenic is a metalloid. It can exist in various allotropes, although only the gray form has important use in industry.

The main use of metallic arsenic is for strengthening alloys of copper and especially lead (for example, in car batteries) . Arsenic is a common n-type dopant in semiconductor electronic devices, and the optoelectronic compound gallium arsenide is the most common semiconductor in use after doped silicon. Arsenic and its compounds, especially the trioxide, are used in the production of pesticides, treated wood products, herbicides, and insecticides. These applications are declining, however.

Arsenic is notoriously poisonous to multicellular life, although a few species of bacteria are able to use arsenic compounds as respiratory metabolites. Arsenic contamination of groundwater is a problem that affects millions of people across the world.

Name, symbol	arsenic, As
Appearance	metallic grey
Atomic number	33
Standard atomic weight	75
Element category	metalloid
Period	period 4
per shell	2 , 8 , 18 , 5
Phase	solid
Sublimation point	615 °C
Density (near r.t.)	5.727 $g \cdot cm^{-3}$ (at 0 °C,)
Liquid density	at m.p. 5.22 $g \cdot cm^{-3}$
Triple point	1090 K, 3628 kPa

Critical point	1673 K, ? MPa
Heat of fusion	(grey) 24.44 kJ·mol^{-1}
Heat of vaporization	? 34.76 kJ·mol^{-1}
Molar heat capacity	24.64 J·mol^{-1}·K^{-1}
Oxidation states	**5**, **3**, 2, 1, −3 (a mildly acidic oxide)
Electro negativity	2.18 (Pauling scale)
Ionization energies	1st : 947.0 kJ·mol^{-1} 2nd : 1798 kJ·mol^{-1} 3rd : 2735 kJ·mol^{-1}
Atomic radius	empirical: 119 pm
Crystal structure	trigonal
Thermal conductivity	50.2 W·m^{-1}·K^{-1}
Electrical resistivity	at 20 °C: 333 n Ω·m
Magnetic ordering	diamagnetic
Young's modulus	8 GPa
Mohs hardness	3.5
Discovery	Early Bronze Age (2500 BC)
First isolation	Albertus Magnus (1250)

2 – Characteristics

2 – 1 - Physical characteristics

The three most common arsenic allotropes are *metallic gray*, *yellow* and *black arsenic*, with gray being the most common. *Gray arsenic* (α-As, space group R3m No. 166) adopts a double-layered structure consisting of many interlocked ruffled six-membered rings. Because of weak bonding between the layers, gray arsenic is brittle and has a relatively low Mohs hardness of 3.5. Nearest and next-nearest neighbors form a distorted octahedral complex, with the three atoms in the same double-layer being slightly closer than the three atoms in the next. This relatively close packing leads to a high density of 5.73 g / cm^3. Gray arsenic is a semimetal, but becomes a semiconductor with a band gap of 1.2 – 1.4 eV if amorphized. Gray arsenic is also the most stable form. *Yellow arsenic* is soft and waxy, and some what similar to tetra phosphorus (P4).

Both have four atoms arranged in a tetrahedral structure in which each atom is bound to each of the other three atoms by a single bond. This unstable allotrope, being molecular, is the most volatile, least dense and most toxic. Solid yellow arsenic is produced by rapid cooling of arsenic vapor, As 4 .

It is rapidly transformed into the gray arsenic by light. The yellow form has a density of 1.97 g / cm^3. *Black arsenic* is similar in structure to red phosphorus . Black arsenic can also be formed by cooling vapor at around 100 – 220 °C. It is glassy and brittle. It is also a poor electrical conductor .

2 – 2 - Isotopes

Naturally occurring arsenic is composed of one stable isotope, ^{75}As . This makes it a mono isotopic element. As of 2003, at least 33 radioisotopes have also been synthesized, ranging in atomic mass from 60 to 92. The most stable of these is ^{73}As with a half-life of 80.30 days. All other isotopes have half-lives of under one day, with the exception of ^{71}As ($t_{1/2}$ = 65.30 hours) , ^{72}As ($t_{1/2}$=26.0 hours), ^{74}As ($t_{1/2}$ =17.77 days) , ^{76}As ($t_{1/2}$ =1.0942 days), and ^{77}As ($t_{1/2}$=38.83 hours). Isotopes that are lighter than the stable ^{75}As tend to decay by β^+ decay, and those that are heavier tend to decay by β^- decay, with some exceptions.

At least 10 nuclear isomers have been described, ranging in atomic mass from 66 to 84. The most stable of arsenic's isomers is ^{68m}As with a half-life of 111 seconds.

2 – 3 – Chemistry

When heated in air, arsenic oxidizes to arsenic trioxide; the fumes from this reaction have an odor resembling garlic. This odor can be detected on striking arsenide minerals such as arsenopyrite with a hammer. Arsenic (and some arsenic compounds) sublimes upon heating at atmospheric pressure, converting directly to a gaseous form without an intervening liquid state at 887 K (614 °C).[1] The triple point is 3.63 MPa and 820 °C. Arsenic makes arsenic acid with concentrated nitric acid, arsenious acid with dilute nitric acid, and arsenic trioxide with concentrated sulfuric acid.

3 – Compounds

Arsenic compounds resemble in some respects those of phosphorus which occupies the same group (column) of the periodic table. Arsenic is less commonly observed in the pentavalent state, however. The most common oxidation states for arsenic are: −3 in the arsenides, such as alloy-like intermetallic compounds; and +3 in the arsenites, arsenates (III), and most organo arsenic compounds. Arsenic also bonds readily to itself as seen in the square As3−4 ions in the mineral skutterudite. In the +3 oxidation state, arsenic is typically pyramidal owing to the influence of the lone pair of electrons.

3 – 1 - Inorganic compounds

Arsenic forms colorless, odorless, crystalline oxides As_2O_3 ("white arsenic") and As_2O_5 which are hygroscopic and readily soluble in water to form acidic solutions. Arsenic(V) acid is a weak acid. Its salts are called arsenates which are the basis of arsenic contamination of groundwater, a problem that affects many people. Synthetic arsenates include Paris Green (copper (II) aceto arsenite), calcium arsenate, and lead hydrogen arsenate. These three have been used as agricultural insecticides and poisons.

The protonation steps between the arsenate and arsenic acid are similar to those between phosphate and phosphoric acid. Unlike phosphorous acid, arsenous acid is genuinely tribasic, with the formula $As(OH)_3$.

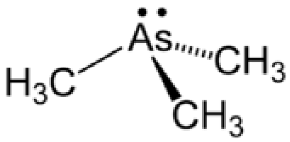
A broad variety of sulfur compounds of arsenic are known. Orpiment (As_2S_3) and real gar (As_4S_4) are somewhat abundant and were formerly used as painting pigments. In As_4S_{10}, arsenic has a formal oxidation state of +2 in As_4S_4 which features As-As bonds so that the total covalency of As is still 3.

All tri halides of arsenic (III) are well known except the astatide which is unknown. Arsenic penta fluoride (AsF_5) is the only important penta halide, reflecting the lower stability of the 5+ oxidation state. (pentachloride is stable only below −50 °C) .

3 – 1 – 1 – Alloys

Arsenic is used as the group 5 element in the III-V semiconductors gallium arsenide, indium arsenide, and aluminium arsenide. The valence electron count of GaAs is the same as a pair of Si atoms, but the band structure is completely different which results distinct bulk properties. Other arsenic alloys include the II-V semiconductor cadmium arsenide.

3 – 2 - Organoarsenic compounds



Tri methyl arsine

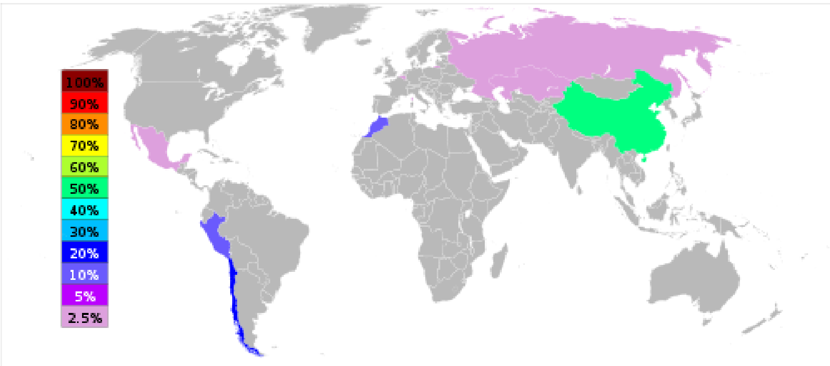
A large variety of organo arsenic compounds are known. Several were developed as chemical warfare agents during World War I, including vesicants such as lewisite and vomiting agents such as adamsite. Cacodylic acid, which is of historic and practical interest, arises from the methylation of arsenic trioxide, a reaction that has no analogy in phosphorus chemistry.

4 - Occurrence and production

Arsenic makes up about 1.5 ppm (0.00015%) of the Earth's crust, making it the 53rd most abundant element. Soil contains 1–10 ppm of arsenic. Seawater has only 1.6 ppb arsenic.

Minerals with the formula MAsS and MAs_2 (M = Fe, Ni, Co) are the dominant commercial sources of arsenic, together with real gar (an arsenic sulfide mineral) and native arsenic. An illustrative mineral is arseno pyrite (Fe As S), which is structurally related to iron pyrite.

Many minor As-containing minerals are known. Arsenic also occurs in various organic forms in the environment.



Arsenic output in 2006

In 2005, China was the top producer of white arsenic with almost 50 % world share, followed by Chile, Peru, and Morocco, according to the British Geological Survey and the United States Geological Survey . Most operations in the US and Europe have closed for environmental reasons. The arsenic is recovered mainly as a side product from the purification of copper. Arsenic is part of the smelter dust from copper, gold, and lead smelters.

On roasting in air of arseno pyrite, arsenic sublimes as arsenic (III) oxide leaving iron oxides , while roasting without air results in the production of metallic arsenic. Further purification from sulfur and other chalcogens is achieved by sublimation in vacuum or in a hydrogen atmosphere or by distillation from molten lead-arsenic mixture.

Country	**2012 AsO_3 Production**
Belgium	1,000 T
Chile	10,000 T
China	25,000 T
Morocco	6,000 T
Russia	1,500 T
Other Countries	300 T
World Total	**44,000 T**

5 – History

Realgar

The word *arsenic* has its origin in the Syriac word ܠܐ ܙܐܦܢܝܐ *(al) zarniqa*, from the Persian word زرنيخ *zarnikh*, meaning "yellow" (literally "gold-colored") and hence "(yellow) orpiment". It was adopted into Greek as *arsenikon* (ἀρσενικόν), a form that is folk etymology, being the neuter form of the Greek word *arsenikos* (ἀρσενικός), meaning "male", "virile". The Greek word was adopted in Latin as *arsenicum*, which in French became *arsenic*, from which the English word *arsenic* is taken.[27] Arsenic sulfides (orpiment, realgar) and oxides have been known and used since ancient times.[28] Zosimos (circa 300 AD) describes roasting *sandarach* (realgar) to obtain *cloud of arsenic* (arsenious oxide), which he then reduces to metallic arsenic. As the symptoms of arsenic poisoning were somewhat ill-defined, it was frequently used for murder until the advent of the Marsh test, a sensitive chemical test for its presence. (Another less sensitive but more general test is the Reinsch test.) Owing to its use by the ruling class to murder one another and its potency and discreetness, arsenic has been called the *Poison of Kings* and the *King of Poisons*.

The arsenic labyrinth, part of Botallack Mine, Cornwall.

During the Bronze Age, arsenic was often included in bronze, which made the alloy harder (so - called "arsenical bronze").[31][32]

Albertus Magnus (Albert the Great, 1193–1280) is believed to have been the first to isolate the element from a compound in 1250, by heating soap together with arsenic tri sulfide. In 1649, Johann Schröder published two ways of preparing arsenic.[34] Crystals of elemental (native) arsenic are found in nature, although rare.

Cadet's fuming liquid (impure cacodyl), often claimed as the first synthetic organometallic compound, was synthesized in 1760 by Louis Claude Cadet de Gassicourt by the reaction of potassium acetate with arsenic trioxide.

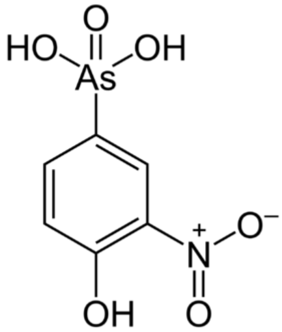
In the Victorian era, "arsenic" ("white arsenic" or arsenic trioxide) was mixed with vinegar and chalk and eaten by women to improve the complexion of their faces, making their skin paler to show they did not work in the fields. Arsenic was also rubbed into the faces and arms of women to "improve their complexion". The accidental use of arsenic in the adulteration of foodstuffs led to the Bradford sweet poisoning in 1858, which resulted in approximately 20 deaths.

Two pigments based on arsenic have been widely used since their discovery – Paris Green and Scheele's Green. After arsenic's toxicity became widely known, they were less often used as pigments, so these compounds were more often used as insecticides. In the 1860s an arsenic by - product of dye production, London Purple – a solid consisting of a mixture of arsenic trioxide, aniline, lime and ferrous oxide, which is insoluble in water and very toxic by inhalation and ingestion – was widely used, but Paris Green, another arsenic based dye, was later substituted for it. With better understanding of the toxicology mechanism, two other compounds were used starting in the 1890s. Arsenite of lime and arsenate of lead were used widely as insecticides until the discovery of DDT in 1942.

6 – Applications

6 – 1 – Agricultural

The toxicity of arsenic to insects, bacteria and fungi led to its use as a wood preservative. In the 1950s a process of treating wood with chromated copper arsenate (also known as CCA or Tanalith) was invented, and for decades this treatment was the most extensive industrial use of arsenic. An increased appreciation of the toxicity of arsenic resulted in a ban for the use of CCA in consumer products; the European Union and United States initiated this process in 2004. CCA remains in heavy use in other countries however, e.g. Malaysian rubber plantations.



Roxarsone is a controversial arsenic compound used as a nutritional supplement for chickens

Arsenic was also used in various agricultural insecticides and poisons. For example, lead hydrogen arsenate was a common insecticide on fruit trees , but contact with the compound sometimes resulted in brain damage among those working the sprayers. In the second half of the 20th century, monosodium methyl arsenate (MSMA) and disodium methyl arsenate (DSMA) – less toxic organic forms of arsenic – have replaced lead arsenate in agriculture. With the exception of cotton farming the use of the organic arsenicals was phased out until 2013.

Arsenic is used as a feed additive in poultry and swine production, in particular in the U.S. to increase weight gain, improve feed efficiency, and to prevent disease . An example is roxarsone, which had been used as a broiler starter by about 70 % of U.S. broiler growers . The Poison - Free Poultry Act of 2009 proposed to ban the use of roxarsone in industrial swine and poultry production.[51] Alpharma, a subsidiary of Pfizer Inc., which produces Roxarsone, voluntarily suspended sales of the drug in response to studies showing elevated levels of inorganic arsenic, a carcinogen, in treated chickens.[52] A successor to Alpharma, Zoetis, continues to sell nitarsone, primarily for use in turkeys.

6 – 2 - Medical use

During the 18th, 19th, and 20th centuries, a number of arsenic compounds were used as medicines, including arsphenamine (by Paul Ehrlich) and arsenic trioxide (by Thomas Fowler). Arsphenamine as well as neosalvarsan was indicated for syphilis and trypanosomiasis, but has been superseded by modern antibiotics. Arsenic trioxide has been used in a variety of ways over the past 500 years, but most commonly in the treatment of cancer. The US Food and Drug Administration in 2000 approved this compound for the treatment of patients with acute promyelocytic leukemia that is resistant to ATRA.[54] It was also used as Fowler's solution in psoriasis.[55] Recently new research has been done in locating tumors using arsenic-74 (a positron emitter). The advantages of using this isotope instead of the previously used iodine-124 is that the signal in the PET scan is clearer as the body tends to transport iodine to the thyroid gland producing a lot of noise.

In subtoxic doses, soluble arsenic compounds act as stimulants, and were once popular in small doses as medicine by people in the mid-18th century.

6 – 3 – Alloys

The main use of metallic arsenic is for alloying with lead. Lead components in car batteries are strengthened by the presence of a very small percentage of arsenic. Dezincification can be strongly reduced by adding arsenic to brass, a copper-zinc alloy.[58] "Phosphorus Deoxidized Arsenical Copper" with an arsenic content of 0.3% has an increased corrosion stability in certain environments.[59] Gallium arsenide is an important semiconductor material, used in integrated circuits. Circuits made from GaAs are much faster (but also much more expensive) than those made in silicon. Unlike silicon it has a direct band gap, and so can be used in laser diodes and LEDs to directly convert electricity into light.

6 – 4 – Military

After World War I, the United States built up a stockpile of 20,000 tones of lewisite ($Cl\ CH = CH\ As\ Cl_2$) , a chemical weapon that is a vesicant (blister agent) and lung irritant. The stockpile was neutralized with bleach and dumped into the Gulf of Mexico after the 1950s.[60] During the Vietnam War the United States used Agent Blue, a mixture of sodium cacodylate and its acid form, as one of the rainbow herbicides to deprive invading North Vietnamese soldiers of foliage cover and rice.

6 – 5 - Other uses v

Copper aceto arsenite was used as a green pigment known under many names, including 'Paris Green' and 'Emerald Green'. It caused numerous arsenic poisonings. Scheele's Green, a copper arsenate, was used in the 19th century as a coloring agent in sweets.

Also used in bronzing and pyrotechnics.

Up to 2 % of arsenic is used in lead alloys for lead shots and bullets.

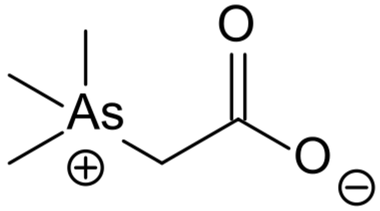
Arsenic is added in small quantities to alpha - brass to make it dezincification resistant. This grade of brass is used to make plumbing fittings or other items that are in constant contact with water.

Arsenic is also used for taxonomic sample preservation.

Until recently arsenic was used in optical glass. Modern glass manufacturers, under pressure from environmentalists, have removed it, along with lead.

7 – Biological role

7 – 1 – Bacteria



Arseno betaine

Some species of bacteria obtain their energy by oxidizing various fuels while reducing arsenate to arsenite. Under oxidative environmental conditions some bacteria use arsenite, which is oxidized to arsenate as fuel for their metabolism. The enzymes involved are known as arsenate reductases (Arr).

In 2008, bacteria were discovered that employ a version of photosynthesis in the absence of oxygen with arsenites as electron donors, producing arsenates (just as ordinary photosynthesis uses water as electron donor, producing molecular oxygen). Researchers conjecture that, over the course of history, these photosynthesizing organisms produced the arsenates that allowed the arsenate-reducing bacteria to thrive. One strain PHS-1 has been isolated and is related to the gamma proteo bacterium *Ectothiorhodospira shaposhnikovii*. The mechanism is unknown, but an encoded Arr enzyme may function in reverse to its known homologues.

Although the arsenate and phosphate anions are similar structurally, no evidence exists for the replacement of phosphate in ATP or nucleic acids by arsenic.

7 – 2 – Heredity

Arsenic has been linked to epigenetic changes, heritable changes in gene expression that occur without changes in DNA sequence. These include DNA methylation, histone modification, and RNA interference. Toxic levels of arsenic cause significant DNA hyper methylation of tumor suppressor genes p16 and p53, thus increasing risk of carcinogenesis. These epigenetic events have been studied *in vitro* using human kidney cells and *in vivo* using rat liver cells and peripheral blood leukocytes in humans. Inductively coupled plasma mass spectrometry (ICP-MS) is used to detect precise levels of intracellular arsenic and its other bases involved in epigenetic modification of DNA.[74] Studies investigating arsenic as an epigenetic factor will help in developing precise biomarkers of exposure and susceptibility.

The Chinese brake fern (*Pteris vittata*) hyperaccumulates arsenic present in the soil into its leaves and has a proposed use in phytoremediation.

7 – 3 - Bio methylation

Inorganic arsenic and its compounds, upon entering the food chain, are progressively metabolized through a process of methylation

For example, the mold *Scopulariopsis brevicaulis* produces significant amounts of tri methylarsine if inorganic arsenic is present.[78] The organic compound arseno betaine is found in some marine foods such as fish and algae, and also in mushrooms in larger concentrations. The average person's intake is about 10–50 µg / day. Values about 1000 µg are not unusual following consumption of fish or mushrooms, but there is little danger in eating fish because this arsenic compound is nearly non - toxic.

8 - Environmental issues

8 – 1 – Exposure

Other naturally occurring pathways of exposure include volcanic ash, weathering of arsenic-containing minerals and ores, and dissolved in groundwater. It is also found in food, water, soil, and air.[80] Arsenic is absorbed by all plants, but is more concentrated in leafy vegetables, rice, apple and grape juice, and seafood.[81] An additional route of exposure is through inhalation.

8 – 2 - Occurrence in drinking water

Widespread arsenic contamination of groundwater has led to a massive epidemic of arsenic poisoning in Bangladesh[83] and neighboring countries. It is estimated that approximately 57 million people in the Bengal basin are drinking groundwater with arsenic concentrations elevated above the World Health Organization's standard of 10 parts per billion (ppb). However, a study of cancer rates in Taiwan suggested that significant increases in cancer mortality appear only at levels above 150 ppb. The arsenic in the groundwater is of natural origin, and is released from the sediment into the groundwater, owing to the anoxic conditions of the subsurface. This groundwater began to be used after local and western NGOs and the Bangladeshi government undertook a massive shallow tube well drinking-water program in the late twentieth century. This program was designed to prevent drinking of bacteria-contaminated surface waters, but failed to test for arsenic in the groundwater. Many other countries and districts in Southeast Asia, such as Vietnam and Cambodia have geological environments conducive to generation of high - arsenic ground waters. Arsenicosis was reported in Nakhon Si

Thammarat, Thailand in 1987, and the Chao Phraya River is suspected of containing high levels of naturally occurring dissolved arsenic, but has not been a public health problem owing to the use of bottled water.

In the United States, arsenic is most commonly found in the ground waters of the southwest.[87] Parts of New England, Michigan, Wisconsin, Minnesota and the Dakotas are also known to have significant concentrations of arsenic in ground water. Increased levels of skin cancer have been associated with arsenic exposure in Wisconsin, even at levels below the 10 part per billion drinking water standard.[89] According to a recent film funded by the US Superfund, millions of private wells have unknown arsenic levels, and in some areas of the US, over 20 % of wells may contain levels that exceed established limits.

Low-level exposure to arsenic at concentrations of 100 parts per billion (i.e., above the 10 parts per billion drinking water standard) compromises the initial immune response to H1N1 or swine flu infection according to NIEHS - supported scientists. The study, conducted in laboratory mice, suggests that people exposed to arsenic in their drinking water may be at increased risk for more serious illness or death in response to infection from the virus.

Some Canadians are drinking water that contains inorganic arsenic. Private dug well waters are most at risk for containing inorganic arsenic. Preliminary well water analyses typically does not test for arsenic. Researchers at the Geological Survey of Canada have modelled relative variation in natural arsenic hazard potential for the province of New Brunswick. This study has important implications for potable water and health concerns relating to inorganic arsenic.

Epidemiological evidence from Chile shows a dose - dependent connection between chronic arsenic exposure and various forms of cancer, in particular when other risk factors, such as cigarette smoking, are present. These effects have been demonstrated to persist below 50 ppb.

Analyzing multiple epidemiological studies on inorganic arsenic exposure suggests a small but measurable risk increase for bladder cancer at 10 ppb. According to Peter Ravenscroft of the Department of Geography at the University of Cambridge , roughly 80 million people worldwide consume between 10 and 50 ppb arsenic in their drinking water. If they all consumed exactly 10 ppb arsenic in their drinking water, the previously cited multiple epidemiological study analysis would predict an additional 2,000 cases of bladder cancer alone. This represents a clear underestimate of the overall impact, since it does not include lung or skin cancer, and explicitly underestimates the exposure. Those exposed to levels of arsenic above the current WHO standard should weigh the costs and benefits of arsenic remediation.

Early (1973) evaluations of the removal of dissolved arsenic by drinking water treatment processes demonstrated that arsenic is very effectively removed by co - precipitation with either iron or aluminum oxides. The use of iron as a coagulant, in particular, was found to remove arsenic with efficiencies exceeding 90 %. Several adsorptive media systems have been approved for point-of-service use in a study funded by the United States Environmental Protection Agency (US EPA) and the National Science Foundation (NSF). A team of European and Indian scientists and engineers have set up six arsenic treatment plants in West Bengal based on in-situ remediation method (SAR Technology). This technology does not use any chemicals and arsenic is left as an insoluble form (+ 5 state) in the subterranean zone by recharging aerated water into the aquifer and thus developing an oxidation zone to support arsenic oxidizing micro-organisms. This process does not produce any waste stream or sludge and is relatively cheap.

Another effective and inexpensive method to remove arsenic from contaminated well water is to sink wells 500 feet or deeper to reach purer waters. A recent 2011 study funded by the US National Institute of Environmental Health Sciences' Superfund Research Program shows that deep sediments can remove arsenic and take it out of circulation. Through this process called adsorption in which arsenic sticks to the surfaces of deep sediment particles, arsenic can be naturally removed from well water.

Magnetic separations of arsenic at very low magnetic field gradients have been demonstrated in point - of - use water purification with high - surface - area and mono disperse magnetite ($Fe_3 O_4$) nano crystals. Using the high specific surface area of $Fe_3 O_4$ nano crystals the mass of waste associated with arsenic removal from water has been dramatically reduced.

Epidemiological studies have suggested a correlation between chronic consumption of drinking water contaminated with arsenic and the incidence of all leading causes of mortality.[101] The literature provides reason to believe arsenic exposure is causative in the pathogenesis of diabetes.

Hungarian engineer László Schremmer has recently discovered that by the use of chaff - based filters it is possible to reduce the arsenic content of water to 3 µg / L. This is especially important in areas where the potable water is provided by filtering the water extracted from the underground aquifer.

8 – 2 - 1 – San Pedro de Atacama

For several centuries, the people of San Pedro de Atacama in Chile have been drinking water that is contaminated with arsenic, and it is believed that they may have developed some immunity to the ill effects of consuming it.

8 – 3 – Wood preservation in the US

As of 2002, US - based industries consumed 19,600 metric tons of arsenic. Ninety percent of this was used for treatment of wood with chromated copper arsenate (CCA). In 2007, 50% of the 5,280 metric tons of consumption was still used for this purpose.[24][107] In the United States, the voluntary phasing - out of arsenic in production of consumer products and residential and general consumer construction products began on 31 December 2003, and alternative chemicals are now used, such as Alkaline Copper Quaternary, borates, copper azole, cyproconazole, and propiconazole.

Although discontinued, this application is also one of the most concern to the general public. The vast majority of older pressure-treated wood was treated with CCA. CCA lumber is still in widespread use in many countries, and was heavily used during the latter half of the 20th century as a structural and outdoor building material. Although the use of CCA lumber was banned in many areas after studies showed that arsenic could leach out of the wood into the surrounding soil (from playground equipment, for instance), a risk is also presented by the burning of older CCA timber. The direct or indirect ingestion of wood ash from burnt CCA lumber has caused fatalities in animals and serious poisonings in humans; the lethal human dose is approximately 20 grams of ash . Scrap CCA lumber from construction and demolition sites may be inadvertently used in commercial and domestic fires. Protocols for safe disposal of CCA lumber do not exist evenly throughout the world; there is also concern in some quarters about the widespread landfill disposal of such timber.

8 – 4 – Mapping of industrial releases in the US

One tool that maps releases of arsenic to particular locations in the United States and also provides additional information about such releases is TOXMAP. TOXMAP is a Geographic Information System (GIS) from the Division of Specialized Information Services of the United States National Library of Medicine (NLM) that uses maps of the United States to help users visually explore data from the United States Environmental Protection Agency's (EPA) Toxics Release Inventory and Superfund Basic Research Programs. TOXMAP is a resource funded by the US Federal Government . TOXMAP's chemical and environmental health information is taken from NLM's Toxicology Data Network (TOXNET) and PubMed, and from other authoritative sources.

9 - Toxicity and precautions

Arsenic and many of its compounds are especially potent poisons. Many water supplies close to mines are contaminated by these poisons.

9 – 1 – Classification

Elemental arsenic and arsenic compounds are classified as "toxic" and "dangerous for the environment" in the European Union under directive 67 / 548 / EEC. The International Agency for Research on Cancer (IARC) recognizes arsenic and arsenic compounds as group 1 carcinogens, and the EU lists arsenic trioxide, arsenic pentoxide and arsenate salts as category 1 carcinogens.

Arsenic is known to cause arsenicosis owing to its manifestation in drinking water, "the most common species being arsenate [$HAsO_2^{-4}$; As (V)] and arsenite [H_3AsO_3; As(III)]".

9 – 2 – Legal limits , food , and drink

In the United States, since 2006, the maximum concentration in drinking water allowed by the Environmental Protection Agency (EPA) is 10 ppb and the FDA set the same standard in 2005 for bottled water. The Department of Environmental Protection for New Jersey set a drinking water limit of 5 ppb in 2006.

In 2008, based on its ongoing testing of a wide variety of American foods for toxic chemicals , the U.S. Food and Drug Administration set 23 ppb as the "level of concern" for inorganic arsenic apple and pear juices based on non - carcinogenic effects, and began refusing imports and demanding recalls for domestic products exceeding this level . In 2011, the national Dr. Oz television show broadcast a program high lighting tests performed by an independent lab hired by the producers. Though the methodology was disputed (it did not distinguish between organic and inorganic arsenic) the tests showed levels of arsenic up to 36 ppb. In response, FDA testing of the worst brand from the Oz show showed much lower levels, and its ongoing testing found 95 % of apple juice samples were below the level of concern. Later testing by Consumer Reports showed inorganic arsenic at levels slightly above 10 ppb, with the organization urging parents to reduce consumption . In July 2013, after taking into account consumption by children, chronic exposure, and carcinogenic effect, the FDA established an "action level" of 10 ppb for apple juice, the same as the drinking water standard.

Concern about arsenic in rice in Bangladesh was raised in 2002, but at the time only Australia had a legal limit for the level found in food (one milligram per kilogram). The People's Republic of China has a food standard of 150 ppb for arsenic, as of 2011. Further concern was raised about people who were eating U.S. rice exceeding WHO standards for personal arsenic intake in 2005.

In the United States in 2012, testing by separate groups of researchers at the Children's Environmental Health and Disease Prevention Research Center at Dartmouth College (early in the year, focusing on urinary levels in children) and Consumer Reports (in November)[123][124] found levels of arsenic in rice which resulted in calls for the FDA to set limits. The FDA released some testing results in September 2012 , and as of July 2013 is still collecting data in support of a new potential regulation. It has not recommended any changes in consumer behavior . Consumer Reports recommended that the EPA and FDA eliminate arsenic - containing fertilizer, drugs, and pesticides in food production; that the FDA establish a legal limit for food; that industry change production practices to lower arsenic levels, especially in food for children; and that consumers test home water supplies, eat a varied diet, and cook rice with excess water which is drained off (reducing inorganic arsenic by about one third along with a slight reduction in vitamin content) . Evidence - based public health advocates also recommend that, given the lack of regulation or labeling for arsenic in the U.S., children should eat no more than 1 to 1.5 servings per week of rice and should not drink rice milk as part of their daily diet before age 5.[128] They also offer recommendations for adults and infants on how to limit arsenic exposure from rice, drinking water, and fruit juice.

A 2014 World Health Organization advisory conference will consider limits of 200 – 300 ppb for rice.

9 – 3 – Biological mechanism

The high affinity of arsenic (III) oxides for thiols is usually assigned as the cause of the high toxicity. Thiols, usually in the form of cysteine residues, but also in cofactors such as lipoic acid and coenzyme A, are situated at the active sites of many important enzymes.

Arsenic disrupts ATP production through several mechanisms. At the level of the citric acid cycle, arsenic inhibits lipoic acid, which is a cofactor for pyruvate dehydrogenase. In addition, by competing with phosphate, arsenate uncouples oxidative phosphorylation, thus inhibiting energy - linked reduction of NAD+, mitochondrial respiration and ATP synthesis. Hydrogen peroxide production is also increased, which, it is speculated, has potential to form reactive oxygen species and oxidative stress. These metabolic interferences lead to death from multi - system organ failure. The organ failure is presumed to be from necrotic cell death, not apoptosis, since energy reserves have been too depleted for apoptosis to occur.

Although arsenic causes toxicity, it can also play a protective role.

9 – 4 – Exposure risks and remediation

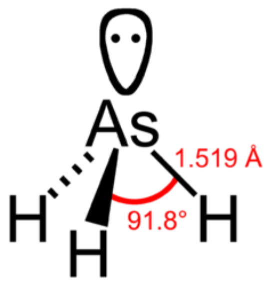
Occupational exposure and arsenic poisoning may occur in persons working in industries involving the use of inorganic arsenic and its compounds, such as wood preservation, glass production, nonferrous metal alloys, and electronic semiconductor manufacturing. Inorganic arsenic is also found in coke oven emissions associated with the smelter industry.

The ability of arsenic to undergo redox conversion between As(III) and As(V) makes its availability in the environment more abundant. According to Croal, Gralnick, Malasarn and Newman, "[the] under standing [of] what stimulates As (III) oxidation and/or limits As(V) reduction is relevant for bioremediation of contaminated sites (Croal) . The study of chemolithoautotrophic As (III) oxidizers and the heterotrophic As (V) reducers can help the understanding of the oxidation and/or reduction of arsenic . It has been proposed that As (III) which is more toxic than Arsenic (V) can be removed from the ground water using baker's yeast *Saccharomyces cerevisiae*.

9 – 5 – Treatment

Treatment of chronic arsenic poisoning is easily accomplished. British anti-lewisite (dimercaprol) is prescribed in doses of 5 mg/kg up to 300 mg every 4 hours for the first day, then every 6 hours for the second day, and finally every 8 hours for 8 additional days.[134] However the USA's Agency for Toxic Substances and Disease Registry (ATSDR) states that the long-term effects of arsenic exposure cannot be predicted. Blood, urine, hair, and nails may be tested for arsenic; however, these tests cannot foresee possible health outcomes from the exposure. Excretion occurs in the urine and long-term exposure to arsenic has been linked to bladder and kidney cancer in addition to cancer of the liver, prostate, skin, lungs, and nasal cavity.

Arsine



Contents

1 - Introduction

Arsine is the inorganic compound with the formula AsH_3. This flammable, pyrophoric, and highly toxic gas is one of the simplest compounds of arsenic. Despite its lethality, it finds some applications in the semiconductor industry and for the synthesis of organo arsenic compounds. The term *arsine* is commonly used to describe a class of organo arsenic compounds of the formula $AsH_{3-x}R_x$, where R = aryl or alkyl. For example, $As(C_6H_5)_3$, called triphenylarsine, is referred to as "an arsine."

IUPAC name : Arsenic trihydride Arsane Tri hydrido arsenic	
Other names Arseniuretted hydrogen, Arsenous hydride, hydrogen arsenide	
Molecular formula	AsH_3
Molar mass	78 g / mol
Appearance	colourless gas
Density	4.93 g / l , gas ; 1.640 g / mL (− 64 °C)
Melting point	− 111.2 °C
Boiling point	− 62.5 °C
Solubility in water	0.07 g / 100 ml (25 °C)
MSDS	External MSDS
EU classification	Very flammable (**F+**) Highly toxic (**T+**) Harmful (**Xn**) Dangerous for the environment (**N**)
Flash point	− 62 °C
Thermo dynamic data	Phase behaviour Solid , liquid , gas
Spectral data	UV, IR, NMR, MS

2 - General properties

At its standard state, arsine is a colorless, denser-than-air gas that is slightly soluble in water (20 % at 20 C) and in many organic solvents as well . Whereas arsine itself is odorless · owing to its oxidation by air it is possible to smell a slight garlic or fish-like scent when the compound is present at above about 0.5 ppm.[2] This compound is generally regarded as stable, since at room temperature it decomposes only slowly. At temperatures of ca. 230 °C decomposition to arsenic and hydrogen is rapid.[*citation needed*] Several factors, such as humidity, presence of light and certain catalysts (namely aluminium) facilitate the rate of decomposition.[3]

AsH_3 is a pyramidal molecule with H – As – H angles of 91.8° and three equivalent As – H bonds, each of 1.519 Å length.

3 - Discovery and synthesis

AsH_3 is generally prepared by the reaction of As^{3+} sources with H^{-} equivalents.

$$4\ AsCl_3 + 3\ NaBH_4 \rightarrow 4\ AsH_3 + 3\ Na\ Cl + 3\ BCl_3$$

As reported in 1775, Carl Scheele reduced arsenic(III) oxide with zinc in the presence of acid. This reaction is a prelude to the Marsh test, described below.

Alternatively, sources of As^{3-} react with protonic reagents to also produce this gas:

$$Zn_3As_2 + 6\ H^{+} \rightarrow 2\ AsH_3 + 3\ Zn^{2+}$$
$$Na_3As + 3\ HBr \rightarrow AsH_3 + 3\ NaBr$$

4 – Reactions

Our understanding of the chemical properties of AsH_3 is well developed and can be anticipated based on an average of the behavior of PH_3 and SbH_3.

4 – 1 - Thermal decomposition

Typical for a heavy hydride (e.g., SbH_3, H_2Te, SnH_4), AsH_3 is unstable with respect to its elements. In other words, AsH_3 is stable kinetically but not thermodynamically.

$$2\ AsH_3 \rightarrow 3\ H_2 + 2\ As$$

This decomposition reaction is the basis of the Marsh Test described below, which detects the metallic As.

4 – 2 – Oxidation

Continuing the analogy to SbH_3, AsH_3 is readily oxidized by concentrated O_2 or the dilute O_2 concentration in air:

$2\ AsH_3 + 3\ O_2 \rightarrow As_2O_3 + 3\ H_2O$

Arsine will react violently in presence of strong oxidizing agents, such as potassium permanganate, sodium hypochlorite or nitric acid.

4 – 3 - Precursor to metallic derivatives

AsH_3 is used as a precursor to metal complexes of "naked" (or "nearly naked") As. Illustrative is the dimanganese species $[(C_5H_5)Mn(CO)_2]_2AsH$, wherein the Mn_2AsH core is planar.

4 – 4 - Gutzeit test

A characteristic test for arsenic involves the reaction of AsH_3 with Ag^+, called the Gutzeit test for arsenic.[8] Although this test has become obsolete in analytical chemistry, the underlying reactions further illustrate the affinity of AsH_3 for "soft" metal cations. In the Gutzeit test, AsH_3 is generated by reduction of aqueous arsenic compounds, typically arsenites, with Zn in the presence of H_2SO_4. The evolved gaseous AsH_3 is then exposed to $AgNO_3$ either as powder or as a solution. With solid $AgNO_3$, AsH_3 reacts to produce yellow Ag_4AsNO_3, whereas AsH_3 reacts with a solution of $AgNO_3$ to give black Ag_3As.

4 – 5 – Acid - base reactions

The acidic properties of the As – H bond are often exploited. Thus, AsH_3 can be deprotonated :

$AsH_3 + NaNH_2 \rightarrow NaAsH_2 + NH_3$

Upon reaction with the aluminium trialkyls, AsH_3 gives the trimeric $[R_2AlAsH_2]_3$, where R = $(CH_3)_3C$. This reaction is relevant to the mechanism by which Ga As forms from AsH_3 (see below).

AsH_3 is generally considered non-basic, but it can be protonated by super acids to give isolable salts of the tetrahedral species $[AsH_4]^+$.

4 – 6 - Reaction with halogen compounds

Reactions of arsine with the halogens (fluorine and chlorine) or some of their compounds, such as nitrogen trichloride, are extremely dangerous and can result in explosions.

4 – 7 – Catenation

In contrast to the behavior of PH_3, AsH_3 does not form stable chains, although $H_2As– AsH_2$ and even $H_2As – As(H) – AsH_2$ have been detected. The diarsine is unstable above −100 °C.

5 – Applications

5 – 1 - Microelectronics applications

AsH_3 is used in the synthesis of semiconducting materials related to microelectronics and solid-state lasers. Related to Phosphorus, Arsenic is an n-dopant for silicon and germanium.[3] More importantly, AsH_3 is used to make the semiconductor GaAs by chemical vapor deposition (CVD) at 700 – 900 °C:

$$Ga(CH_3)_3 + AsH_3 \rightarrow GaAs + 3\ CH_4$$

For microelectronic applications, arsine can be provided via a sub-atmospheric gas source. In this type of gas package, the arsine is adsorbed on a solid microporous adsorbent inside a gas cylinder. This method allows the gas to be stored without pressure, significantly reducing the risk of an arsine gas leak from the cylinder. With this apparatus, arsine is obtained by applying vacuum to the gas cylinder valve outlet. For semiconductor manufacturing, this method is practical as these processes usually operate under high vacuum.

5 – 2 - Chemical warfare

Since before WWII AsH_3 was proposed as a possible chemical warfare weapon. The gas is colorless, almost odorless, and 2.5 times denser than air, as required for a blanketing effect sought in chemical warfare. It is also lethal in concentrations far lower than those required to smell its garlic - like scent. In spite of these characteristics, arsine was never officially used as a weapon, because of its high flammability and its lower efficacy when compared to the non-flammable alternative phosgene. On the other hand, several organic compounds based on arsine, such as lewisite (β - chloro vinyl dichloro arsine), adamsite (diphenyl amine chloro arsine), Clark I (diphenyl chloro arsine) and Clark II (diphenyl cyano arsine) have been effectively developed for use in chemical warfare.

6 - Forensic science and the Marsh test

AsH_3 is also well known in forensic science because it is a chemical intermediate in the detection of arsenic poisoning. The old (but extremely sensitive) Marsh test generates AsH_3 in the presence of arsenic.[1] This procedure, developed around 1836 by James Marsh, is based upon treating an As - containing sample of a victim's body (typically the stomach) with As-free zinc and dilute sulfuric acid: if the sample contains arsenic, gaseous arsine will form. The gas is swept into a glass tube and decomposed by means of heating around 250–300 °C. The presence of As is indicated by formation of a deposit in the heated part of the equipment. On the other hand, the appearance of a black mirror deposit in the *cool* part of the equipment indicates the presence of antimony (the highly unstable SbH_3 decomposes even at low temperatures).

The Marsh test was widely used by the end of the 19th century and the start of the 20th; nowadays more sophisticated techniques such as atomic spectroscopy, inductively coupled plasma and x-ray fluorescence analysis are employed in the forensic field. Though neutron activation analysis was used to detect trace levels of arsenic in the mid 20 th century, it has since fallen out of use in modern forensics.

7 – Toxicology

, Arsenic trioxide, and Arsenicosis . The toxicity of arsine is distinct from that of other arsenic compounds. The main route of exposure is by inhalation, although poisoning after skin contact has also been described. Arsine attacks haemoglobin in the red blood cells, causing them to be destroyed by the body.

The first signs of exposure, which can take several hours to become apparent, are headaches, vertigo and nausea, followed by the symptoms of haemolytic anaemia (high levels of unconjugated bilirubin), haemoglobin uria and nephropathy. In severe cases, the damage to the kidneys can be long-lasting .

Exposure to arsine concentrations of 250 ppm is rapidly fatal: concentrations of 25–30 ppm are fatal for 30 min exposure, and concentrations of 10 ppm can be fatal at longer exposure times Symptoms of poisoning appear after exposure to concentrations of 0.5 ppm. There is little information on the chronic toxicity of arsine, although it is reasonable to assume that, in common with other arsenic compounds, a long-term exposure could lead to arsenicosis .

Arson

The Skyline Parkway Motel at Rockfish Gap after arson on July 9, 2004.

Contents

1 - Introduction

Arson is the crime of intentionally and maliciously setting fire to buildings, wildland areas, vehicles or other property with the intent to cause damage. It may be distinguished from other causes such as spontaneous combustion and natural wildfires. Arson often involves fires deliberately set to the property of another or to one's own property as to collect insurance compensation.

A person who commits this crime is called an **arsonist**. More often than not, arsonists use accelerants (such as gasoline or kerosene) to ignite, propel, and direction alize fires.

2 - English common law

Historically, the common law crime of arson had four elements:
The malicious

burning
of the dwelling
of another

The malicious – for purposes of common law arson, "malicious" means action creating a great risk of a burning. It is not required that the defendant acted intentionally or willfully for the purpose of burning a dwelling.

burning – at common law charring to any part of dwelling was sufficient to satisfy this element. No significant amount of damage to the dwelling was required. On the other hand mere discoloration from smoke was insufficient. Actual damage to the material from which the structure was built is required. Damage to surface coverings such as carpets and wallpaper is insufficient. Arson was not limited to the burning of wooden structures. Any injury or damage to the structure caused by exposure to heat or flame is sufficient.

of the dwelling – dwelling means a place of residence. The destruction of an unoccupied building was not considered as arson, "since arson protected habitation, the burning of an unoccupied house did not constitute arson." At common law a structure did not become a residence until the first occupants had moved in and ceased to be a dwelling if the occupants abandoned the premises with no intention of resuming their residency.[8] Dwelling includes structures and outbuildings within the curtilage.[9] Dwellings were not limited to houses. A barn could be the subject of arson if it was occupied as a dwelling.

of another – burning one's own dwelling does not constitute common law arson, even if the purpose was to collect insurance, because "it was generally assumed in early England that one had the legal right to destroy his own property in any manner he chose."[10] Moreover, for purposes of common law arson, possession or occupancy rather than title determines whose dwelling the structure is.[9] Thus a tenant who sets fire to his rented house would not be guilty of common law arson, while the landlord who set fire to a rented dwelling house would be guilty.

3 – Degrees

In many states arson is divided into degrees, depending sometimes on the value of the property but more commonly on its use and whether the crime was committed in the day or night.

First-degree arson - The act in which the arsonist sets fire to an occupied domain or building such as a school.

Second-degree arson - The act in which the arsonist sets fire to an unoccupied building such as an empty barn.

Third-degree arson - The act in which the arsonist sets fire to an abandoned building or an abandoned area of space such as a field.

Many statutes vary the degree of the crime according to the criminal intent of the accused.

4 - United States

In the U.S., the common law elements of arson are often varied in different jurisdictions. For example, the element of "dwelling" is no longer required in most states, and arson occurs by the burning of any real property without consent or with unlawful intent . Arson is prosecuted with attention to degree of severity in the alleged offense. First degree arson generally occurs when persons are harmed or killed in the course of the fire, while second degree arson occurs when significant destruction of property occurs . While usually a felony, arson may also be prosecuted as a misdemeanor,[15] "criminal mischief", or "destruction of property." Burglary also occurs, if the arson involved a "breaking and entering". A person may be sentenced to death if arson occurred as a method of homicide, as was the recent case in California of Raymond Lee Oyler and in Texas of Cameron Willingham.

In New York, arson is charged in five degrees. Arson in the first degree is a Class A-1 felony and requires the intent to burn the building with a person inside using an explosive incendiary device. It has a maximum sentence of 25 years to life.

In California, a conviction for arson of property that is not your own is a felony punishable by up to three years in state prison. Aggravated arson, which carries the most severe punishment for arson, is punishable by 10 years to life in state prison.

Some states, such as California, prosecute the lesser offense of "reckless burning" when the fire is set recklessly as opposed to willfully and maliciously. The study of the causes is the subject of fire investigation.

5 - England and Wales

In English law, arson was a common law offence[21] dealing with the criminal destruction of buildings by fire. The offence was abolished by the S.11(1) Criminal Damage Act 1971. The 1971 Act makes no general distinction as to the mode of destruction except that s.1(3) requires that if the destruction is by fire then the offence will be charged as arson; s.4 of the Act provides a maximum penalty of life imprisonment for conviction under s.1 whether or not the offence is charged as arson.

6 – Scotland

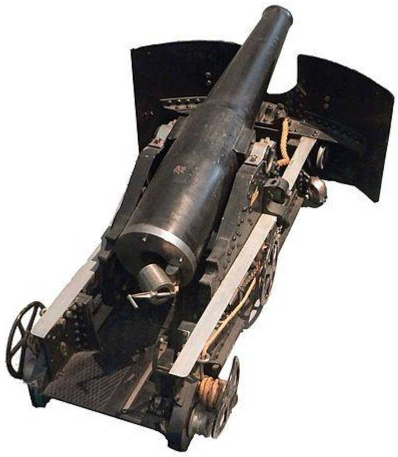
Scotland has no offence known as arson. Events constituting arson in English Law might be dealt with as one or more of a variety of offences such as Wilful Fire - Raising, Culpable and Reckless Conduct, Vandalism or other offences depending on the circumstances of the event. The more serious offences (in particular Wilful Fire - raising and Culpable and Reckless Conduct) can incur a sentence of life imprisonment.

Artillery

Contents

1 - Introductıon

Artillery is a class of large military weapons built to fire munitions far beyond the range of infantry's small arms. Early artillery development focused on the ability to breach fortifications, and led to heavy, fairly immobile siege engines. As technology improved, lighter, more mobile field artillery developed for battlefield use. This development continues today; modern self-propelled artillery vehicles are highly mobile weapons of great versatility providing the largest share of an army's total firepower.



French naval piece of the late 19th century

In its earliest sense, the word artillery referred to any group of soldiers primarily armed with some form of manufactured weapon or armour. Since the introduction of gunpowder and cannon, the word "artillery" has largely meant cannon and in contemporary usage it usually refers to shell - firing guns, howitzers, mortars and rockets. In common speech, the word artillery is often used to refer to individual devices along with their accessories and fittings, although these assemblages are more properly called "equipments". However, there is no generally recognized generic term for a gun, howitzer, mortar, and so forth: the United States uses "artillery piece", but most English speaking armies use "gun" and "mortar". The projectiles fired are typically either "shot" (if solid) or "shell" if not. "Shell" is a widely used generic term for a projectile, which is a component of munitions. By association, artillery may also refer to the arm of service that customarily operates such engines.

Artillery is arguably the most lethal form of land-based armament currently employed and has been since at least the early industrial revolution. The vast majority of combat deaths in the

Napoleonic Wars, World War I and World War II were caused by artillery. In 1944, Joseph Stalin said in a speech that artillery was "the God of War".

2 - Artillery piece

French soldiers in the Franco - Prussian War 1870 – 71.

British 64 Pounder Rifled Muzzle-Loaded (RML) Gun on a Moncrieff disappearing mount, at Scaur Hill Fort, Bermuda. This is a part of a fixed battery, meant to protect against over-land attack and to serve as coastal artillery.

Although not called as such, machines performing the role recognizable as artillery have been employed in warfare since antiquity. The first references in the western historical tradition begin at Syracuse in 399 BC and these devices were widely employed by the Roman Legions in Republican times well before the Christian era. Until the introduction of gunpowder into western warfare artillery depended upon mechanical energy to operate and this severely limited the kinetic energy of the projectiles while also requiring the construction of very large apparatus to store sufficient energy. For comparison, a Roman 1st century BC catapult using stones of 6.55 kg fired with a kinetic energy of 16,000 joules, while a mid-19th century 12-pounder gun firing projectiles of 4.1 kg fired the projectile with a kinetic energy of 240,000 joules.

From the Middle Ages through most of the modern era, artillery pieces on land were moved by horse - drawn gun carriages. In the contemporary era the artillery and crew rely on wheeled or tracked vehicles as transportation, though some of the largest were railway guns. Artillery used by naval forces has changed significantly also, with missiles replacing guns in surface warfare.

Over the course of military history, projectiles were manufactured from a wide variety of materials, made in a wide variety of shapes, and used different means of inflicting physical damage and casualties to defeat specific types of targets. The engineering designs of the means of delivery have likewise changed significantly over time, and have become some of the most complex technological application today.

In some armies, the weapon of artillery is the projectile, not the equipment that fires it. The process of delivering fire onto the target is called gunnery. The actions involved in operating the piece are collectively called "serving the gun" by the "detachment" or gun crew, constituting either direct or indirect artillery fire. The manner in which artillery units or formations are employed is called artillery support, and may at different periods in history refer to weapons designed to be fired from ground, sea, and even air-based weapons platforms.

3 – Crew

The term "gunner" is used in some armed forces for the soldiers and sailors with the primary function of using artillery.

7-person gun crew firing a US M777 Light Towed Howitzer, War in Afghanistan, 2009.

The gunners and their guns are usually grouped in teams called either "crews" or "detachments". Several such crews and teams with other functions are combined into a unit of artillery usually called a battery, although sometimes called a company. In gun detachments each role is numbered, starting with "1" the Detachment Commander and the highest number being the Coverer, the second-in-command. "Gunner" is also the lowest rank and junior non-commissioned officers are "Bombadiers" in some artillery arms.

Batteries are roughly equivalent to a company in the infantry, and are combined into larger military organizations for administrative and operational purposes, either battalions or regiments depending on the army. These may be grouped into brigades, The Russian army also groups some brigades into artillery divisions and the People's Liberation Army has artillery corps.

The term "artillery" is also applied to a combat arm of most military services when used organizationally to describe units and formations of the national armed forces that operate the weapons.

During military operations the role of field artillery is to provide support to other arms in combat or to attack targets, particularly in depth. Broadly these effects fall into two categories, either to suppress or neutralize the enemy, or to cause casualties, damage and destruction. This is mostly achieved by delivering high explosive munitions to suppress, or inflict casualties on the enemy from casing fragments and other debris and blast, or by destroying enemy positions, equipment and vehicles. Non-lethal munitions, notably smoke, can also be used to suppress or neutralize the enemy by obscuring their view.

Fire may be directed by an artillery observer or other observer, including manned and unmanned aircraft pilots, or called onto map coordinates. Military doctrine has played a significant influence on the core engineering design considerations of artillery ordnance through its history, in seeking to achieve a balance between delivered volume of fire with ordnance mobility. However, during the modern period the consideration of protecting the gunners also arose due to the late-19th century introduction of the new generation of infantry weapons using conoidal bullet, better known as the Minié ball, with a range almost as long as that of field artillery.

The gunners' increasing proximity to and participation in direct combat against other combat arms and attacks by aircraft made the introduction of a gun shield necessary. The problems of how to employ a fixed or horse towed gun in mobile warfare necessitated the development of new methods of transporting the artillery into combat. Two distinct forms of artillery developed: the towed gun, which was used primarily to attack or defend a fixed line; and the self-propelled gun, which was designed to accompany a mobile force and provide continuous fire support. These influences have guided the development of artillery ordnance, systems, organizations, and operations until the present, with artillery systems capable of providing support at ranges from as little as 100 m to the intercontinental ranges of ballistic missiles. The only combat in which artillery is unable to take part in is close quarters combat.

4 – Etymology

The word as used in the current context originated in the Middle Ages. One suggestion is that it comes from the Old French *atellier* meaning "to arrange", and *attillement* meaning "equipment".

From the 13th century an *artillier* referred to a builder of any war equipment, and for the next 250 years the sense of the word "artillery" covered all forms of military weapons. Hence the naming of the Honourable Artillery Company an essentially infantry unit until the 19th century. Another suggestion is that comes from the Italian *arte de tirare* (art of shooting) coined by one of the first theorists on the use of artillery, Niccolo Tartaglia.

5 - History

Mechanical systems used for throwing ammunition in ancient warfare, also known as "engines of war", like the catapult, onager, trebuchet, and ballista, are also referred to by military historians as artillery.

5 – 1 - Invention of gunpowder

The first documented record of artillery with gunpowder propellant used on the battlefield was on January 28, 1132, when General Han Shizhong of the Song Dynasty used escalade and Huochong to capture a city in Fujian . Early Chinese artillery had vase-like shapes. This includes the "long range awe inspiring" cannon dated from 1350 and found in the 14th century Ming Dynasty treatise *Huolongjing* . With the development of better metallurgy techniques, later cannons abandoned the vase shape of early Chinese artillery. This change can be seen in the bronze "thousand ball thunder cannon," an early example of field artillery . These small, crude weapons diffused into the Middle East (the *madfaa*, see also the German Wikipedia and *midfa*) and reached Europe in the 13th century, in a very limited manner.

In Asia, Mongols adopted the Chinese artillery and used it effectively in the great conquest. By the late 14th century, Chinese rebels used organized artillery and cavalry to push Mongols out.

As small smooth-bore tubes these were initially cast in iron or bronze around a core, with the first drilled bore ordnance recorded in operation near Seville in 1247. They fired lead, iron, or stone balls, sometimes large arrows and on occasions simply handfuls of whatever scrap came to hand. During the Hundred Years' War, these weapons became more common, initially as the bombard and later the cannon. Cannon were always muzzle-loaders. While there were many early attempts at breech - loading designs, a lack of engineering knowledge rendered these even more dangerous to use than muzzle-loaders.

Expansion of artillery use

In 1415, the Portuguese invaded the Mediterranean port town of Ceuta. While it is difficult to confirm the use of firearms in the siege of the city, it is known the Portuguese defended it thereafter with firearms, namely *bombardas*, *colebratas*, and *falconetes*. In 1419, Sultan Abu Sa'id led an army to reconquer the fallen city, and Moroccans brought cannons and used them in the assault on Ceuta.

Finally, hand-held firearms and riflemen appear in Morocco, in 1437, in an expedition against the people of Tangiers. It is clear these weapons had developed into several different forms, from small guns to large artillery pieces.

French gunner in the 15th century, a 1904 illustration.

The artillery revolution in Europe caught on during the Hundred Years' War and changed the way that battles were fought. In the preceding decades, the English had even used a gunpowder-like weapon in military campaigns against the Scottish. However, at this time, the cannons used in battle were very small and not particularly powerful. Cannons were only useful for the defense of a castle, as demonstrated at Breteuil in 1356, when the besieged English used a cannon to destroy an attacking French assault tower. By the end of the 14th century, cannon were only powerful enough to knock in roofs, and could not penetrate castle walls.

The Austrian Pumhart von Steyr, the earliest extant supergun.

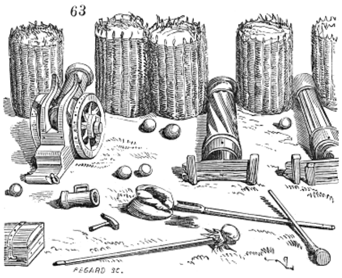
However, a major change occurred between 1420 and 1430, when artillery became much more powerful and could now batter strongholds and fortresses quite efficiently. The English, French, and Burgundians all advanced in military technology, and as a result the traditional advantage that went to the defense in a siege was lost. The cannon during this period were elongated, and the recipe for gunpowder was improved to make it three times as powerful as before These changes led to the increased power in the artillery weapons of the time.

Joan of Arc encountered gunpowder weaponry several times. When she led the French against the English at the Battle of Tourelles, in 1430, she faced heavy gunpowder fortifications, and yet her troops prevailed in that battle. In addition, she led assaults against the English-held towns of Jargeau, Meung, and Beaugency, all with the support of large artillery units. When she led the assault on Paris, Joan faced stiff artillery fire, especially from the suburb of St. Denis, which ultimately led to her defeat in this battle. In April 1430, she went to battle against the Burgundians, whose support was purchased by the English. At this time, the Burgundians had the strongest and largest gunpowder arsenal among the European powers, and yet the French, under Joan of Arc's leadership, were able to beat back the Burgundians and defend themselves. As a result, most of the battles of the Hundred Years' War that Joan of Arc participated in were fought with gunpowder artillery.

The army of Mehmet the Conqueror, which conquered Constantinople in 1453, included both artillery and foot soldiers armed with gunpowder weapons . The Ottomans brought to the siege sixty-nine guns in fifteen separate batteries and trained them at the walls of the city. The barrage of Ottoman cannon fire lasted forty days, and they are estimated to have fired 19,320 times.[14] Artillery also played a decisive role in the Battle of St. Jakob an der Birs of 1444.

3 – Smoothbores

Bombards were of value mainly in sieges. A famous Turkish example used at the siege of Constantinople in 1453 weighed 19 tons , took 200 men and sixty oxen to emplace, and could fire just seven times a day. The Fall of Constantinople was perhaps "*the first event of supreme importance whose result was determined by the use of artillery*" when the huge bronze cannons of Mehmed II breached the city's walls, ending the Byzantine Empire, according to Sir Charles Oman.



Artillery *with Gabion fortification.*

Bombards developed in Europe were massive smoothbore weapons distinguished by their lack of a field carriage, immobility once emplaced, highly individual design, and noted unreliability (in 1460 James II, King of Scots, was killed when one exploded at the siege of Roxburgh). Their large size precluded the barrels being cast and they were constructed out of metal staves or rods bound together with hoops like a barrel, giving their name to the gun barrel.

The use of the word "cannon" marks the introduction in the 15th century of a dedicated field carriage with axle, trail and animal-drawn limber—this produced mobile field pieces that could move and support an army in action, rather than being found only in siege and static defences. The reduction in the size of the barrel was due to improvements in both iron technology and gunpowder manufacture, while the development of trunnions – projections at the side of the cannon as an integral part of the cast – allowed the barrel to be fixed to a more movable base, and also made raising or lowering the barrel much easier.

The Tsar Cannon (caliber 890 mm), cast in 1586 in Moscow. It is the largest bombard in the world

The first land - based mobile weapon is usually credited to Jan Žižka, who deployed his oxen-hauled cannon during the Hussite Wars of Bohemia (1418 –1424). However cannons were still large and cumbersome. With the rise of musketry in the 16th century, cannon were largely (though not entirely) displaced from the battlefield—the cannon were too slow and cumbersome to be used and too easily lost to a rapid enemy advance.

The combining of shot and powder into a single unit, a cartridge, occurred in the 1620s with a simple fabric bag, and was quickly adopted by all nations. It speeded loading and made it safer, but unexpelled bag fragments were an additional fouling in the gun barrel and a new tool — a worm — was introduced to remove them. Gustavus Adolphus is identified as the general who made cannon an effective force on the battlefield — pushing the development of much lighter and smaller weapons and deploying them in far greater numbers than previously. The outcome of battles was still determined by the clash of infantry.

Shells , explosive - filled fused projectiles, were also developed in the 17th century.The development of specialized pieces— shipboard artillery, howitzers and mortars — was also begun in this period. More esoteric designs, like the multi - barrel *ribauldequin* (known as "organ guns"), were also produced.

The 1650 book by Kazimierz Siemienowicz "*Artis Magnae Artilleriae pars prima*" was one of the most important contemporary publications on the subject of artillery. For over two centuries this work was used in Europe as a basic artillery manual .

One of the most significant effects of artillery during this period was however somewhat more indirect – by easily reducing to rubble any medieval-type fortification or city wall (some which had stood since Roman times), it abolished millennia of siege - warfare strategies and styles of fortification building . This led, among other things, to a frenzy of new bastion - style fortifications to be built all over Europe and in its colonies, but also had a strong integrating effect on emerging nation - states, as kings were able to use their newfound artillery superiority to force any local dukes or lords to submit to their will, setting the stage for the absolutist kingdoms to come.

Modern Rocket artillery can trace its heritage back to the Mysorean rockets of India. Their first recorded use was in 1780 during the battles of the Second, Third and Fourth Mysore Wars. The wars fought between the British East India Company and the Kingdom of Mysore in India made use of the rockets as a weapon. In the Battle of Pollilur (1780), the Siege of Seringapatam (1792) and in Battle of Seringapatam in 1799 these rockets were used with considerable effect against the British " · After the wars, several Mysore rockets were sent to England, and from 1801, William Congreve copied the rockets with minor modifications as the Congreve rocket which were used effectively during the Napoleonic Wars and the War of 1812.

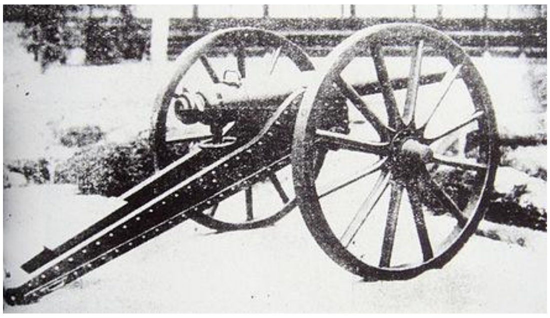
5 – 4 - Napoleonic artillery

Cannons continued to become smaller and lighter — Frederick II of Prussia deployed the first genuine light artillery during the Seven Years' War.

Jean - Baptiste de Gribeauval, a French artillery engineer, introduced the standardization of cannon design in the mid-18th century. He developed a 150 mm field howitzer whose gun barrel, carriage assembly and ammunition specifications were made uniform for all French cannons. The standardized interchangeable parts of these cannons down to the nuts, bolts and screws made their mass production and repair much easier. Another major change at this time was the development of a flintlock firing mechanism for the cannons to replace the old method of igniting powder in the cannon touchhole. The flintlock was a far more reliable (and safe) mechanism.

These improvements in the French artillery were essential for the later military successes of Napoleon. Napoleon, himself a former artillery officer, perfected the tactic of massed artillery batteries unleashed upon a critical point in his enemies' line as a prelude to a decisive infantry and cavalry assault.

5 – 5 - Modern artillery



Armstrong gun deployed by Japan during the Boshin war (1868–69).

The development of modern artillery occurred in the mid to late 19th century as a result of the convergence of various improvements in the underlying technology. Advances in metallurgy allowed for the construction of breech - loading rifled guns that could fire at a much greater muzzle velocity.

After the British artillery was shown up in the Crimean War as having barely changed since the Napoleonic Wars the industrialist William Armstrong was awarded a contract by the government to design a new piece of artillery. Production started in 1855 at the Elswick Ordnance Company and the Royal Arsenal at Woolwich, and the outcome was the revolutionary Armstrong Gun, which marked the birth of modern artillery. Three of its features particularly stand out.

First, the piece was rifled, which allowed for a much more accurate and powerful action. Although rifling had been tried on small arms since the 15th century, the necessary machinery to accurately rifle artillery was only available by the mid-19th century. Martin von Wahrendorff, and Joseph Whitworth independently produced rifled cannon in the 1840s, but it was Armstrong's gun that was first to see widespread use during the Crimean War . The cast iron shell of the Armstrong gun was similar in shape to a Minié ball and had a thin lead coating which made it fractionally larger than the gun's bore and which engaged with the gun's rifling grooves to impart spin to the shell. This spin, together with the elimination of windage as a result of the tight fit, enabled the gun to achieve greater range and accuracy than existing smooth - bore muzzle - loaders with a smaller powder charge.

8-inch Armstrong gun during American Civil War, Fort Fisher, 1865.

His gun was also a breech-loader. Although attempts at breech-loading mechanisms had been made since medieval times, the essential engineering problem was that the mechanism couldn't withstand the explosive charge. It was only with the advances in metallurgy and precision engineering capabilities during the Industrial Revolution that Armstrong was able to construct a viable solution. The gun combined all the properties that make up an effective artillery piece. The gun was mounted on a carriage in such a way as to return the gun to firing position after the recoil.

What made the gun really revolutionary lay in the technique of the construction of the gun barrel that allowed it to withstand much more powerful explosive forces. The "built-up" method involved assembling the barrel with wrought-iron (later mild steel was used) tubes of successively smaller diameter . The tube would then be heated to allow it to expand and fit over the previous tube. When it cooled the gun would contract although not back to its original size, which allowed an even pressure along the walls of the gun which was directed inward against the outward forces that the gun firing exerted on the barrel.

Another innovative feature, more usually associated with 20th-century guns, was what Armstrong called its "grip", which was essentially a squeeze bore; the 6 inches of the bore at the muzzle end was of slightly smaller diameter, which centered the shell before it left the barrel and at the same time slightly swaged down its lead coating, reducing its diameter and slightly improving its ballistic qualities.

Armstrong's system was adopted in 1858, initially for "special service in the field" and initially he only produced smaller artillery pieces, 6 - pounder (64 mm) mountain or light field guns, 9- pounder (76 mm) guns for horse artillery, and 12- pounder (76 mm) field guns.

The first cannon to contain all 'modern' features is generally considered to be the French 75 of 1897.[25][26] It was the first field gun to include a hydro - pneumatic recoil mechanism, which kept the gun's trail and wheels perfectly still during the firing sequence. Since it did not need to be re-aimed after each shot, the crew could fire as soon as the barrel returned to its resting position. In typical use, the French 75 could deliver fifteen rounds per minute on its target, either shrapnel or melinite high - explosive, up to about 5 miles (8,500 m) away. Its firing rate could even reach close to 30 rounds per minute, albeit only for a very short time and with a highly experienced crew. These were rates that contemporary bolt action rifles could not match. The gun used cased ammunition, was breech-loading, had modern sights, a self - contained firing mechanism and hydro-pneumatic recoil dampening.

5 – 5 – 1 - Indirect Fire

The firing of a projectile without relying on direct line of sight between the gun and the target, possibly dates back to the 16th century.[27] Early battlefield use of indirect fire may have occurred at Paltzig in July 1759 when the Russian artillery fired over the tops of trees,[28] and at the Battle of Waterloo where a battery of the Royal Horse Artillery fired an indirect Shrapnel barrage against advancing French troops.

In 1882 a Russian officer, Lieutenant Colonel KG Guk, published *Indirect Fire for Field Artillery* that provided a practical method of using aiming points for indirect fire by describing, "all the essentials of aiming points, crest clearance, and corrections to fire by an observer".

A few years later the Richtfläche (lining-plane) sight was invented in Germany and provided a means of indirect laying in azimuth, complementing the clinometers for indirect laying in elevation which already existed. Despite conservative opposition within the German army, indirect fire was adopted as doctrine by the 1890s. In the early 1900s Goertz in Germany developed an optical sight for azimuth laying. It quickly replaced the lining - plane; in English it became the 'Dial Sight' (UK) or 'Panoramic Telescope' (US).

The British halfheartedly experimented with indirect fire techniques since the 1890s, but with the onset of the Boer War they were the first to apply the theory in practice in 1899, although they had to improvise without a lining - plane sight.

In the next 15 years leading up to World War I, the techniques of indirect fire became available for all types of artillery. Indirect fire was the defining characteristic of 20th century artillery and led to undreamt of changes in the amount of artillery, its tactics, organization and techniques most of which occurred during World War I.

An implication of indirect fire and improving guns was increasing range between gun and target, this increased the time of flight and the vertex of the trajectory. The result was decreasing accuracy (the increasing distance between the target and the mean point of impact of the shells aimed at it) caused by the increasing effects of non-standard conditions. Indirect firing data was based on standard conditions including a specific muzzle velocity, zero wind, air temperature and density, and propellant temperature. In practice this standard combination of conditions almost never existed, they varied throughout the day and day to day, and the greater the time of flight the greater the inaccuracy. An added complication was the need for survey to accurately fix the coordinates of the gun position and provide accurate orientation for the guns. Of course targets had to be accurately located but by 1916 air photo interpretation techniques enabled this and ground survey techniques could sometimes be used.

In 1914 the methods of correcting firing data for the actual conditions were often convoluted, and the availability of data about actual conditions was rudimentary or non - existent, the assumption was that fire would always be ranged (adjusted). British heavy artillery worked energetically to progressively solve all these problems from late 1914 onwards and by early 1918 had effective processes in place for both field and heavy artillery. These processes enabled 'map-shooting', later called 'predicted fire', it meant that effective fire could be delivered against an accurately located target without ranging. Nevertheless the mean point of impact was still some tens of yards from the target - center aiming point. It was not precision fire but it was good enough for concentrations and barrages. These processes remain in use into the 21st Century with refinements to calculations enabled by computers and improved data capture about non-standard conditions.

The British major - general Henry Hugh Tudor pioneered armour and artillery cooperation at the breakthrough Battle of Cambrai. The improvements in accommodating non-standard conditions allowed effective predicted. Major General J. B. A. Bailey, British Army (retired) wrote.

From the middle of the eighteenth century to the middle of the nineteenth, artillery is judged to have accounted for perhaps 50% of battlefield casualties. In the sixty years preceding 1914, this figure was probably as low as 10 percent. The remaining 90 percent fell to small arms, whose range and accuracy had come to rival those of artillery. ... [By WWI] The British Royal Artillery, at over one million men, grew to be larger than the Royal Navy. Bellamy (1986), pp. 1–7, cites the percentage of casualties caused by artillery in various theaters since 1914: in the First World War, 45 percent of Russian casualties and 58 percent of British casualties on the Western Front; in the Second World War, 75 percent of British casualties in North

Africa and 51 percent of Soviet casualties (61 percent in 1945) and 70 percent of German casualties on the Eastern Front; and in the Korean War, 60 percent of US casualties, including those inflicted by mortars.

—J. B. A. Bailey (2004). *Field artillery and firepower*

An estimated 75,000 French soldiers were casualties of friendly artillery in the four years of World War I.

5 – 6 - Precision artillery

XM982 Excalibur guided artillery shell

Modern artillery is most obviously distinguished by its long range, firing an explosive shell or rocket and a mobile carriage for firing and transport. However, its most important characteristic is the use of indirect fire, whereby the firing equipment is aimed without seeing the target through its sights. Indirect fire emerged at the beginning of the 20th century and was greatly enhanced by the development of predicted fire methods in World War I. However, indirect fire was area fire; it was and is not suitable for destroying point targets; its primary purpose is area suppression. Nevertheless by the late 1970s precision munitions started to appear, notably the US 155mm Copperhead and its Soviet 152mm equivalent that had success in Indian service. These relied on laser designation to 'illuminate' the target that the shell homed onto. However, in the early 21st Century the Global Positioning System (GPS) enabled relatively cheap and accurate guidance for shells and missiles, notably the US 155mm Excalibur and the 227mm GMLRS rocket. The introduction of these led to a new issue, the need for very accurate three dimensional target coordinates - the mensuration process.

Weapons covered by the term 'modern artillery' include "cannon" artillery (such as howitzer, mortar, and field gun) and rocket artillery. Certain smaller - caliber mortars are more properly designated small arms rather than artillery, albeit indirect - fire small arms. This term also came to include coastal artillery which traditionally defended coastal areas against seaborne attack and controlled the passage of ships. With the advent of powered flight at the start of the 20th century, artillery also included ground-based anti-aircraft batteries.

The term "artillery" has traditionally not been used for projectiles with internal guidance systems, preferring the term "missilery", though some modern artillery units employ surface-to-surface missiles. Advances in terminal guidance systems for small munitions has allowed large - caliber guided projectiles to be developed, blurring this distinction.

6 – Ammunition

Artillery ammunition can also make use of nuclear warheads, as seen in this 1953 nuclear test.

One of the most important roles of logistics is the supply of munitions as a primary type of artillery consumable, their storage and the provision of fuses, detonators and warheads at the point where artillery troops will assemble the charge, projectile, bomb or shell.

A round of artillery ammunition comprises four components :

1: The fuze
2: The projectile
3: The propellant
4: The primer

6 – 1 – Fuzes

Fuzes are the devices that initiate an artillery projectile, either to detonate its high explosive (HE) filling or eject its cargo (illuminating flare or smoke canisters being examples). The official military spelling is "fuze" . Broadly there are four main types :

impact (including graze and delay)
mechanical time including airburst
proximity sensor including airburst
electronic time including airburst

Most artillery fuzes are nose fuzes. However, base fuzes have been used with armour piercing shells and for squash head (HESH or HEP) anti-tank shells. At least one nuclear shell and its non-nuclear spotting version also used a multi-deck mechanical time fuze fitted into its base.

Impact fuzes were, and in some armies remain, the standard fuze for HE projectiles. Their default action is normally 'superquick', some have had a 'graze' action which allows them to penetrate light cover and others have 'delay'. Delay fuzes allow the shell to penetrate the ground before exploding. Armor- or concrete - piercing fuzes are specially hardened. During World War I and later, ricochet fire with delay or graze fuzed HE shells, fired with a flat angle of descent, was used to achieve airburst.

HE shells can be fitted with other fuzes. Airburst fuzes usually have a combined airburst and impact function. However, until the introduction of proximity fuzes, the airburst function was mostly used with cargo munitions — for example shrapnel, illumination, and smoke. The larger calibers of anti-aircraft artillery are almost always used airburst. Airburst fuzes have to have the fuze length (running time) set on them. This is done just before firing using either a wrench or a fuze setter pre-set to the required fuze length.

Early airburst fuzes used igniferous timers which lasted into the second half of the 20th century. Mechanical time fuzes appeared in the early part of the century. These required a means of powering them. The Thiel mechanism used a spring and escapement (i.e. 'clockwork'), Junghans used centrifugal force and gears, and Dixi used centrifugal force and balls. From about 1980, electronic time fuzes started replacing mechanical ones for use with cargo munitions.

Proximity fuzes have been of two types: photo-electric or radar. The former was not very successful and seems only to have been used with British anti-aircraft artillery 'un rotated projectiles' (rockets) in World War II. Radar proximity fuzes were a big improvement over the mechanical (time) fuzes which they replaced. Mechanical time fuzes required an accurate calculation of their running time, which was affected by non-standard conditions. With HE (requiring a burst 20 to 30 feet (9.1 m) above the ground), if this was very slightly wrong the rounds would either hit the ground or burst too high. Accurate running time was less important with cargo munitions that burst much higher.

The first radar proximity fuzes (codenamed 'VT') were initially used against aircraft in World War II. Their ground use was delayed for fear of the enemy recovering 'blinds' (artillery shells which failed to detonate) and copying the fuze. The first proximity fuzes were designed to detonate about 30 feet (9.1 m) above the ground. These air-bursts are much more lethal against personnel than ground bursts because they deliver a greater proportion of useful fragments and deliver them into terrain where a prone soldier would be protected from ground bursts.

However, proximity fuzes can suffer premature detonation because of the moisture in heavy rain clouds. This led to 'controlled variable time' (CVT) after World War II. These fuzes have a mechanical timer that switched on the radar about 5 seconds before expected impact, they also detonated on impact.

The proximity fuze emerged on the battlefields of Europe in late December 1944. They have become known as the U.S. Artillery's "Christmas present", and were much appreciated when they arrived during the Battle of the Bulge. They were also used to great effect in anti-aircraft projectiles in the Pacific against *kamikaze* as well as in Britain against V-1 flying bombs.

Electronic multi - function fuzes started to appear around 1980. Using solid-state electronics they were relatively cheap and reliable, and became the standard fitted fuze in operational ammunition stocks in some western armies. The early versions were often limited to proximity airburst, albeit with height of burst options, and impact. Some offered a go / no - go functional test through the fuze setter.

Later versions introduced induction fuze setting and testing instead of physically placing a fuze setter on the fuze. The latest, such as Junghan's DM84U provide options giving, super quick, delay, a choice of proximity heights of burst, time and a choice of foliage penetration depths.

A new type of artillery fuze will appear soon. In addition to other functions these offer some course correction capability, not full precision but sufficient to significantly reduce the dispersion of the shells on the ground.

6 – 2 – Projectiles

The projectile is the munition or "bullet" fired downrange. This may or may not be an explosive device. Traditionally, projectiles have been classified as "shot" or "shell", the former being solid and the latter having some form of "payload".

Shells can also be divided into three configurations: bursting, base ejection or nose ejection. The latter is sometimes called the shrapnel configuration. The most modern is base ejection, which was introduced in World War I. Both base and nose ejection are almost always used with airburst fuzes. Bursting shells use various types of fuze depending on the nature of the payload and the tactical need at the time.

Payloads have included :

Bursting: high - explosive, white phosphorus ("Willie Pete" or "Wilson Picket") , coloured marker, chemical, nuclear devices; high explosive anti-tank (HEAT) and canister may be considered special types of bursting shell.

Base Ejection: dual purpose improved conventional munitions (DPICM)-bomblets, which arm themselves and function after a set number of rotations after having been ejected from the projectile (this produces unexploded sub-munitions, or "duds", which remain dangerous), scatter able mines, illuminating, coloured flare, smoke, incendiary, propaganda, chaff (foil to jam radars: originally known as "window") and modern exotics such as electronic payloads and sensor-fuzed munitions.

Nose Ejection: shrapnel, star, incendiary and flechette (a more modern version of shrapnel).

6 – 3 – Stabilization

Rifled Traditionally, artillery projectiles have been spin-stabilised, meaning that they spin in flight so that gyroscopic forces prevent them from tumbling. Spin is induced by gun barrels having rifling which engages a soft metal band around the projectile, called a "driving band" (UK) or "rotating band" (U.S.). The driving band is usually made of copper, but synthetic materials have also been used.

Smoothbore / Fin - Stabilized In modern artillery smoothbore tubes have been used mostly by mortars. These projectiles use fins in the airflow at their rear to maintain correct orientation. The primary benefits over rifled barrels is reduced barrel wear, longer ranges that can be achieved (due to the reduced loss of energy to friction and gas escaping around the projectile via the rifling) and larger explosive cores for a given caliber artillery due to less metal needing to be used to form the case of the projectile because of less force applied to the shell from the non - rifled sides of the barrel of smooth bore guns.

Rifled / Fin - Stabilized A combination of the above can be used, where the barrel is rifled, but the projectile also has deployable fins for stabilization, guidance or gliding .

6 – 4 – Propellant

152 mm howitzer D-20 during the Iran-Iraq war.

Most forms of artillery require a propellant to propel the projectile at the target. Propellant is always a low explosive, this means it deflagrates instead of detonating, as with high explosives. The shell is accelerated to a high velocity in a very short time by the rapid generation of gas from the burning propellant. This high pressure is achieved by burning the propellant in a contained area, either the chamber of a gun barrel or the combustion chamber of a rocket motor.

Until the late 19th century the only available propellant was black powder. Black powder had many disadvantages as a propellant; it has relatively low power, requiring large amounts of powder to fire projectiles, and created thick clouds of white smoke that would obscure the targets, betray the positions of guns and make aiming impossible. In 1846 nitrocellulose (also known as guncotton) was discovered, and the high explosive nitroglycerin was discovered at much the same time. Nitrocellulose was significantly more powerful than black powder, and was smokeless. Early guncotton was unstable however, and burned very fast and hot, leading to greatly increased barrel wear. Widespread introduction of smokeless powder would wait until the advent of the double-base powders, which combine nitrocellulose and nitroglycerin to produce powerful, smokeless, stable propellant.

Many other formulations were developed in the following decades, generally trying to find the optimum characteristics of a good artillery propellant; low temperature, high energy, non corrosive, highly stable, cheap, and easy to manufacture in large quantities. Broadly, modern gun propellants are divided into three classes: single - base propellants which are mainly or entirely nitrocellulose based, double-base propellants composed of a combination of nitrocellulose and nitroglycerin, and triple base composed of a combination of nitrocellulose and nitroglycerin and Nitro guanidine.

Artillery shells fired from a barrel can be assisted to greater range in three ways:

rocket assisted projectiles (RAP) enhance and sustain the projectile's velocity by providing additional 'push' from a small rocket motor that is part of the projectile's base.

Base bleed uses a small pyrotechnic charge at the base of the projectile to introduce sufficient combustion products into the low-pressure region behind the base of the projectile responsible for a large proportion of the drag.

ramjet assisted, similar to rocket assisted but using a ramjet instead of a rocket motor; it is anticipated that a ramjet-assisted 120 - mm mortar shell could reach a range of 35 km .

Propelling charges for tube artillery can be provided in one of two ways: either as cartridge bags or in metal cartridge cases. Generally anti-aircraft artillery and smaller caliber up to 76.2 mm guns use metal cartridge cases that include the round and propellant, similar to a modern rifle cartridge. This simplifies loading and is necessary for very high rates of fire. Bagged propellant allows the amount of powder to be raised or lowered depending on the range to the target. it also makes handling of larger shells easier. Each requires a totally different type of breech to the other. A metal case holds an integral primer to initiate the propellant and provides the gas seal to prevent the gases leaking out of the breech, this is called obturation. With bagged charges the breech itself provides obturation and holds the primer. In either case the primer is usually percussion but electrical is also used and laser ignition is emerging. Modern 155 mm guns have a primer magazine fitted to their breech.

Battleship Ammunition: 16" artillery shells aboard one of the United States Iowa - class battleships.

Artillery ammunition has four classifications according to use :

Service: ammunition used in live fire training or for wartime use in a combat zone. Also known as "war shot" ammunition.

Practice: Ammunition with a non- or minimally-explosive projectile that mimics the characteristics (range, accuracy) of live rounds for use under training conditions. Practice artillery ammunition often utilizes a colored-smoke-generating bursting charge for marking purposes in place of the normal high explosive charge.

Dummy: Ammunition with an inert warhead, inert primer, and no propellant; used for training or display.

Blank: Ammunition with live primer, greatly reduced propellant charge (typically black powder) and no projectile; used for training, demonstration or ceremonial use.

7 - Field artillery system

Because field artillery mostly uses indirect fire the guns have to be part of a system that enables them to attack targets invisible to them in accordance with the combined arms plan.

Cyclone of the 320th French Artillery, in Hoogstade, Belgium, 5 September 1917.

The main functions in the field artillery system are:

Communications

Command: authority to allocate resources;

Target acquisition: detect, identify and deduce the location of targets;

Control: authority to decide which targets to attack and allot fire units to the attack;

Computation of firing data – to deliver fire from a fire unit onto its target;

Fire units: guns, launchers or mortars grouped together;

Specialist services – produce data to support the production of accurate firing data;

Logistic services – to provide combat supplies, particularly ammunition, and equipment support.

Organizationally and spatially these functions can be arranged in many ways. Since the creation of modern indirect fire different armies have done it differently at different times and in different places. Technology is often a factor but so are military-social issues, the relationships between artillery and other arms, and the criteria by which military capability, efficiency and effectiveness are judged. Cost is also an issue because artillery is expensive due to the large quantities of ammunition that it uses and its level of manpower.

Communications underpin the artillery system, they have to be reliable and in real-time to link the various elements. During the 20th century communications used flags, morse code by radio, line and lights, voice and teleprinter by line. Radio has included HF, VHF, satellite and radio relay as well as modern tactical trunk systems. In western armies at least radio communications are now usually encrypted.

The emergence of mobile and man-portable radios after World War I had a major impact on artillery because it enable fast and mobile operations with observers accompanying the infantry or armoured troops. In World War II some armies fitted their self-propelled guns with radios. However, sometimes in the first half of the 20th century hardcopy artillery fire plans and map traces were distributed.

Data communications can be especially important for artillery because by using structured messages and defined data types fire control messages can be automatically routed and processed by computers. For example a target acquisition element can send a message with target details which is automatically routed through the tactical and technical fire control elements to deliver firing data to the gun's laying system and the gun automatically laid. As tactical data networks become pervasive they will provide any connected soldier with a means for reporting target information and requesting artillery fire.

Command is the authority to allocate resources, typically by assigning artillery formations or units. Terminology and its implications vary widely. However, very broadly, artillery units are assigned in direct support or in general support. Typically, the former mostly provide close support to manoeuvre units while the latter may provide close support and or depth fire, notably counter-battery. Generally, 'direct support' also means that the artillery unit provides artillery observation and liaison teams to the supported units. Sometimes direct support units are placed under command of the regiment / brigade they support. General support units may be grouped into artillery formations for example, brigades even divisions, or multi-battalion regiments, and usually under command of division, corps or higher HQs. General support units tend to be moved to where they are most required at any particular time. Artillery command may impose priorities and constraints to support their combined arms commander's plans.

Target acquisition can take many forms, it is usually observation in real time but may be the product of analysis. Artillery observation teams are the most common means of target acquisition. However, air observers have been use since the beginning of indirect fire and were quickly joined by air photography. Target acquisition may also be by anyone that can get the information into the artillery system. Targets may be visible to forward troops or in depth and invisible to them.

Observation equipment can vary widely in its complexity.

Unmanned air vehicles are the latest form of air observation, having been first introduced in the early 1960s.

The equipment available to observation teams has progressed from just prismatic compass, hand-held or tripod mounted binoculars and sometimes optical range-finders.

Special equipment for locating hostile artillery: flash spotting and notably sound ranging appeared in World War I the latter has been undergone increasing refinement as technology has improved. These were joined by radar in World War II.

In the mid-1970s several armies started equipping their artillery observation teams with laser rangefinders, ground surveillance radars and night vision devices, these were soon followed by inertial orienting and navigating devices to improve the accuracy of target locations. The Global Positioning System (GPS) provided a smaller and cheaper means of quick and accurate fixation for target acquisition devices.

Specialized units with ground surveillance radars, unattended ground sensors or observation patrols operating in depth have also been used.

Targets in depth may also be 'acquired' by intelligence processes using various sources and agencies such as HUMINT, SIGINT, ELINT and IMINT.

Laser guided shells require laser target designators, usually with observation teams on the ground but UAV installations are possible.

Specialised artillery observation vehicles appeared in World War II and have greatly increased in sophistication since that time.

Control, sometimes called tactical fire control, is primarily concerned with 'targeting' and the allotment of fire units to targets. This is vital when a target is within range of many fire units and the number of fire units needed depends on the nature of the target, and the circumstances and purpose of its engagement. Targeting is concerned with selecting the right weapons in the right quantities to achieve the required effects on the target. Allotment attempts to address the artillery dilemma—important targets are rarely urgent and urgent targets are rarely important. Of course importance is a matter of perspective; what is important to a divisional commander is rarely the same as what is important to an infantry platoon commander.

Afghans with two captured artillery field guns in Jaji, 1984.

Broadly, there are two situations: fire against opportunity targets and targets whose engagement is planned as part of a particular operation. In the latter situation command assigns fire units to the operation and an overall artillery fire planner makes a plan, possibly delegating resources for some parts of it to other planners. Fire plans may also involve use of non-artillery assets such as mortars and aircraft.

Control of fire against opportunity targets is an important differentiator between different types of artillery system. In some armies only designated artillery HQs have the tactical fire control authority to order fire units to engage a target, all 'calls for fire' being requests to these HQs. This authority may also extend to deciding the type and quantity of ammunition to be used. In other armies an 'authorised observer' (for example, artillery observation team or other target acquisition element) can order fire units to engage. In the latter case a battery observation team can order fire to their own battery and may be authorized to order fire to their own battalion and sometimes to many battalions. For example a divisional artillery commander may authorise selected observers to order fire to the entire divisional artillery. When observers or cells are not authorized they can still request fire.

Armies that apply forward tactical control generally put the majority of the more senior officers of artillery units forward in command observation posts or with the supported arm. Those that do not use this approach tend to put these officers close to the guns. In either case the observation element usually controls fire in detail against the target, such as adjusting it onto the target, moving it and co - ordinating it with the supported arm as necessary to achieve the required effects.

Firing data has to be calculated and is the key to indirect fire, the arrangements for this have varied widely. In the end firing data has two components: quadrant elevation and azimuth, to these may be added the size of propelling charge and the fuze setting. The process to produce firing data this is sometimes called technical fire control. Before computers, some armies set the range on the gun's sights, which mechanically corrected it for the gun's muzzle velocity. For the first few decades of indirect fire, the firing data were often calculated by the observer who then adjusted the fall of shot onto the target.

However, the need to engage targets at night, in depth or hit the target with the first rounds quickly led to predicted fire being developed in World War I. Predicted fire existed alongside the older method. After World War II predicted methods were invariably applied but the fall of shot usually needed adjustment because of inaccuracy in locating the target, the proximity of friendly troops or the need to engage a moving target. Target location errors were significantly reduced once laser rangefinders, orientation and navigation devices were issued to observation parties.

In predicted fire the basic geospatial data of range, angle of sight and azimuth between a fire unit and its target was produced and corrected for variations from the 'standard conditions'. These variations included barrel wear, propellant temperature, different projectiles weights that all affected the muzzle velocity, and air temperature, density, wind speed & direction and rotation of the earth that affect the shell in flight. The net effect of variations can also be determined by shooting at an accurately known point, a process called 'registration'.

All these calculations to produce a quadrant elevation (or range) and azimuth were done manually by highly trained soldiers using instruments, tabulated data, data of the moment and approximations until battlefield computers started appearing in the 1960s and 1970s. While some early calculators copied the manual method (typically substituting polynomials for tabulated data), computers use a different approach. They simulate a shell's trajectory by 'flying' it in short steps and applying data about the conditions affecting the trajectory at each step. This simulation is repeated until it produces a quadrant elevation and azimuth that lands the shell within the required 'closing' distance of the target co- ordinates. NATO has a standard ballistic model for computer calculations and has expanded the scope of this into the NATO Armaments Ballistic Kernel (NABK) within the SG2 Shareable (Fire Control) Software Suite (S4).

Technical fire control has been performed in various places, but mostly in firing batteries. However, in the 1930s the French moved it to battalion level and combined it with some tactical fire control. This was copied by the US. Nevertheless most armies seemed to have retained it within firing batteries and some duplicated the technical fire control teams in a battery to give operational resilience and tactical flexibility. Computers reduced the number of men needed and enabled decentralization of technical fire control to autonomous sub-battery fire units such as platoons, troops or sections, although some armies had some times done this with their manual methods. Computation on the gun or launcher, integrated with their laying system, is also possible. MLRS led the way in this.

A **fire unit** is the smallest artillery or mortar element, consisting of one or more weapon systems, capable of being employed to execute a fire assigned by a tactical fire controller. Generally it is a battery, but sub-divided batteries are quite common, and in some armies very common. On occasions a battery of 6 guns has been 6 fire units. Fire units may or may not occupy separate positions. Geographically dispersed fire units may or may not have an integral capability for technical fire control.

Specialist services provide data need for predicted fire. Increasingly, they are provided from within firing units. These services include:

Survey: accurate fixation and orientation of the guns, historically this involved specialists within field artillery units and specialist units. In some armies mapping and amp supply has also been an artillery responsibility. Survey is also essential for some target acquisition devices. Traditional survey methods of measurement and calculation have been replaced by inertial orientation and navigators and GPS.

Meteorological data: historically these were usually divisional level specialist teams but advances in technology mean they are now increasingly part of artillery units.

Calibration: periodically establishing the "normal" muzzle velocity of each gun as it wears. Originally this involved special facilities and army level teams. Measurement using Doppler radar, introduced in the 1950s, started to simplify arrangements. Some armies now have a muzzle velocity measuring radar permanently fitted to every gun.

Logistic services, supply of artillery ammunition has always been a major component of military logistics. Up until World War I some armies made artillery responsible for all forward ammunition supply because the load of small arms ammunition was trivial compared to artillery. Different armies use different approaches to ammunition supply, which can vary with the nature of operations. Differences include where the logistic service transfers artillery ammunition to artillery, the amount of ammunition carried in units and extent to which stocks are held at unit or battery level. A key difference is whether supply is 'push' or 'pull'. In the former the 'pipeline' keeps pushing ammunition into formations or units at a defined rate. In the latter units fire as tactically necessary and replenish to maintain or reach their authorized holding (which can vary), so the logistic system has to be able to cope with surge and slack.

Artillery has always been equipment intensive and for centuries artillery provided its own artificers to maintain and repair their equipment. Most armies now place these services in specialist branches with specialist repair elements in batteries and units.

8 - Classification of artillery

Artillery types can be categorized in several ways, for example by type or size of weapon or ordnance, by role or by organizational arrangements.

8 – 1 - Types of ordnance

The types of cannon artillery are generally distinguished by the velocity at which they fire projectiles. Types of artillery:

German Army PzH 2000 self-propelled artillery

Field artillery: mobile weapons used to support armies in the field. Subcategories include:

infantry support guns: directly support infantry units.

mountain guns: lightweight weapons that can be moved through difficult terrain.

field guns: capable of long range fire.

howitzers: capable of high angle fire, they are most often employed for indirect-fire.

gun howitzers: capable of high or low angle fire with a long barrel.

mortars: typically short-barreled, high-trajectory weapons designed primarily for an indirect-fire role.

anti-tank artillery: weapons, usually mobile, designed for attacking tanks.

anti-aircraft artillery: weapons, usually mobile, designed for attacking aircraft from the ground. Some guns were suitable for dual-role anti-aircraft and field (anti-tank) use. The World War II German 88 mm gun was a famous example.

rocket artillery: rocket-launched instead of shot or shell.

Motorized artillery: towed by Artillery tractors or APU-installed.

Self-propelled artillery: typically guns, mortars or gun howitzers mounted on a vehicle.

Railway gun: large-caliber weapons that are mounted on, transported by and fired from specially-designed railway wagons.

Naval artillery: guns mounted on warships and used either against other ships or in support of ground forces. The crowning achievement of naval artillery was the battleship, but the advent of airpower and missiles have rendered this type of artillery largely obsolete. They are typically longer-barreled, low-trajectory, high-velocity weapons designed primarily for a direct-fire role.

Coastal artillery: Fixed-position weapons dedicated to defense of a particular location, usually a coast (for example, the Atlantic Wall in World War II) or harbor. Not needing to be mobile, coastal artillery used to be much larger than equivalent field artillery pieces, giving them longer range and more destructive power. Modern coastal artillery (for example, Russia's "Bereg" system) is often self-propelled, (allowing it to avoid counter-battery fire) and fully integrated, meaning that each battery has all of the support systems that it requires (maintenance, targeting radar, etc.) organic to its unit.

Modern field artillery can also be split into two other categories: towed and self - propelled. As the name suggests, towed artillery has a prime mover, usually a jeep or truck, to move the piece, crew, and ammunition around. Self-propelled howitzers are permanently mounted on a carriage or vehicle with room for the crew and ammunition and are thus capable of moving quickly from one firing position to another, both to support the fluid nature of modern combat and to avoid counter-battery fire. There are also mortar carrier vehicles, many of which allow the mortar to be removed from the vehicle and be used dismounted, potentially in terrain in which the vehicle cannot navigate, or in order to avoid detection.

8 – 2 - Organizational types

Australian gunners, wearing gas masks,
operate a 230 mm howitzer during World War I.

At the beginning of the modern artillery period, the late 19th century, many armies had three main types of artillery, in some case they were sub - branches within the artillery branch in others they were separate branches or corps. There were also other types excluding the armament fitted to warships :

Horse artillery, first formed as regular units in the late 18th century, with the role of supporting cavalry, they were distinguished by the entire crew being mounted.

Field or "foot" artillery, the main artillery arm of the field army, using either guns, howitzers or mortars. In World War II this branch again started using rockets and later surface to surface missiles.

Fortress or garrison artillery, manned a nation's fixed defences using guns, howitzers or mortars, either on land or coastal frontiers. Some had deployable elements to provide heavy artillery to the field army. In some nations coast defense artillery was a naval responsibility.

Mountain artillery, a few nations treated mountain artillery as a separate branch, in others it was a speciality in another artillery branch. They used light guns or howitzers, usually designed for pack animal transport and easily broken down into small easily handled loads

Naval artillery, some nations carried pack artillery on some warships, these were used and manhandled by naval (or marine) landing parties. At times, part of a ship's armament would be unshipped and mated to makeshift carriages and limbers for actions ashore, for example during the Second Boer War, during the First World War the guns from the stricken SMS *Königsberg* formed the main artillery strength of the German forces in East Africa.

After World War I many nations merged these different artillery branches, in some cases keeping some as sub-branches. Naval artillery disappeared apart from that belonging to marines. However, two new branches of artillery emerged during that war and its aftermath, both used specialized guns (and a few rockets) and used direct not indirect fire, in the 1950s and 1960s both started to make extensive use of missiles:

Anti-tank artillery, also under various organisational arrangements but typically either field artillery or a specialist branch and additional elements integral to infantry, etc., units. However, in most armies field and anti-aircraft artillery also had at least a secondary anti-tank role. After World War II anti-tank in Western armies became mostly the responsibility of infantry and armoured branches and ceased to be an artillery matter, with some exceptions.

Anti - aircraft artillery , under various organizational arrangements including being part of artillery, a separate corps, even a separate service or being split between army for the field and airforce for home defense. In some cases infantry and the new armoured corps also operated their own integral light anti - aircraft artillery. Home defence anti - aircraft artillery often used fixed as well as mobile mountings. Some anti-aircraft guns could also be used as field or anti-tank artillery, providing they had suitable sights.

However, the general switch by artillery to indirect fire before and during World War I led to a reaction in some armies. The result was accompanying or infantry guns. These were usually small, short range guns, that could be easily man - handled and used mostly for direct fire but some could use indirect fire. Some were operated by the artillery branch but under command of the supported unit. In World War II they were joined by self-propelled assault guns, although other armies adopted infantry or close support tanks in armoured branch units for the same purpose, subsequently tanks generally took on the accompanying role.

8 – 3 - Equipment types

The three main types of artillery "gun" are guns, howitzers and mortars. During the 20 th century, guns and howitzers have steadily merged in artillery use, making a distinction between the terms somewhat meaningless. By the end of the 20th century, true guns with calibers larger than about 60 mm had become very rare in artillery use, the main users being tanks, ships, and a few residual anti-aircraft and coastal guns. The term "cannon" is a United States generic term that includes guns, howitzers and mortars; it is not used in other English speaking armies.

The traditional definitions differentiated between guns and howitzers in terms of maximum elevation (well less than 45° as opposed to close to or greater than 45°), number of charges (one or more than one charge), and having higher or lower muzzle velocity, sometimes indicated by barrel length. These three criteria give eight possible combinations, of which guns and howitzers are but two. However, modern "howitzers" have higher velocities and longer barrels than the equivalent "guns" of the first half of the 20th century.

True guns are characterized by long range, having a maximum elevation significantly less than 45°, a high muzzle velocity and hence a relatively long barrel, smooth bore (no rifling) and a single charge. The latter often led to fixed ammunition where the projectile is locked to the cartridge case. There is no generally accepted minimum muzzle velocity or barrel length associated with a gun.

Howitzers can fire at maximum elevations at least close to 45°; elevations up to about 70° are normal for modern howitzers. Howitzers also have a choice of charges, meaning that the same elevation angle of fire will achieve a different range depending on the charge used. They have rifled bores, lower muzzle velocities and shorter barrels than equivalent guns. All this means they can deliver fire with a steep angle of descent. Because of their multi-charge capability, their ammunition is mostly separate loading (the projectile and propellant are loaded separately).

That leaves six combinations of the three criteria, some of which have been termed gun howitzers. A term first used in the 1930s when howitzers with a relatively high maximum muzzle velocities were introduced, it never became widely accepted, most armies electing to widen the definition of "gun" or "howitzer". By the 1960s, most equipments had maximum elevations up to about 70°, were multi-charge, had quite high maximum muzzle velocities and relatively long barrels.

Mortars are simpler. The modern mortar originated in World War I and there were several patterns. After that war, most mortars settled on the Stokes pattern, characterized by a short barrel, smooth bore, low muzzle velocity, elevation angle of firing generally greater than 45°, and a very simple and light mounting using a "baseplate" on the ground. The projectile with its integral propelling charge was dropped down the barrel from the muzzle to hit a fixed firing pin. Since that time, a few mortars have become rifled and adopted breech loading.

There are other recognized typifying characteristics for artillery. One such characteristic is the type of obturation used to seal the chamber and prevent gases escaping through the breech. This may use a metal cartridge case that also holds the propelling charge, a configuration called "QF" or "quick firing" by some nations. The alternative does not use a metal cartridge case, the propellant being merely bagged or in combustible cases with the breech itself providing all the sealing. This is called "BL" or "breech loading" by some nations.

A second characteristic is the form of propulsion. Modern equipment can either be towed or self-propelled (SP). A towed gun fires from the ground and any inherent protection is limited to a gun shield. Towing by horse teams lasted throughout World War II in some armies, but others were fully mechanized with wheeled or tracked gun towing vehicles by the outbreak of that war. The size of a towing vehicle depends on the weight of the equipment and the amount of ammunition it has to carry.

A variation of towed is portee, where the vehicle carries the gun which is dismounted for firing. Mortars are often carried this way. A mortar is sometimes carried in an armored vehicle and can either fire from it or be dismounted to fire from the ground. Since the early 1960s it has been possible to carry lighter towed guns and most mortars by helicopter. Even before that, they were parachuted or landed by glider from the time of the first airborne trials in the USSR in the 1930s.

In an SP equipment, the gun is an integral part of the vehicle that carries it. SPs first appeared during World War I, but did not really develop until World War II. They are mostly tracked vehicles, but wheeled SPs started to appear in the 1970s. Some SPs have no armor and carry little or no ammunition. Armoured SPs usually carry a useful ammunition load. Early armoured SPs were mostly a "casemate" configuration, in essence an open top armored box offering only limited traverse. However, most modern armored SPs have a full enclosed armored turret, usually giving full traverse for the gun. Many SPs cannot fire without deploying stabilizers or spades, sometimes hydraulic. A few SPs are designed so that the recoil forces of the gun are transferred directly onto the ground through a baseplate. A few towed guns have been given limited self-propulsion by means of an auxiliary engine.

Two other forms of tactical propulsion were used in the first half of the 20th century: Railways or transporting the equipment by road, as two or three separate loads, with disassembly and re-assembly at the beginning and end of the journey. Railway artillery took two forms, railway mountings for heavy and super-heavy guns and howitzers and armored trains as "fighting vehicles" armed with light artillery in a direct fire role. Disassembled transport was also used with heavy and super heavy weapons and lasted into the 1950s.

8 – 4 - Caliber categories

A third form of artillery typing is to classify it as "light", "medium", "heavy" and various other terms. It appears to have been introduced in World War I, which spawned a very wide array of artillery in all sorts of sizes so a simple categorical system was needed. Some armies defined these categories by bands of calibers. Different bands were used for different types of weapons—field guns, mortars, anti-aircraft guns and coast guns.

9 - Modern operations

Two French Army Giat GCT 155mm (155mm AUF1) Self-propelled Guns, 40th Regiment d' Artillerie, with IFOR markings are parked at Hekon base, near Mostar, Bosnia-Herzegovina, in support of Operation Joint Endeavor.

List of countries in order of amount of artillery:
Russia - 26,121
Democratic People's Republic of Korea - 17,900+
China - 17,700+
India - 11,258+
Republic of Korea - 10,774+
United States - 8,137
Turkey - 7,450+
Israel - 5,432
Egypt - 4,480
Pakistan - 4,291+
Syria - 3805+
Algeria - 3465
Iran - 3668+
Jordan - 2339
Iraq - 2300+
Finland - 1398
France - 758
Brazil - 900
Cameroon - 883
Morocco - 848
Hungary -835

Artillery is used in a variety of roles depending on its type and caliber. The general role of artillery is to provide *fire support*—"the application of fire, coordinated with the manoeuvre of forces to destroy, *neutralize* or *suppress* the enemy". This NATO definition, of course, makes artillery a supporting arm although not all NATO armies agree with this logic. The *italicised* terms are NATO's.

Unlike rockets, guns (or howitzers as some armies still call them) and mortars are suitable for delivering *close supporting fire*. However, they are all suitable for providing *deep supporting fire* although the limited range of many mortars tends to exclude them from the role. Their control arrangements and limited range also mean that mortars are most suited to *direct supporting fire*. Guns are used either for this or *general supporting fire* while rockets are mostly used for the latter. However, lighter rockets may be used for direct fire support. These rules of thumb apply to NATO armies.

Modern mortars, because of their lighter weight and simpler, more transportable design, are usually an integral part of infantry and, in some armies, armor units. This means they generally do not have to *concentrate* their fire so their shorter range is not a disadvantage. Some armies also consider infantry operated mortars to be more responsive than artillery, but this is a function of the control arrangements and not the case in all armies. However, mortars have always been used by artillery units and remain with them in many armies, including a few in NATO.

In NATO armies artillery is usually assigned a tactical mission that establishes its relationship and responsibilities to the formation or units it is assigned to. It seems that not all NATO nations use the terms and outside NATO others are probably used. The standard terms are: *direct support*, *general support*, *general support reinforcing* and *reinforcing*. These tactical missions are in the context of the command authority: *operational command, operational control, tactical command* or *tactical control*.

In NATO direct support generally means that the directly supporting artillery unit provides observers and liaison to the manoeuvre troops being supported, typically an artillery battalion or equivalent is assigned to a brigade and its batteries to the brigade's battalions. However, some armies achieve this by placing the assigned artillery units under command of the directly supported formation. Nevertheless, the batteries' fire can be *concentrated* onto a single target, as can the fire of units in range and with the other tactical missions.

9 – 1 - Application of fire

There are several dimensions to this subject. The first is the notion that fire may be against an *opportunity* target or may be *prearranged*. If it is the latter it may be either *on - call* or *scheduled*. Prearranged targets may be part of a *fire plan*. Fire may be either *observed* or *unobserved*, if the former it may be *adjusted*, if the latter then it has to be *predicted*. Observation of adjusted fire may be directly by a forward observer or indirectly via some other *target acquisition* system.

A 155 mm artillery shell fired by a United States 11th Marine Regiment M-198 howitzer

NATO also recognizes several different types of fire support for tactical purposes:

Counterbattery fire: delivered for the purpose of destroying or *neutralizing* the enemy's fire support system.

Counterpreparation fire: intensive prearranged fire delivered when the imminence of the enemy attack is discovered.

Covering fire: used to protect troops when they are within range of enemy small arms.

Defensive fire: delivered by supporting units to assist and protect a unit engaged in a defensive action.

Final Protective Fire: an immediately available prearranged barrier of fire designed to impede enemy movement across defensive lines or areas.

Harassing fire: a random number of shells are fired at random intervals, without any pattern to it that the enemy can predict. This process is designed to hinder enemy forces' movement, and, by the constantly imposed stress, threat of losses and inability of enemy forces to relax or sleep, lowers their morale.

Interdiction fire: placed on an area or point to prevent the enemy from using the area or point.

Preparation fire: delivered before an attack to weaken the enemy position.

These purposes have existed for most of the 20th century, although their definitions have evolved and will continue to do so, lack of *suppression* in *counterbattery* is an omission. Broadly they can be defined as either:

Deep supporting fire: directed at objectives not in the immediate vicinity of own force, for neutralizing or destroying enemy reserves and weapons, and interfering with enemy command, supply, communications and observation; or

Close supporting fire: placed on enemy troops, weapons or positions which, because of their proximity present the most immediate and serious threat to the supported unit.

USMC M-198 firing outside of Fallujah, Iraq in 2004

Two other NATO terms also need definition:

Neutralization fire: delivered to render a target temporarily ineffective or unusable; and

Suppression fire: that degrades the performance of a target below the level needed to fulfill its mission. Suppression is usually only effective for the duration of the fire.

The tactical purposes also include various "mission verbs", a rapidly expanding subject with the modern concept of "effects based operations".

Targeting is the process of selecting target and matching the appropriate response to them taking account of operational requirements and capabilities. It requires consideration of the type of fire support required and the extent of coordination with the supported arm. It involves decisions about:

what effects are required, for example, *neutralization* or *suppression*;

the proximity of and risks to own troops or non-combatants;

what types of munitions, including their fuzing, are to be used and in what quantities;

when the targets should be attacked and possibly for how long;

what methods should be used, for example, *converged* or *distributed*, whether adjustment is permissible or surprise essential, the need for special procedures such as precision or danger close

how many fire units are needed and which ones they should be from those that are available (in range, with the required munitions type and quantity, not allotted to another target, have the most suitable line of fire if there is a risk to own troops or non-combatants);

The *targeting* process is the key aspect of tactical fire control. Depending on the circumstances and national procedures it may all be undertaken in one place or may be distributed. In armies practicing control from the front, most of the process may be undertaken by a forward observer or other target acquirer. This is particularly the case for a smaller target requiring only a few fire units. The extent to which the process is formal or informal and makes use of computer based systems, documented norms or experience and judgement also varies widely armies and other circumstances.

Surprise may be essential or irrelevant. It depends on what effects are required and whether or not the target is likely to move or quickly improve its protective posture. During World War II UK researchers concluded that for impact fuzed munitions the relative risk were as follows:

men standing – 1
men lying – 1/3
men firing from trenches – 1/15–1/50
men crouching in trenches – 1/25–1/100

Airburst munitions significantly increase the relative risk for lying men, etc. Historically most casualties occur in the first 10–15 seconds of fire, i.e. the time needed to react and improve protective posture, however, this is less relevant if airburst is used.

There are several ways of making best use of this brief window of maximum vulnerability:

ordering the guns to fire together, either by executive order or by a "fire at" time. The disadvantage is that if the fire is *concentrated* from many dispersed *fire units* then there will be different times of flight and the first rounds will be spread in time. To some extent a large concentration offsets the problem because it may mean that only one round is required from each gun and most of these could arrive in the 15 second window.

burst fire, a rate of fire to deliver three rounds from each gun within 10 or 15 seconds, this reduces the number of guns and hence fire units needed, which means they may be less dispersed and have less variation in their times of flight. Smaller caliber guns, such as 105 mm, have always been able to deliver three rounds in 15 seconds, larger calibers firing fixed rounds could also do it but it wasn't until the 1970s that a multi-charge 155 mm howitzer, FH-70 first gained the capability.

multiple round simultaneous impact (MRSI).

time on target, fire units fire at the time less their time of flight, this works well with prearranged scheduled fire but is less satisfactory for opportunity targets because it means delaying the delivery of fire by selecting a 'safe' time that all or most fire units can achieve. It can be used with both the previous two methods.

9 – 2 - Counter-battery fire

Modern **Counter-battery fire** developed in World War I, with the objective of defeating the enemy's artillery. Typically such fire was used to suppress enemy batteries when they were or were about to interfere with the activities of friendly forces (such as a to prevent enemy defensive artillery fire against an impending attack) or to systematically destroy enemy guns. In World War I the latter required air observation. The first indirect counter-battery fire was in May 1900 by an observer in a balloon.

Enemy artillery can be detected in two ways, either by direct observation of the guns from the air or by ground observers (including specialist reconnaissance), or from their firing signatures. This includes radars tracking the shells in flight to determine their place of origin, sound ranging detecting guns firing and resecting their position from pairs of microphones or cross-observation of gun flashes using observation by human observers or opto-electronic devices, although the widespread adoption of 'flashless' propellant limited the effectiveness of the latter.

Once hostile batteries have been detected they may be engaged immediately by friendly artillery or later at an optimum time, depending on the tactical situation and the counter-battery policy. Air strike is another option. In some situations the task is to locate all active enemy batteries for attack using a counter-battery fire at the appropriate moment in accordance with a plan developed by artillery intelligence staff. In other situation counter - battery fire may occur whenever a battery is located with sufficient accuracy.

Modern counter-battery target acquisition uses unmanned aircraft, counter-battery radar, ground reconnaissance and sound-ranging. Counter-battery fire may be adjusted by some of the systems, for example the operator of an unmanned aircraft can 'follow' a battery if it moves. Defensive measures by batteries include frequently changing position or constructing defensive earthworks, the tunnels used by North Korea being an extreme example. Counter-measures include air defence against aircraft and attacking counter-battery radars physically and electronically.

9 – 3 - Field artillery team

'Field Artillery Team' is a US term and the following description and terminology applies to the US, other armies are broadly similar but differ in significant details. The 'Field Artillery System' above gives a more comprehensive description. Modern field artillery (post–

World War I) has three distinct parts: the forward observer (or FO), the fire direction center (FDC) and the actual guns themselves. The forward observer observes the target using tools such as binoculars, laser rangefinders, designators and call back fire missions on his radio, or relays the data through a portable computer via an encrypted digital radio connection protected from jamming by computerized frequency hopping. A lesser known part of the team is the FAS or Field Artillery Survey team which setups up the "Gun Line" for the cannons. Today most artillery battalions use a(n) "Aiming Circle" which allows for faster setup and more mobility. FAS teams are still used for checks and balances purposes and if a gun battery has issues with the "Aiming Circle" a FAS team will do it for them.

The FO can communicate directly with the battery FDC, of which there is one per each battery of 4 – 8 guns. Otherwise the several FOs communicate with a higher FDC such as at a Battalion level, and the higher FDC prioritizes the targets and allocates fires to individual batteries as needed to engage the targets that are spotted by the FOs or to perform preplanned fires.

The Battery FDC computes firing data—ammunition to be used, powder charge, fuse settings, the direction to the target, and the quadrant elevation to be fired at to reach the target, what gun will fire any rounds needed for adjusting on the target, and the number of rounds to be fired on the target by each gun once the target has been accurately located — to the guns. Traditionally this data is relayed via radio or wire communications as a warning order to the guns, followed by orders specifying the type of ammunition and fuse setting, direction, and the elevation needed to reach the target, and the method of adjustment or orders for fire for effect (FFE). However in more advanced artillery units, this data is relayed through a digital radio link.

Other parts of the field artillery team include meteorological analysis to determine the temperature, humidity and pressure of the air and wind direction and speed at different altitudes. Also radar is used both for determining the location of enemy artillery and mortar batteries and to determine the precise actual strike points of rounds fired by battery and comparing that location with what was expected to compute a registration allowing future rounds to be fired with much greater accuracy.

9 – 4 - Time on Target

A technique called Time on Target was developed by the British Army in North Africa at the end of 1941 and early 1942 particularly for counter-battery fire and other concentrations, it proved very popular. It relied on BBC time signals to enable officers to synchronize their watches to the second because this avoided the need to use military radio networks and the possibility of losing surprise, and the need for field telephone networks in the desert.[57] With this technique the time of flight from each fire unit (battery or troop) to the target is taken from the range or firing tables, or the computer and each engaging fire unit subtracts its time of flight from the TOT to determine the time to fire. An executive order to fire is given to all guns in the fire unit at the correct moment to fire. When each fire unit fires their rounds at their individual firing time all the opening rounds will reach the target area almost simultaneously. This is especially effective when combined with techniques that allow fires for effect to be made without preliminary adjusting fires.

9 – 5 – MRSI

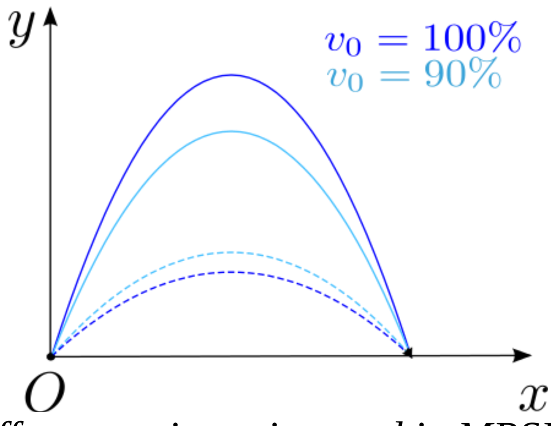


Illustration of different trajectories used in MRSI: For any muzzle velocity there is a steeper (> 45°, solid line) and a lower (<45°, dashed line) trajectory. On these different trajectories, the shells have different flight times.

This is a modern version of the earlier "time on target" concept in which fire from different weapons was timed to arrive on target at the same time. It is possible for artillery to fire several shells per gun at a target and have all of them arrive simultaneously, which is called MRSI (Multiple Rounds Simultaneous Impact). This is because there is more than one trajectory for the rounds to fly to any given target: typically one is below 45 degrees from horizontal and the other is above it, and by using different size propelling charges with each shell, it is possible to create multiple trajectories. Because the higher trajectories cause the shells to arc higher into the air, they take longer to reach the target and so if the shells are fired on these trajectories for the first volleys (starting with the shell with the most propellant and working down) and then after the correct pause more volleys are fired on the lower trajectories, the shells will all arrive at the same time. This is useful because many more shells can land on the target with no warning. With traditional volleys along the same trajectory, anybody at the target area may have time (however long it takes to reload and re-fire the guns) to take cover between volleys. However, guns capable of burst fire can deliver several rounds in 10 seconds if they use the same firing data for each, and if guns in more than one location are firing on one target they can use Time on Target procedures so that all their shells arrive at the same time and target.

To engage targets using MRSI requires two things, firstly guns with the requisite rate of fire and sufficient different size propelling charges, secondly a fire control computer that has been designed to compute such missions and the data handling capability that allows all the firing data to be produced, sent to each gun and then presented to the gun commander in the correct order. The number of rounds that can be delivered in MRSI depends primarily on the range to the target and the rate of fire, for maximum rounds the range is limited to that of lowest propelling charge that will reach the target.

Examples of guns with a rate of fire that makes them suitable for MRSI includes UK's AS-90, South Africa's Denel G6-52 (which can land six rounds simultaneously at targets at least 25 km (16 mi) away), Germany's Panzerhaubitze 2000 (which can land five rounds simultaneously at targets at least 17 km (11 mi) away) and Slovakia's 155 mm SpGH ZUZANA model 2000. The Archer project (Developed by BAE-Systems in Sweden), a 155 mm howitzer on a wheeled chassis claiming to be able to deliver up to 7 shells on target simultaneously from the same gun. The 120 mm twin barrel AMOS mortar system, joint developed by Hägglunds (Sweden) Patria (company) (Finland),[58] is capable of 7 + 7 shells MRSI. The United States Crusader program (now cancelled) was slated to have MRSI capability. It is unclear how many fire control computers have the necessary capabilities.

Two-round MRSI firings were a popular artillery demonstration in the 1960s, where well trained detachments could show off their skills for spectators.

9 – 6 - Air burst

The destructiveness of artillery bombardments can be enhanced when some or all of the shells are set for airburst, meaning that they explode in the air above the target instead of upon impact. This can be accomplished either through time fuses or proximity fuses. Time fuses use a precise timer to detonate the shell after a preset delay. This technique is tricky and slight variations in the functioning of the fuse can cause it to explode too high and be ineffective, or to strike the ground instead of exploding above it. Since December 1944 (Battle of the Bulge), proximity fuzed artillery shells have been available that take the guesswork out of this process. These embody a miniature, low powered radar transmitter in the fuse to detect the ground and explode them at a predetermined height above it. The return of the weak radar signal completes an electrical circuit in the fuze which explodes the shell. The proximity fuse itself was developed by the British to increase the effectiveness of anti-aircraft warfare.

This is a very effective tactic against infantry and light vehicles, because it scatters the fragmentation of the shell over a larger area and prevents it from being blocked by terrain or entrenchments that do not include some form of robust overhead cover. Combined with TOT or MRSI tactics that give no warning of the incoming rounds, these rounds are especially devastating because many enemy soldiers are likely to be caught in the open. This is even more so if the attack is launched against an assembly area or troops moving in the open rather than a unit in an entrenched tactical position.

Shell (Projectile)

155mm M107 projectiles. All have fuzes fitted

Some sectioned shells from the First World War. From left to right: 90 mm fragmentation shell, 120 mm pig iron incendiary shell, 77/14 model - 75 mm high explosive shell, model 16–75 mm fragmentation shell

US scientists with a full - scale cut - away model of the W48 155-millimeter nuclear artillery shell, a very small tactical nuclear weapon with an explosive yield equivalent to 72 tons of TNT . It could be fired from any standard 155 mm howitzer (e.g., the M114 or M198)

Contents

1 - Introduction

A **shell** is a payload - carrying projectile which, as opposed to shot, contains an explosive or other filling, though modern usage sometimes includes large solid projectiles properly termed **shot** (AP, APCR, APCNR, APDS, APFSDS and proof shot). Solid shot may contain a pyrotechnic compound if a tracer or spotting charge is used. Originally it was called a "bombshell", but "shell" has come to be unambiguous in a military context. "Bombshell" is still used figuratively to refer to an extremely sexually attractive woman and a shockingly unexpected happening or revelation.

All explosive- and incendiary - filled projectiles, particularly for mortars, were originally called *grenades*, derived from the pomegranate, whose seeds are similar to grains of powder. Words cognate with *grenade* are still used for an artillery or mortar projectile in some European languages.

Shells are usually large - calibre projectiles fired by artillery and combat vehicles (including tanks) , and warships.

Shells usually have the shape of a cylinder topped by an ogive-shaped nose for good aerodynamic performance, possibly with a tapering base; but some specialized types are quite different.

2 – History

Solid cannonballs (“shot”) did not need a fuse, but hollow munitions (“shells”) filled with something such as gunpowder to fragment the ball, needed a fuse, either impact (percussion) or time. Percussion fuses with a spherical projectile presented a challenge because there was no way of ensuring that the impact mechanism hit the target. Therefore shells needed a time fuse that was ignited before or during firing and burnt until the shell reached its target.

2 – 1 - Early shells

The earliest record of shells being used in combat was by the Republic of Venice at Jadra in 1376. Shells with fuses were used at the 1421 siege of St Boniface in Corsica. These were two hollowed hemispheres of stone or bronze held together by an iron hoop.

Written evidence for early explosive shells in China appears in the early Ming Dynasty (1368 – 1644) Chinese military manual *Huolongjing*, compiled by Jiao Yu (fl. 14th to early 15th century) and Liu Ji (1311–1375) sometime before the latter's death, a preface added by Jiao in 1412. As described in their book, these hollow, gunpowder-packed shells were made of cast iron.

An early problem was that there was no means of measuring the time precisely enough — reliable fuses did not yet exist and the burning time of the powder fuse was subject to considerable trial and error. Early powder burning fuses had to be loaded fuse down to be ignited by firing or a portfire put down the barrel to light the fuse. Other shells were wrapped in bitumen cloth which would ignite during the firing and in turn ignite a powder fuse. Nevertheless, shells came into regular use in the 16th Century, for example a 1543 English mortar shell was filled with 'wildfire'.

A mortar with a hollowed shell from the Boshin war.

By the 18th Century it was known that the fuse towards the muzzle could be lit by the flash through the windage between shell and barrel. At about this time shells began to be employed for horizontal fire from howitzers with a small propelling charge and in 1779 experiments demonstrated that they could be used from guns with heavier charges.

The use of exploding shells from field artillery became relatively commonplace from early in the 19th Century. Until the mid 19th century, shells remained as simple exploding spheres that used gunpowder, set off by a slow burning fuse. They were usually made of cast iron, but bronze, lead, brass and even glass shell casings were experimented with.[5] The word *bomb* encompassed them at the time, as heard in the lyrics of *The Star-Spangled Banner* ("the bombs bursting in air"), although today that sense of *bomb* is obsolete. Typically the thickness of the metal body was about 1/6 their diameter and they were about 2/3s the weight of solid shot of the same calibre.

In order to ensure that shells were loaded with their fuses towards the muzzle they were attached to wooden bottoms called 'sabots'. In 1819 a committee of British artillery officers recognised that they were essential stores and in 1830 Britain standardised sabot thickness as half inch.[6] The sabot was also intended to reduce jamming during loading. Despite the use of exploding shell, the use of smoothbore cannons, firing spherical projectiles of shot, remained the dominant artillery method until the 1850s.

2 – 2 - Shrapnel shell

By the late 18th century, artillery could use "canister shot" to defend themselves from infantry or cavalry attack. This involved loading a tin or canvas container filled with small iron or lead balls instead of the usual cannonball. When fired, the container burst open during passage through the bore or at the muzzle, giving the effect of an over - sized shotgun shell. At ranges of up to 300 m canister shot was still highly lethal, though at this range the shots' density was much lower, making a hit on a human target less likely. At longer ranges, solid shot or the common shell — a hollow cast iron sphere filled with black powder — was used, although with more of a concussive than a fragmentation effect, as the pieces of the shell were very large and sparse in number.

In 1784, Lieutenant Henry Shrapnel of the Royal Artillery developed the shrapnel shell as an anti-personnel weapon. His innovation was to combine the multi - projectile shotgun effect of canister shot, with a time fuze to open the canister and disperse the bullets it contained at some distance along the canister's trajectory from the gun. His shell was a hollow cast-iron sphere filled with a mixture of balls and powder, with a crude time fuse. If the fuse was set correctly then the shell would break open, either in front or above the intended target, releasing its contents (of musket balls). The shrapnel balls would carry on with the "remaining velocity" of the shell.

It took until 1803 for the British artillery to adopt the shrapnel shell (as "spherical case"), albeit with great enthusiasm when it did. Henry Shrapnel was promoted to Major in the same year. The design was improved by Captain E. M. Boxer of the Royal Arsenal around 1852 and crossed over when cylindrical shells for rifled guns were introduced. Lieutenant - Colonel Boxer adapted his design in 1864 to produce shrapnel shells for the new rifled muzzle - loader (RML) guns : the walls were of thick cast iron, but the gunpowder charge was now in the shell base with a tube running through the centre of the shell to convey the ignition flash from the time fuze in the nose to the gunpowder charge in the base. The powder charge both shattered the cast iron shell wall and liberated the bullets.

In the 1870s William Armstrong provided a design with the bursting charge in the head and the shell wall made of steel and hence much thinner than previous cast-iron shrapnel shell walls. While the thinner shell wall and absence of a central tube allowed the shell to carry far more bullets, it had the disadvantage that the bursting charge separated the bullets from the shell casing by firing the case forward and at the same time slowing the bullets down as they were ejected through the base of the shell casing, rather than increasing their velocity. Britain adopted this solution for several smaller calibres (below 6 – inch) but by World War I few if any such shells remained.

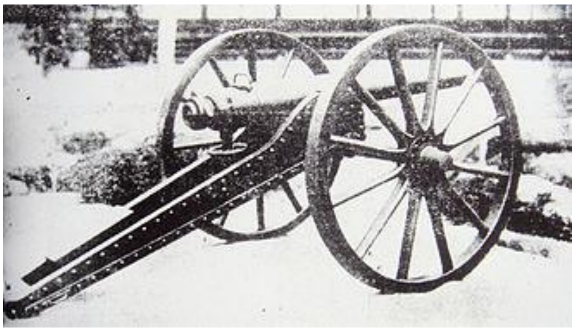
The final shrapnel shell design used a much thinner forged steel shell case with a timer fuze in the nose and a tube running through the centre to convey the ignition flash to a gunpowder bursting charge in the shell base. The use of steel allowed the shell wall to be made much thinner and hence allow space for many more bullets. It also withstood the force of the powder charge without shattering, so that the bullets were fired forward out of the shell case with increased velocity, much like a shotgun. This is the design that came to be adopted by all countries and was in standard use when World War I began in 1914.

2 – 3 - Modern shell

The mid 19th century saw a revolution in artillery, with the introduction of the first practical rifled breech loading weapons. The new methods resulted in the reshaping of the cylindrical shell into its modern recognizable cylindro-conoidal form. This shape greatly improved the in-flight stability of the projectile and meant that the primitive time fuzes could be replaced with the percussion fuze situated in the nose of the shell. The new shape also meant that further, armour piercing designs could be used.

During the 20th Century shells became increasingly streamlined. In World War I ogives were typically 2 circular radius head (crh), the curve was a segment of a circle having a radius of twice the shell calibre. After that war ogive shapes became more complex and elongated. From the 1960s higher quality steels were introduced by some countries for their HE shells, this enabled thinner shell walls with less weight of metal and hence a greater weight of explosive. Ogives were further elongated to improve their ballistic performance.

2 – 3 - 1 - Rifled breech loaders



The Armstrong gun was a pivotal development for modern artillery as the first practical rifled breech loader. Pictured, deployed by Japan during the Boshin war (1868–69).

Advances in metallurgy in the industrial era allowed for the construction of rifled breech - loading guns that could fire at a much greater muzzle velocity. After the British artillery was shown up in the Crimean War as having barely changed since the Napoleonic Wars the industrialist William Armstrong was awarded a contract by the government to design a new piece of artillery. Production started in 1855 at the Elswick Ordnance Company and the Royal Arsenal at Woolwich.

The piece was rifled, which allowed for a much more accurate and powerful action. Although rifling had been tried on small arms since the 15th century, the necessary machinery to accurately rifle artillery was only available by the mid-19th century. Martin von Wahrendorff, and Joseph Whitworth independently produced rifled cannon in the 1840s, but it was Armstrong's gun that was first to see widespread use during the Crimean War . The cast iron shell of the Armstrong gun was similar in shape to a Minié ball and had a thin lead coating which made it fractionally larger than the gun's bore and which engaged with the gun's rifling grooves to impart spin to the shell. This spin, together with the elimination of windage as a result of the tight fit, enabled the gun to achieve greater range and accuracy than existing smooth-bore muzzle - loaders with a smaller powder charge.

The gun was also a breech - loader. Although attempts at breech-loading mechanisms had been made since medieval times, the essential engineering problem was that the mechanism couldn't withstand the explosive charge. It was only with the advances in metallurgy and precision engineering capabilities during the Industrial Revolution that Armstrong was able to construct a viable solution. Another innovative feature was what Armstrong called its "grip", which was essentially a squeeze bore; the 6 inches of the bore at the muzzle end was of slightly smaller diameter, which centered the shell before it left the barrel and at the same time slightly swaged down its lead coating, reducing its diameter and slightly improving its ballistic qualities.

Rifled guns were also developed elsewhere - by Major Giovanni Cavalli and Baron Martin von Wahrendorff in Sweden, Krupp in Germany and the Wiard gun in the United States . However, rifled barrels required some means of engaging the shell with the rifling. Lead coated shells were used with the Armstrong gun, but were not satisfactory so studded projectiles were adopted. However these did not seal the gap between shell and barrel. Wads at the shell base were also tried without success.

In 1878 the British adopted a copper 'gas - check' at the base of their studded projectiles, and in 1879 tried a rotating gas check to replace the studs, leading to the 1881 automatic gas - check. This was soon followed by the Vavaseur copper driving band as part of the projectile. The driving band rotated the projectile, centred it in the bore and prevented gas escaping forwards. A driving band has to be soft but tough enough to prevent stripping by rotational and engraving stresses. Copper is generally most suitable but cupro nickel or gilding metal were also used.

2 – 3 - 2 - Percussion fuze

Although an early percussion fuze appeared in 1650 that used a flint to create sparks to ignite the powder, the shell had to fall in a particular way for this to work and this did not work with spherical. An additional problem was finding a suitably stable 'percussion powder'. Progress was not possible until the discovery of mercury fulminate in 1800, leading to priming mixtures for small arms patented by the Rev Alexander Forsyth, and the copper percussion cap in 1818.

The percussion fuze was adopted by Britain in 1842. Many designs were jointly examined by the army and navy, but were unsatisfactory, probably because of the safety and arming features. However, in 1846 the design by Quartermaster Freeburn of the Royal Artillery was adopted by the army. It was a wooden fuze some 6 inches long and used shear wire to hold blocks between the fuze magazine and a burning match. The match was ignited by propellant flash and the shear wire broke on impact. A British naval percussion fuze made of metal did not appear until 1861.

2 – 3 – 3 - Smokeless powders

Gun powder was used as the only form of explosive up until the end of the 19th century. Guns using black powder ammunition would have their view obscured by a huge cloud of smoke and concealed shooters were given away by a cloud of smoke over the firing position. Guncotton, a nitrocellulose-based material, was discovered by Swiss chemist Christian Friedrich Schönbein in 1846. He promoted its use as a blasting explosive[16] and sold manufacturing rights to the Austrian Empire. Guncotton was more powerful than gunpowder, but at the same time was somewhat more unstable. John Taylor obtained an English patent for guncotton; and John Hall & Sons began manufacture in Faversham. English interest languished after an explosion destroyed the Faversham factory in 1847. Austrian Baron Wilhelm Lenk von Wolfsberg built two guncotton plants producing artillery propellant, but it was dangerous under field conditions, and guns that could fire thousands of rounds using gunpowder would reach their service life after only a few hundred shots with the more powerful guncotton.

Small arms could not withstand the pressures generated by guncotton. After one of the Austrian factories blew up in 1862, Thomas Prentice & Company began manufacturing guncotton in Stowmarket in 1863; and British War Office chemist Sir Frederick Abel began thorough research at Waltham Abbey Royal Gunpowder Mills leading to a manufacturing process that eliminated the impurities in nitrocellulose making it safer to produce and a stable product safer to handle. Abel patented this process in 1865, when the second Austrian guncotton factory exploded. After the Stowmarket factory exploded in 1871, Waltham Abbey began production of guncotton for torpedo and mine warheads.

Sir James Dewar developed the cordite explosive in 1889.

In 1884, Paul Vieille invented a smokeless powder called Poudre B (short for *poudre blanche* — white powder, as distinguished from black powder)[18] made from 68.2 % insoluble nitrocellulose, 29.8% soluble nitrocellusose gelatinized with ether and 2 % paraffin. This was adopted for the Lebel rifle . Vieille's powder revolutionized the effectiveness of small guns, because it gave off almost no smoke and was three times more powerful than black powder. Higher muzzle velocity meant a flatter trajectory and less wind drift and bullet drop, making 1000 meter shots practicable. Other European countries swiftly followed and started using their own versions of Poudre B, the first being Germany and Austria which introduced new weapons in 1888. Subsequently Poudre B was modified several times with various compounds being added and removed. Krupp began adding diphenylamine as a stabilizer in 1888.

Britain conducted trials on all the various types of propellant brought to their attention, but were dissatisfied with them all and sought something superior to all existing types. In 1889, Sir Frederick Abel, James Dewar and Dr W Kellner patented (Nos 5614 and 11,664 in the names of Abel and Dewar) a new formulation that was manufactured at the Royal Gunpowder Factory at Waltham Abbey. It entered British service in 1891 as Cordite Mark 1. Its main composition was 58% Nitro - glycerine, 37 % Guncotton and 3 % mineral jelly. A modified version, Cordite MD, entered service in 1901, this increased guncotton to 65 % and reduced nitro-glycerine to 30 %, this change reduced the combustion temperature and hence erosion and barrel wear. Cordite's advantages over gunpowder were reduced maximum pressure in the chamber (hence lighter breeches, etc.) but longer high pressure. Cordite could be made in any desired shape or size. The creation of cordite led to a lengthy court battle between Nobel Maxim, and another inventor over alleged British patent infringement.

2 – 3 - 4 - High explosive shells

Picric acid was used in the first high explosive shells. Cut out section of a high explosive shell belonging to a Canon de 75 modèle 1897.

Although smokeless powders were used as a propellant, they could not be used as the substance for the explosive warhead, because shock sensitivity sometimes caused detonation in the artillery barrel at the time of firing. Picric acid was the first high explosive nitrated organic compound widely considered suitable to withstand the shock of firing in conventional artillery. In 1885, based on research of Hermann Sprengel, French chemist Eugène Turpin patented the use of pressed and cast picric acid in blasting charges and artillery shells. In 1887 the French government adopted a mixture of picric acid and guncotton under the name *Melinite*. In 1888, Britain started manufacturing a very similar mixture in Lydd, Kent, under the name *Lyddite*.

Japan followed with an "improved" formula known as *shimose powder*. In 1889, a similar material, a mixture of ammonium cresylate with trinitrocresol, or an ammonium salt of trinitrocresol, started to be manufactured under the name *ecrasite* in Austria-Hungary. By 1894 Russia was manufacturing artillery shells filled with picric acid. Ammonium picrate (known as *Dunnite* or explosive D) was used by the

United States beginning in 1906 . Germany began filling artillery shells with TNT in 1902. Toluene was less readily available than phenol, and TNT is less powerful than picric acid, but improved safety of munitions manufacturing and storage caused replacement of picric acid by TNT for most military purposes between the World Wars. However, pure TNT was expensive to produce and most nations made some use of mixtures using cruder TNT and ammonium nitrate, some with other compounds included. These fills included Ammonal, Schneiderite and Amatol. The latter was still in wide use in World War II.

The percentage of shell weight taken up by its explosive fill increased steadily throughout the 20th Century. Less than 10% was usual in the first few decades, by World War II leading designs were around 15%. However, British researchers in that war identified 25% as being the optimal design for anti - personnel purposes, based on the recognition that far smaller fragments than hitherto would give a better effect. This guideline was achieved by the 1960s with the 155 mm L15 shell, developed as part of the German-British FH-70 program. The key requirement for increasing the HE content without increasing shell weight was to reduce the thickness of shell walls, which required improvements in high tensile steel.

2 – 3 - 5 - Armour piercing shells

With the introduction of the first ironclads in the 1850s and 1860s, it became clear that shells had to be designed to effectively pierce the ship armour. A series of British tests in 1863 demonstrated that the way forward lay with high velocity lighter shells. The first pointed armour-piercing shell was introduced by Major Palliser in 1863. Approved in 1867, Palliser shot and shell was an improvement over the ordinary elongated shot of the time. Palliser shot was made of cast iron, the head being chilled in casting to harden it, using composite molds with a metal, water cooled portion for the head.

Britain also deployed Palliser shells in the 1870s-1880s. In the shell the cavity was slightly larger than in the shot and was filled with gunpowder instead of being empty, to provide a small explosive effect after penetrating armour plating. The shell was correspondingly slightly longer than the shot to compensate for the lighter cavity. The powder filling was ignited by the shock of impact and hence did not require a fuze.

However, ship armour rapidly improved during the 1880s and 1890s, and it was realised that explosive shells with steel had advantages including better fragmentation and resistance to the stresses of firing. These were cast and forged steel.

An important development was the Armour-piercing discarding sabot, or APDS. An early version was developed by engineers working for the French Edgar Brandt company, and was fielded in two calibers (75 mm / 57 mm for the Mle1897 / 33 75 mm anti - tank cannon, 37 mm / 25 mm for several 37 mm gun types) just before the French-German armistice of 1940 . The Edgar Brandt engineers, having been evacuated to the United Kingdom, joined ongoing APDS development efforts there, culminating in significant improvements to the concept and its realization.

The APDS projectile type was further developed in the United Kingdom between 1941-1944 by L. Permutter and S. W. Coppock, two designers with the Armaments Research Department. In mid - 1944 the APDS projectile was first introduced into service for the UK's QF 6 pdr anti-tank gun and later in September 1944 for the 17 pdr anti-tank gun.[25] The idea was to use a stronger penetrator material to allow increased impact velocity and armour penetration.

The chosen new penetrator material, tungsten carbide, was too heavy at full bore to be accelerated to a sufficient muzzle velocity. To overcome this, a lightweight full diameter carrier shell (APCR) was developed to sheathe the inner high density core. However, the low sectional density of the APCR resulted in high aerodynamic drag. Instead, the British devised a way for the outer sheath to be discarded after leaving the bore. The name given to the discarded outer sheath was the sabot (a French word for a wooden shoe).

Armour - piercing, composite non - rigid projectile design was a high density core within a shell of soft iron or other alloy, but fired by a gun with a tapered barrel. The projectile was initially full - bore, but the outer shell was deformed as it passes through the taper, leaving the projectile with a smaller overall cross - section and giving it better flight characteristics.

The Germans deployed their initial design as a light anti-tank weapon, *2,8 cm schwere Panzerbüchse 41*, early in the Second World War, and followed on with the 4.2 cm Pak 41 and 7.5 cm Pak 41. Although HE rounds were also put into service, they weighed only 93 grams and had low effectiveness . The German taper was fixed on the barrel.

In contrast, the British used the Littlejohn squeeze-bore adaptor which could be attached or removed as necessary. The adaptor extended the usefulness of armoured cars and light tanks which could not fit any gun larger than the QF 2 pdr. Although a full range of shells and shot could be used, changing the adaptor in the heat of battle was highly impractical.

2 – 3 – 5 - 1 - Anti tank explosive shells

High - explosive anti - tank warheads (HEAT for short) were developed during the Second World War as a munition made of an explosive shaped charge that uses the Munroe effect to create a very high-velocity partial stream of metal in a state of superplasticity, and used to penetrate solid vehicle armour.

Shaped charge warheads were promoted internationally by the Swiss inventor Henry Mohaupt, who exhibited the weapon before the Second World War. Prior to 1939 Mohaupt demonstrated his invention to British and French ordnance authorities.

Claims for priority of invention are difficult to resolve due to subsequent historic interpretations, secrecy, espionage, and international commercial interest.[28] By mid - 1940 Germany introduced the first HEAT round to be fired by a gun, the 7.5 cm fired by the Kw.K.37 L/24 of the Panzer IV tank and the Stug III self-propelled gun (7.5 cm Gr.38 Hl/A, later editions B and C). In mid -1941 Germany started the production of HEAT rifle-grenades, first issued to paratroopers and by 1942 to the regular army units. In 1943 the *Püppchen*, *Panzerschreck* and *Panzerfaust* were introduced. The Panzerfaust and Panzerschreck or 'tank terror' gave the German infantryman the ability to destroy any tank on the battlefield from 50-150m with relative ease of use and training (unlike the UK PIAT).

The first British HEAT weapon to be developed and issue was a rifle grenade using a 2 1 / 2 inch cup launcher on the end of the barrel; the British No. 68 AT grenade issued to the British army in 1940. By 1943 the PIAT was developed; a combination of a HEAT warhead and a spigot mortar delivery system. While cumbersome the weapon at last allowed British infantry to engage armour at range; the earlier magnetic hand-mines and grenades required them to approach suicidally close.[29] During World War II the British referred to the Monroe effect as the *cavity effect on explosives*.

During the war, the French communicated Henry Mohaupt's technology to the U.S. Ordnance Department, who invited him to the USA, where he worked as a consultant on the Bazooka project.

HEAT rounds caused a revolution in anti - tank warfare when they were first introduced in the later stages of World War II. A single infantryman could effectively destroy any existing tank with a handheld weapon, thereby dramatically altering the nature of mobile operations. During World War II, weapons using HEAT warheads were known as having a *hollow charge* or *shape charge* warhead.

The high - explosive squash head (HESH) was developed by Charles Dennistoun Burney in the 1940s for the British war effort, originally as an anti - fortification "wallbuster" munition for use against concrete. HESH rounds were thin metal shells filled with plastic explosive and a delayed-action base fuze. The plastic explosive is "squashed" against the surface of the target on impact and spreads out to form a disc or "pat" of explosive. The base fuze detonates the explosive milli seconds later, creating a shock wave that, owing to its large surface area and direct contact with the target, is transmitted through the material. At the point where the compression and tension waves intersect a high-stress zone is created in the metal, causing pieces of steel to be projected off the interior wall at high velocity. This fragmentation by blast wave is known as spalling , with the fragments themselves known as spall. Unlike high - explosive anti - tank (HEAT) rounds which are shaped charge ammunition, HESH shells are not specifically designed to perforate the armour of main battle tanks. HESH shells rely instead on the transmission of the shock wave through the solid steel armour.

HESH was found to be surprisingly effective against metallic armour as well, although the British already had effective weapons using HEAT, such as the PIAT. HESH was for some time a competitor to the more common HEAT round, again in combination with recoilless rifles as infantry weapons and was effective against tanks such as the T-55 and T-62.

2 – 4 - Other shell types

A variety of fillings have been used in shells throughout history. An incendiary shell was invented by Valturio in 1460. The carcass shell was first used by the French under Louis XIV in 1672. Initially in the shape of an oblong in an iron frame (with poor ballistic properties) it evolved into a spherical shell. Their use continued well into the 19th Century.

A modern version of the incendiary shell was developed in 1857 by the British and was known as Martin's shell. It was filled with molten iron and was used against enemy warships. It replaced the use of red hot shot (notably used at the Great Siege of Gibraltar in 1782). Two patterns of incendiary shell were used by the British in World War 1, one designed for use against Zeppelins.

Similar to incendiary shells were star shells, designed for illumination rather than arson. Sometimes called lightballs they were in use from the 17th Century onwards. The British adopted parachute lightballs in 1866 for 10, 8 and $5\frac{1}{2}$ inch calibres. The 10-inch wasn't officially declared obsolete until 1920.

Smoke balls also date back to the 17th Century, British ones contained a mix of saltpetre, coal, pitch, tar, resin, sawdust, crude antimony and sulphur. They produced a 'noisome smoke in abundance that is impossible to bear'. In the 19th Century British service they were made of concentric paper with thickness about 1/15 th of total diameter and filled with powder, saltpetre, pitch, coal and tallow. They were used to 'suffocate or expel the enemy in casemates, mines or between decks; for concealing operations; and as signals.

During the First World War, shrapnel shells and explosive shells inflicted terrible casualties on infantry, accounting for nearly 70% of all war casualties and leading to the adoption of steel helmets on both sides. Shells filled with poison gas were used from 1917 onwards. Frequent problems with shells led to many military disasters when shells failed to explode, most notably during the 1916 Battle of the Somme.

3 – Sizes

British gun crew preparing 155mm shells at Vergato, Italy on 22 February 1945

The calibre of a shell is its diameter. Depending on the historical period and national preferences, this may be specified in millimetres, centimetres, or inches. The length of gun barrels for large cartridges and shells (naval) is frequently quoted in terms of the ratio of the barrel length to the bore size, also called calibre. For example, the 16"/50 caliber Mark 7 gun is 50 calibers long, that is, 16"×50 = 800" = 66.7 feet long. Some guns, mainly British, were specified by the weight of their shells .

Due to manufacturing difficulties the smallest shells commonly used are around 20 mm calibre, used in aircraft cannon and on armoured vehicles. Smaller shells are only rarely used as they are difficult to manufacture and can only have a small explosive charge. The largest shells ever fired were those from the German super - railway guns, Gustav and Dora, which were 800 mm in calibre. Very large shells have been replaced by rockets, guided missile, and bombs, and today the largest shells in common use are 155 mm .

Gun calibres have standardized around a few common sizes, especially in the larger range, mainly due to the uniformity required for efficient military logistics. Shells of 105, 120, and 155 mm diameter are common for NATO forces' artillery and tank guns. Artillery shells of 122, 130 and 152 mm, and tank gun ammunition of 100, 115, or 125 mm calibre remain in use in Eastern Europe and China. Most common calibres have been in use for many years, since it is logistically complex to change the calibre of all guns and ammunition stores.

155mm American artillery shells, March 1945

The weight of shells increases by and large with calibre. A typical 150 mm shell weighs about 50 kg, a common 203 mm shell about 100 kg, a concrete demolition 203 mm shell 146 kg, a 280 mm battleship shell about 300 kg, and a 460 mm battleship shell over 1500 kg. The Schwerer Gustav supergun fired 4.8 and 7.1 tonne shells.

During the 19th Century the British adopted a particular form of designating artillery. Field guns were designated by nominal standard projectile weight while howitzers were designated by barrel caliber. British guns and their ammunition were designated in pounds, e.g., as "two-pounder" shortened to "2 - pr" or "2 - pdr". Usually this referred to the actual weight of the standard projectile (shot, shrapnel or HE), but, confusingly, this was not always the case.

Some were named after the weights of obsolete projectile types of the same calibre, or even obsolete types that were considered to have been functionally equivalent. Also, projectiles fired from the same gun, but of non-standard weight, took their name from the gun. Thus, conversion from "pounds" to an actual barrel diameter requires consulting a historical reference. A mixture of designations were in use for land artillery from the First World War (such as the 60 - pounder gun, 2.5 inch mountain gun, 4 inch gun, 4.5 inch howitzer) through to the end of World War II (5.5 inch medium gun, 25 - pounder gun-howitzer, 17 - pounder tank gun) but the majority of naval guns were by caliber. After World War II, guns were designated by calibre.

4 – Types

There are many different types of shells. The principal ones include:

4 – 1 – High - explosive

15 inch high - explosive howitzer shells. Circa 1917.

The most common shell type is high explosive, commonly referred to simply as HE. They have a strong steel case, a bursting charge, and a fuse. The fuse detonates the bursting charge which shatters the case and scatters hot, sharp case pieces (*fragments*, *splinters*) at high velocity. Most of the damage to soft targets such as unprotected personnel is caused by shell pieces rather than by the blast. The term "shrapnel" is sometimes used to describe the shell pieces, but shrapnel shells functioned very differently and are long obsolete. Depending on the type of fuse used the HE shell can be set to burst on the ground (percussion), in the air above the ground (time or proximity), or after penetrating a short distance into the ground (percussion with delay, either to transmit more ground shock to covered positions, or to reduce the spread of fragments).

Early high explosives used before and during World War I in HE shells were Lyddite (picric acid), PETN, TNT.

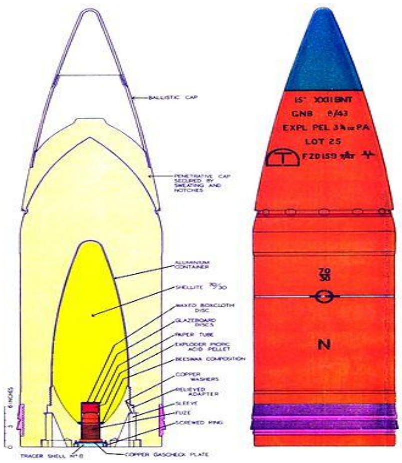
RDX and TNT mixtures are the standard chemicals used, notably "Composition B" (cyclotol). The introduction of 'insensitive munition' requirements, agreements and regulations in the 1990s caused modern western designs to use various types of plastic bonded explosives (PBX) based on RDX.

4 – 1 - 1 - Mine shell

The mine shell is a particular form of HE shell developed for use in small caliber weapons such as 20 mm to 30 mm cannon. Small HE shells of conventional design can contain only a limited amount of explosive. By using a thin - walled steel casing of high tensile strength, a larger explosive charge can be used. Most commonly the explosive charge also was a more expensive but higher - detonation - energy type.

The *mine shell* concept was invented by the Germans in the Second World War primarily for use in aircraft guns intended to be fired at opposing aircraft. Mine shells produced relatively little damage due to fragments, but a much more powerful blast. The aluminium structures and skins of Second World War aircraft were readily damaged by this greater level of blast.

4 – 2 – Armour - piercing



British APCBC Shell Mk XXII BNT (circa 1943) for BL 15 inch Mk I naval gun, showing base fuze

Naval and anti - tank shells have to withstand the extreme shock of punching through armour plate. Shells designed for this purpose sometimes have a greatly strengthened case with a small bursting charge, and some times are solid metal, i.e. shot. In either case, they almost always have a specially hardened and shaped nose to facilitate penetration. These are known as in armour-piercing (AP) projectiles.

A further refinement of such designs improves penetration by adding a softer metal cap to the penetrating nose giving armour-piercing, capped (APC) design. The softer cap damps the initial shock that would otherwise shatter the round. The best profile for the cap is not the most aerodynamic; this can be remedied by adding a further hollow cap of suitable shape: Armour - piercing, capped, ballistic cap (APCBC).

AP shells with a bursting charge were sometimes distinguished by appending the suffix "HE". At the beginning of the Second World War, solid shot AP projectiles were common. As the war progressed, ordnance design evolved so that APHE became the more common design approach for anti-tank shells of 75 mm caliber and larger, and more common in naval shell design as well. In modern ordnance, most full caliber AP shells are APHE designs.

4 – 2 – 1 – Armour – piercing , discarding - sabot

The armour - piercing concept calls for more penetration capability than the target's armour thickness. Generally, the penetration capability of an armor piercing round increases with the projectile's kinetic energy and also with concentration of that energy in a small area. Thus an efficient means of achieving increased penetrating power is increased velocity for the projectile. However, projectile impact against armour at higher velocity causes greater levels of shock. Materials have characteristic maximum levels of shock capacity, beyond which they may shatter, or otherwise disintegrate. At relatively high impact velocities, steel is no longer an adequate material for armor piercing rounds. Tungsten and tungsten alloys are suitable for use in even higher velocity armour piercing rounds, due to their very high shock tolerance and shatter resistance, and to their high melting and boiling temperatures. They also have very high density. Energy is concentrated by using a reduced-diameter tungsten shot, surrounded by a lightweight outer carrier, the *sabot* (a French word for a wooden shoe). This combination allows the firing of a smaller diameter (thus lower mass/aerodynamic resistance / penetration resistance) projectile with a larger area of expanding - propellant "push", thus a greater propelling force and resulting kinetic energy.

Once outside the barrel, the sabot is stripped off by a combination of centrifugal force and aerodynamic force, giving the shot low drag in flight. For a given caliber the use of APDS ammunition can effectively double the anti-tank performance of a gun.

4 – 2 – 2 – Armour - piercing, fin – stabilized , discarding - sabot

French "Arrow" armour - piercing round, a form of APFSDS

An Armour-Piercing, Fin - Stabilised, Discarding Sabot (APFSDS) projectile uses the sabot principle with fin (drag) stabilisation. A long, thin sub-projectile has increased sectional density and thus penetration potential. However, once a projectile has a length-to-diameter ratio greater than 10 (less for higher density projectiles) , spin stabilisation becomes ineffective. Instead, drag stabilisation is used, by means of fins attached to the base of the sub - projectile, making it look like a large metal arrow.

Large calibre APFSDS projectiles are usually fired from smooth - bore (unrifled) barrels, though they can be and often are fired from rifled guns. This is especially true when fired from small to medium calibre weapon systems. APFSDS projectiles are usually made from high-density metal alloys such as tungsten heavy alloys (WHA) or depleted uranium (DU); maraging steel was used for some early Soviet projectiles. DU alloys are cheaper and have better penetration than others as they are denser and self - sharpening. Uranium is also pyrophoric and may become opportunistic incendiaries especially as the round shears past the armor exposing non-oxidized metal, but both the metal's fragments and dust contaminate the battlefield with toxic hazards. The less toxic WHAs are preferred in most countries except the USA, UK, and Russia.

4 – 2 – 3 – Armour – piercing , composite rigid

Armour-piercing, composite rigid (**APCR**) is a British term, the US term for the design is high velocity armor piercing (**HVAP**) and German, *Hartkernmunition*. The APCR projectile is a core of a high-density hard material such as tungsten carbide surrounded by a full - bore shell of a lighter material (e.g., an aluminium alloy). Most APCR projectiles are shaped like the standard APCBC shot (although some of the German Pzgr. 40 and some Soviet designs resemble a stubby arrow), but the projectile is lighter: up to half the weight of a standard AP shot of the same calibre. The lighter weight allows a higher velocity. The kinetic energy of the shot is concentrated in the core and hence on a smaller impact area, improving the penetration of the target armour. To prevent shattering on impact, a shock-buffering cap is placed between the core and the outer ballistic shell as with APC rounds. However, because the shot is lighter but still the same overall size it has poorer ballistic qualities, and loses velocity and accuracy at longer ranges. The APCR was superseded by the APDS which dispensed with the outer light alloy shell once the shot had left the barrel.

The concept of a heavy, small-diameter penetrator encased in light metal would be later employed in small - arms armor - piercing incendiary and HEIAP rounds.

4 – 2 – 4 - Armour – piercing , composite non - rigid

Armour-piercing, composite non - rigid (**APCNR**) , the British term, but the more common terms are **squeeze - bore** and **tapered bore** and are based on the same projectile design as the APCR - a high density core within a shell of soft iron or other alloy, but it is fired by a gun with a tapered barrel, either a taper in a fixed barrel or a final added section. The projectile is initially full - bore, but the outer shell is deformed as it passes through the taper. Flanges or studs are swaged down in the tapered section, so that as it leaves the muzzle the projectile has a smaller overall cross-section.

This gives it better flight characteristics with a higher sectional density and the projectile retains velocity better at longer ranges than an undeformed shell of the same weight. As with the APCR the kinetic energy of the round is concentrated at the core on impact. The initial velocity of the round is greatly increased by the decrease of barrel cross - sectional area toward the muzzle, resulting in a commensurate increase in velocity of the expanding propellant gases. Although a full range of shells and shot could be used, changing the adaptor in the heat of battle is highly impractical. The APCNR was superseded by the APDS design which was compatible with non - tapered barrels.

4 – 3 - High – explosive , anti - tank

HEAT shells are a type of shaped charge used to defeat armoured vehicles. They are extremely efficient at defeating plain steel armour but less so against later composite and reactive armour. The effectiveness of the shell is independent of its velocity, and hence the range: it is as effective at 1000 metres as at 100 metres. The speed can even be zero in the case where a soldier simply places a magnetic mine onto a tank's armor plate. A HEAT charge is most effective when detonated at a certain, optimal, distance in front of the target and HEAT shells are usually distinguished by a long, thin nose probe sticking out in front of the rest of the shell and detonating it at the correct distance, e.g., PIAT bomb. HEAT shells are less effective if spun (i.e., fired from a rifled gun).

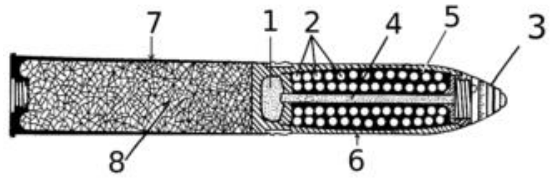
4 – 4 - High-explosive , squash - head or high - explosive plastic

High - explosive, squash - head (**HESH**) is another anti-tank shell based on the use of explosive. A thin-walled shell case contains a large charge of a plastic explosive. On impact the explosive flattens, without detonating, against the face of the armour, and is then detonated by a fuze in the base of the shell. Energy is transferred through the armour plate: when the compressive shock reflects off the air/metal interface on the inner face of the armour, it is transformed into a tension wave which spalls a "scab" of metal off into the tank damaging the equipment and crew without actually penetrating the armour.

HESH is completely defeated by spaced armour, so long as the plates are individually able to withstand the explosion. It is still considered useful as not all vehicles are equipped with spaced armour, and it is also the most effective munition for demolishing brick and concrete. HESH shells, unlike HEAT shells, are best fired from rifled guns.

Another variant is the high - explosive plastic (**HEP**).

4 – 5 - Shrapnel shells



Typical World War I shrapnel round :
1 shell bursting charge
2 bullets
3 nose fuze
4 central ignition tube
5 resin matrix
6 thin steel shell wall
7 cartridge case
8 propellant

Shrapnel shells are an anti-personnel munition which delivered large numbers of bullets at ranges far greater than rifles or machine guns could attain - up to 6,500 yards by 1914. A typical shrapnel shell as used in World War I was streamlined, 75 mm in diameter and contained approximately 300 lead - antimony balls (bullets), each around 1 / 2 inch in diameter. Shrapnel used the principle that the bullets encountered much less air resistance if they travelled most of their journey packed together in a single streamlined shell than they would if they travelled individually, and could hence attain a far greater range.

The gunner set the shell's time fuze so that it was timed to burst as it was angling down towards the ground just before it reached its target (ideally about 150 yards before, and 60 – 100 feet above the ground). The fuze then ignited a small "bursting charge" in the base of the shell which fired the balls forward out of the front of the shell case, adding 200 – 250 ft / second to the existing velocity of 750 – 1200 ft / second. The shell body dropped to the ground mostly intact and the bullets continued in an expanding cone shape before striking the ground over an area approximately 250 yards × 30 yards in the case of the US 3 inch shell . The effect was of a large shotgun blast just in front of and above the target, and was deadly against troops in the open. A trained gun team could fire 20 such shells per minute, with a total of 6,000 balls, which compared very favourably with rifles and machine - guns.

However, shrapnel's relatively flat trajectory (it depended mainly on the shell's velocity for its lethality, and was only lethal in a forward direction) meant that it could not strike trained troops who avoided open spaces and instead used dead ground (dips), shelters, trenches, buildings, and trees for cover. It was of no use in destroying buildings or shelters. Hence it was replaced during World War I by the high-explosive shell which exploded its fragments in all directions and could be fired by high-angle weapons such as howitzers, hence far more difficult to avoid.

4 – 6 - Cluster shells

Cluster shells are a type of carrier shell or cargo munition. Like cluster bombs, an artillery shell may be used to scatter smaller submunitions, including anti-personnel grenades, anti-tank top-attack munitions, and landmines. These are generally far more lethal against both armor and infantry than simple high - explosive shells, since the multiple munitions create a larger kill zone and increase the chance of achieving the direct hit necessary to kill armor. Most modern armies make significant use of cluster munitions in their artillery batteries.

However, in operational use submunitions have demonstrated a far higher malfunction rate than previously claimed, including those that have self-destruct mechanisms. This problem, the 'dirty battlefield", led to the Ottawa Treaty.

Artillery - scattered mines allow for the quick deployment of minefields into the path of the enemy without placing engineering units at risk, but artillery delivery may lead to an irregular and unpredictable minefield with more unexploded ordnance than if mines were individually placed.

Signatories of the Ottawa Treaty have renounced the use of cluster munitions of all types where the carrier contains more than ten submunitions.

4 – 7 - Chemical

155 mm artillery shells containing "HD" agent at Pueblo chemical weapons storage facility . Note the colour - coding scheme on each shell.

Chemical shells contain just a small explosive charge to burst the shell, and a larger quantity of a chemical agent such as a poison gas. Signatories of the Chemical Weapons Convention have renounced such shells.

4 – 8 – Non - lethal shells

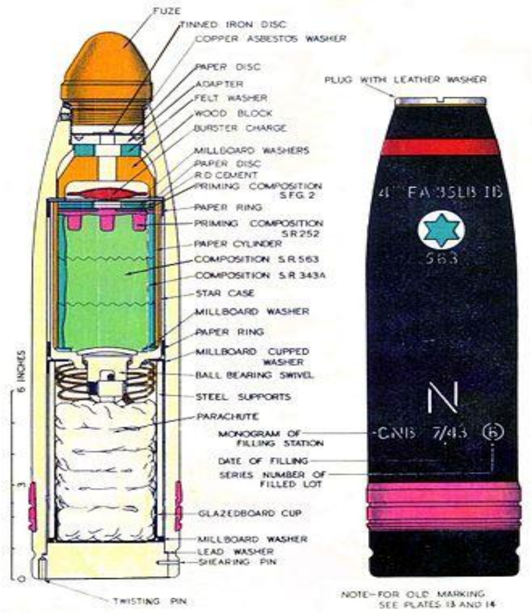
Not all shells are designed to kill or destroy. The following types are designed to achieve particular non - lethal effects. They are not completely harmless: smoke and illumination shells can accidentally start fires, and impact by the discarded carrier of all three types can wound or kill personnel, or cause minor damage to property.

4 – 8 – 1 – Smoke

The smoke shell is designed to create a smoke screen. The main types are bursting (those filled with white phosphorus WP and a small HE bursting charge are best known) and base ejection (delivering three or four smoke canisters, or material impregnated with white phosphorus). Base ejection shells are a type of carrier shell or cargo munition.

Base ejection smoke is usually white, however, coloured smoke has been used for marking purposes. The original canisters were non-burning, being filled with a compound that created smoke when it reacted with atmospheric moisture, modern ones use red phosphorus because of its multi-spectral properties. However, other compounds have been used, in World War II Germany used oleum (fuming sulphuric acid) and pumice.

4 – 8 – 2 – Illumination



British World War II 4-inch naval illuminating shell, showing time fuze (orange, top), illuminating compound (green) and parachute (white, bottom)

Modern illuminating shells are a type of carrier shell or cargo munition. Those used in World War I were shrapnel pattern shells ejecting small burning 'pots'.

A modern illumination shell has a time fuze which ejects a flare 'package' through the base of the carrier shell at a standard height above ground (typically about 600 metres), from where it slowly falls beneath a non-flammable parachute, illuminating the area below. The ejection process also initiates a pyrotechnic flare emitting white or 'black' infrared light.

Illumination rounds fired from a M777 howitzer

Typically illumination flares burn for about 60 seconds. These are also known as *starshell* or *star shell*. Infrared illumination is a more recent development used to enhance the performance of night vision devices. Both white and black light illuminating shells may be used to provide continuous illumination over an area for a period of time, and may use several dispersed aimpoints to illuminate a large area. Alternatively firing single illuminating shells may be coordinated with the adjustment of HE shell fire onto a target.

Coloured flare shells have also been used for target marking and other signaling purposes.

4 – 8 – 3 – Carrier

The carrier shell is simply a hollow carrier equipped with a fuze which ejects the contents at a calculated time. They are often filled with propaganda leaflets (see external links), but can be filled with anything that meets the weight restrictions and is able to withstand the shock of firing. Famously, on Christmas Day 1899 during the siege of Ladysmith, the Boers fired into Ladysmith a carrier shell without fuze, which contained a Christmas pudding, two Union Flags and the message "compliments of the season". The shell is still kept in the museum at Ladysmith.

4 – 8 – 4 - Fire works

Aerial firework bursts are created by shells. In the United States, consumer fire work shells may not exceed 1.75 inches in diameter.

4 – 8 – 5 - Proof shot

A proof shot is not used in combat but to confirm that a new gun barrel can withstand operational stresses. The proof shot is heavier than a normal shot or shell, and an oversize propelling charge is used, subjecting the barrel to greater than normal stress. The proof shot is inert (no explosive or functioning filling) and is often a solid unit, although water, sand or iron powder filled versions may be used for testing the gun mounting. Although the proof shot resembles a functioning shell (of whatever sort) so that it behaves as a real shell in the barrel, it is not aerodynamic as its job is over once it has left the muzzle of the gun. Consequently it travels a much shorter distance and is usually stopped by an earth bank for safety measures.

The gun, operated remotely for safety in case it fails, fires the proof shot, and is then inspected for damage. If the barrel passes the examination "proof marks" are added to the barrel. The gun can be expected to handle normal ammunition, which subjects it to less stress than the proof shot, without being damaged.

5 - Unexploded shells

The fuze of a shell has to keep the shell safe from accidental functioning during storage, due to (possibly) rough handling, fire, etc. It also has to survive the violent launch through the barrel, then reliably function at the appropriate moment. To do this it has a number of arming mechanisms which are successively enabled under the influence of the firing sequence.

Some times, one or more of these arming mechanisms fail, resulting in a projectile that is unable to detonate. More worrying (and potentially far more hazardous) are fully armed shells on which the fuze fails to initiate the HE firing. This may be due to a shallow trajectory of fire, low-velocity firing or soft impact conditions. Whatever the reason for failure, such a shell is called a *blind* or *unexploded ordnance (UXO)* (the older term, "dud", is discouraged because it implies that the shell *cannot* detonate.) Blind shells often litter old battlefields; depending on the impact velocity, they may be buried some distance into the earth, all the while remaining potentially hazardous. For example, antitank ammunition with a piezoelectric fuze can be detonated by relatively light impact to the piezoelectric element, and others, depending on the type of fuze used, can be detonated by even a small movement. The battlefields of the First World War still claim casualties today from leftover munitions. Modern electrical and mechanical fuzes are highly reliable: if they do not arm correctly, they keep the initiation train out of line or (if electrical in nature) discharge any stored electrical energy.

6 - Guided shells

Guided or "smart" ammunition have been developed in recent years, but have yet to supplant unguided munitions in all applications.

M982 Excalibur. A GPS guided artillery shell.

7 - Range enhancing technologies

Extended range shells are sometimes used. These special shell designs may be Rocket Assisted Projectiles (**RAP**) or base bleed to increase range. The first has a small rocket motor built into its base to provide additional thrust. The second has a pyrotechnic device in its base that bleeds gas to fill the partial vacuum created behind the shell and hence reduce base - drag. These shell designs usually have reduced HE filling to remain within the permitted weight for the projectile, and hence less lethality.

Asphyxia

Contents

1 - Introduction

Asphyxia or **asphyxiation** (from Ancient Greek α- "with out" and *sphyxis*, "heart beat") is a condition of severely deficient supply of oxygen to the body that arises from abnormal breathing. An example of asphyxia is choking. Asphyxia causes generalized hypoxia, which affects primarily the tissues and organs. There are many circumstances that can induce asphyxia, all of which are characterized by an inability of an individual to acquire sufficient oxygen through breathing for an extended period of time. Asphyxia can cause coma or death.

2 – Circumstances

Situations that can cause asphyxia include but are not limited to: the constriction or obstruction of airways, such as from asthma, laryngospasm, or simple blockage from the presence of foreign materials; from being in environments where oxygen is not readily accessible: such as underwater, in a low oxygen atmosphere, or in a vacuum; environments where sufficiently oxygenated air is present, but cannot be adequately breathed because of air contamination such as excessive smoke.

Other causes of oxygen deficiency include but are not limited to:

Carbon monoxide inhalation, such as from a car exhaust: carbon monoxide has a higher affinity than oxygen to the hemoglobin in the blood's red blood corpuscles, bonding with it tenaciously, and, in the process, displacing oxygen and preventing the blood from transporting oxygen around the body

Contact with certain chemicals, including pulmonary agents (such as phosgene) and blood agents (such as hydrogen cyanide)

Self - induced hypocapnia by hyperventilation, as in shallow water or deep water blackout and the choking game

A seizure which stops breathing activity
Sleep apnea
Drug over dose

Ondine's curse, central alveolar hypoventilation syndrome, or primary alveolar hypoventilation, a disorder of the autonomic nervous system in which a patient must consciously breathe; although it is often said that persons with this disease will die if they fall asleep, this is not usually the case

Respiratory diseases
Acute respiratory distress syndrome.
Exposure to extreme low pressure or vacuum to the pattern (see space exposure)
Hanging, specifically suspension or short drop hanging.
Strangling
Drowning
Inert gas asphyxiation

3 – Smothering

Smothering is the mechanical obstruction of the flow of air from the environment into the mouth and/or nostrils, for instance, by covering the mouth and nose with a hand, pillow, or a plastic bag.[1] Smothering can be either partial or complete, where partial indicates that the person being smothered is able to inhale some air, although less than required. In a normal situation, smothering requires at least partial obstruction of both the nasal cavities and the mouth to lead to asphyxia. Smothering with the hands or chest is used in some combat sports to distract the opponent, and create openings for transitions, as the opponent is forced to react to the smothering.

In some cases, when performing certain routines, smothering is combined with simultaneous compressive asphyxia. One example is **overlay**, in which an adult accidentally rolls over onto an infant during co-sleeping, an accident that often goes unnoticed and is mistakenly thought to be sudden infant death syndrome.[1] Other accidents involving a similar mechanism are cave-ins or when an individual is buried in sand or grain.

In homicidal cases, the term **burking** is often ascribed to a killing method that involves simultaneous smothering and compression of the torso.[2] The term "burking" comes from the method William Burke and William Hare used to kill their victims during the West Port murders. They killed the usually intoxicated victims by sitting on their chests and suffocating them by putting a hand over their nose and mouth, while using the other hand to push the victim's jaw up. The corpses had no visible injuries, and were supplied to medical schools for money.[*citation needed*]

4 - Compressive asphyxia

The knee - on - belly position compresses the chest, making it difficult for the person on the bottom to breathe.

Compressive asphyxia (also called **chest compression**) is mechanically limiting expansion of the lungs by compressing the torso, hence interfering with breathing. Compressive asphyxia occurs when the chest or abdomen is compressed posteriorly . In accidents, the term traumatic asphyxia or **crush asphyxia** usually refers to compressive asphyxia resulting from being crushed or pinned under a large weight or force. An example of traumatic asphyxia includes cases where an individual has been using a car-jack to repair a car from below, and is crushed under the weight of the vehicle.[2] Pythons, anacondas, and other constrictor snakes kill through compressive asphyxia. In cases of co-sleeping ("overlay"), the weight of an adult or large child may compress an infant's chest, preventing proper expansion of the chest. Risk factors include large or obese adults, parental fatigue or impairment (sedation by drugs or alcohol) of the co - sleeping adult and a small shared sleeping space (for example , both adult and infant sharing a couch) .

In fatal crowd disasters, compressive asphyxia from being crushed against the crowd causes the large part of the deaths, rather than blunt trauma from trampling. This is what occurred at the Ibrox disaster in 1971, where 66 Rangers fans died; the 1979 The Who concert disaster where 11 died; the Luzhniki disaster in 1982, when 66 FC Spartak Moscow fans died; and at the Hillsborough disaster in 1989, when 96 Liverpool fans were crushed to death in an overcrowded terrace. In confined spaces, people push and lean against each other; evidence from bent steel railings in several fatal crowd accidents have shown horizontal forces over 4500 N (equivalent to a weight of approximately 450 kg). In cases where people have stacked up on each other forming a human pile, estimations have been made of around 380 kg of compressive weight in the lowest layer.

"Positional" or "restraint" asphyxia is when a person is restrained and left alone prone, such as in a police vehicle, and is unable to reposition himself or herself in order to breathe. The death can be in the vehicle, or following loss of consciousness to be followed by death while in a coma, having presented with anoxic brain damage. The asphyxia can be caused by facial compression, neck compression, or chest compression. This mostly occurs mostly during restraint and handcuffing situations by law enforcement, including psychiatric incidents. The weight of the restraint(s) doing the compression may contribute to what is attributed to positional asphyxia. Therefore, passive deaths following custody restraint that are presumed to be the result of positional asphyxia may actually be examples of asphyxia occurring during the restraint process.

Chest compression is also featured in various grappling combat sports, where it is sometimes called **wringing**. Such techniques are used either to tire the opponent or as complementary or distractive moves in combination with pinning holds , or sometimes even as submission holds. Examples of chest compression include the knee-on-stomach position; or techniques such as **leg scissors** (also referred to as **body scissors** and in budō referred to as *do - jime* ; "trunk strangle" or "body triangle") where a participant wraps his or her legs around the opponent's midsection and squeezes them together.

Pressing is a form of torture or execution that works through asphyxia e.g.Burking.

5 - Perinatal asphyxia

Perinatal asphyxia is the medical condition resulting from deprivation of oxygen (hypoxia) to a newborn infant long enough to cause apparent harm. It results most commonly from a drop in maternal blood pressure or interference during delivery with blood flow to the infant's brain. This can occur as a result of inadequate circulation or perfusion, impaired respiratory effort, or inadequate ventilation .

Blood Agent

Chemical Agents
Lethal agents
Blood[hide]
Cyanogen chloride (CK)
Hydrogen cyanide (AC)
Blister
Nerve
G-agents
line-height:1.275em
Tabun (GA)
Sarin (GB)
Soman (GD)
Cyclosarin (GF)
GV
V-agents
line-height:1.275em
EA-3148
VE
VG
VM
VR
VX
Novichok agents
Nettle
Pulmonary[show]
Chlorine
Chloropicrin (PS)
Phosgene (CG)
Diphosgene (DP)
Disulfur decafluoride

Incapacitating agents
Agent 15 (BZ)
Dimethylheptylpyran (DMHP)
EA-3167
Kolokol-1
PAVA spray
Sleeping gas
Riot - control (RCAs)
Pepper spray (OC)
CS
CN (mace)
CR

Contents

1 - Introduction

A **blood agent** is a toxic chemical agent that affects the body by being absorbed into the blood.[1] Blood agents are fast-acting, potentially lethal poisons that typically manifest at room temperature as volatile colorless gases with a faint odor.[1] They are either cyanide- or arsenic-based.

2 – Exposure

Blood agents work through inhalation or ingestion.[2] As chemical weapons, blood agents are typically disseminated as aerosols and take effect through inhalation. Due to their volatility, they are more toxic in confined areas than in open areas.

Cyanide compounds occur in small amounts in the natural environment and in cigarette smoke. They are also used in several industrial processes and as pesticides. Cyanides are released when synthetic fabrics or polyurethane burn, and may thus contribute to fire-related deaths . Arsine gas, formed when arsenic encounters an acid, is used as a pesticide and in the semiconductor industry; most exposures to it occur accidentally in the workplace.

3 – Symptoms

The symptoms of blood agent poisoning depend on concentration and duration.

Cyanide-based blood agents irritate the eyes and the respiratory tract, while arsine is nonirritating . Hydrogen cyanide has a faint, bitter, almond odor that only about half of all people can smell. Arsine has a very faint garlic odor detectable only at greater than fatal concentrations.

Exposure to small amounts of cyanide has no effect . Higher concentrations cause dizziness, weakness and nausea, which cease with the exposure, but long-time exposure can cause mild symptoms followed by permanent brain damage and muscle paralysis . Moderate exposure causes stronger and longer - lasting symptoms, including headache , that can be followed by convulsions and coma. Stronger or longer exposure will also lead to convulsions and coma. Very strong exposure causes severe toxic effects within seconds, and rapid death.

The blood of people killed by blood agents is bright red, because the agents inhibit the use of the oxygen in it by the body's cells.[2] Cyanide poisoning can be detected by the presence of thiocyanate or cyanide in the blood, a smell of bitter almonds, or respiratory tract inflammations and congestions in the case of cyanogen chloride poisoning. There is no specific test for arsine poisoning, but it may leave a garlic smell on the victim's breath.

4 – Effects

At sufficient concentrations, blood agents can quickly saturate the blood and cause death in a matter of minutes or seconds . They cause powerful gasping for breath, violent convulsions and a painful death that can take several minutes . The immediate cause of death is usually respiratory failure.

Blood agents work at the cellular level by preventing the exchange of oxygen and carbon dioxide between the blood and the body's cells. This causes the cells to suffocate from lack of oxygen . Cyanide-based agents do so by interrupting the electron transport chain in the inner membranes of mitochondria. Arsine damages the red blood cells which deliver oxygen throughout the body.

5 - Detection and countermeasures

Chemical detection methods, in the form of kits or testing strips, exist for hydrogen cyanide. Ordinary clothing provides some protection, but proper protective clothing and masks are recommended. Mask filters containing only charcoal are ineffective, and effective filters are quickly saturated.

Due to their high volatility, cyanide agents generally need no decontamination. In enclosed areas, fire extinguishers spraying sodium carbonate can decontaminate hydrogen cyanide, but the resulting metal salts remain poisonous on contact . Liquid hydrogen cyanide can be flushed with water.

Cyanide poisoning can be treated with antidotes; see the corresponding article.

6 - List of blood agents

The information in the following table, which lists blood agents of military significance , is taken from Ledgard.[5] The values given are on a scale from 1 to 10.

Agent	Description	Melting / boiling point	Effectiveness as blood agent	Persistence, open area	Persistence, enclosed area	Field stability	Storage stability	Toxicity as blood agent
Hydrogen cyanide	Colorless gas or liquid, almond odor, burns with a bluish flame.	-13 / 26 °C	10	2	9	10	8	10
Cyanogen	Colorless gas, almond odor, burns with a pinkish flame having a blue border.	-28 / -21 °C	9	2	9	8	7	9
Cyanogen chloride	Colorless gas or liquid, pungent and biting odor, soluble in water and alcohol.	-6 / 14 °C	8	3	9	9	9	8
Cyanogen bromide	Colorless needle-shaped or cubic crystals, tending to	52 / 62 °C	9	5	8	5	6	8

	volatize on standing, hence of limited usefulness as a weapon.							
Arsine	Colorless gas, garlic-like odor, slightly soluble in water.	-117 / -62 °C	9	3	8	5	9	9
Vinyl arsine	Colorless liquid, irritating and bitter odor, slightly soluble in water, also acts as a blister agent.	124 °C (boiling)	7	7	9	8	9	6
Phosgene	Colorless gas and slightly yellow liquid, moldy hay odor, slightly soluble in water and soluble in most solvents, also acts as a choking agent.	-118 / 8	10	6	9	5	8	6

Sodium cyanide and potassium cyanide, colorless crystalline compounds similar in appearance to sugar, also act as blood agents.[2] Carbon monoxide could technically be called a blood agent because it binds with oxygen - carrying hemoglobin in the blood (see carbon monoxide poisoning), but its high volatility makes it impractical as a chemical warfare agent.

Aspirating Smoke Detector

Contents

1 - Introduction

An **aspirating smoke detector** (**ASD**), consists of a central detection unit which draws air through a network of pipes to detect smoke.[1] The sampling chamber is based on a nephelometer that detects the presence of smoke particles suspended in air by detecting the light scattered by them in the chamber.

In most cases aspirating smoke detectors require a fan unit to draw in a sample of air from the protected area through its network of pipes, such as is the case for Wagner, Safe Fire Detection's ProSeries and Xtralis ASD systems.

Aspirating smoke detectors can detect smoke before it is visible to the human eye.

2 – History

In 1970 the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) used a nephelometer to carry out research into forest fires. Subsequently, the Australian Postmaster-General's Department (later becoming Australia Post and Telstra) engaged the CSIRO to investigate technologies that could prevent service interruption due to fire. After selecting a sample site to carry out research, the CSIRO suggested that the nephelometer should be used as the benchmark for the APO fire tests. This was installed to monitor smoke levels within the return-air ducts of the mechanical ventilation system, utilising a chart-recorder output display.

At the conclusion of several weeks of testing, it was discovered that there no commercially available fire detection technology suitable for preventing damage to telephone equipment. One technology that did show great promise however was the nephelometer itself.

In 1979, Xtralis, then IEI Pty Ltd., produced and sold an air sampling device they called VESDA (Very Early Smoke Detection Apparatus). The company redesigned the detector in 1982 to provide the reliability, features, size and reduced cost for export markets. There are more than 1.5 million fires annually in the USA, according to the Society for Fire Protection Engineers. Fires result in an estimated $10 billion in property loss each year, the organization reports. ASD systems have gained popularity due to their ability to sense smoke long before a catastrophic incident.

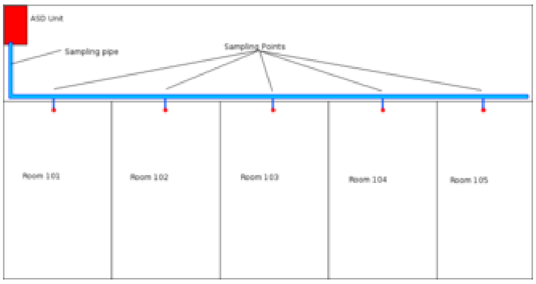
3 – Design

ASD design corrects shortcomings of conventional smoke detectors by using sampling pipe with multiple holes. The air samples are captured and filtered, removing any contaminants or dust to avoid false alarms and then processed by a centralized, highly sensitive laser detection unit. If smoke is detected, the systems alarm is triggered, and signals then are processed through centralized monitoring stations within a few seconds.[6]

Unlike passive smoke detection systems including spot detectors, ASD systems actively draw smoke to the detector through bore holes within a piping system that runs throughout the protected area. Furthermore, ASD systems incorporate integrity monitoring to ensure an alert is raised at any time the ASD’s ability to detect smoke is compromised. This is not the case with passive devices that are generally only electrically monitored with no ability to determine if smoke can actually reach the detection element.

ASD systems incorporate more than one level of alarm, generally configurable. This allows an ASD system to provide very early warning of an event, prompting investigation at the earliest smouldering stage of a fire when it is easily addressed. Other alarm levels may be configured to provide fire alarm inputs to fire systems as well as releasing suppression systems. ASD alarm sensitivities are configurable and can be programmed to levels ranging from thousands of times more sensitive than a conventional detector, to much less sensitive. The detectors work best in non-volatile environments. They can also be used in computer cabinets to alert users to the overheating of computer cables or individual computer components.

4 - Installation and placement



An example of how a simple ASD unit with a single pipe could cover a five room area

ASDs are suitable for environments where a highly sensitive rapid smoke detection capability is required. This makes them suitable in clean rooms; areas which contain goods easily damaged by fire, such as tobacco, electronic rooms and highly flammable liquid and gases. Often, normal point detectors will recognise the danger too late, as smoke often does not reach the ceiling quick enough for a fire to be detected in a timely fashion.

As they can be easily hidden, pipe networks are suitable in environments where point detectors can be considered aesthetically displeasing, such as offices, apartments and hotel rooms. This factor also makes them suitable in locations where point detectors can be easily tampered with, such as in correctional facilities.

Despite their high sensitivity ASDs can be used in dusty or dirty environments as long as correct design, installation and maintenance processes are followed. Most ASD products can accommodate a broad range of environments and applications – from both confined and open spaces to the cleanest or dirtiest environment, including telecomm, control rooms, waste treatment, mining and more.

Astrolite

Contents

1 - Introduction

Astrolite is the trade name of a family of explosives, invented by chemist Gerald Hurst in the 1960s during his employment with the Atlas Powder Company. The Astrolite family consists of two compounds, Astrolite G and Astrolite A. Both are two - part liquid - state high explosive mixtures, composed of ammonium nitrate oxidizer and hydrazine rocket fuel. They still find some use in commercial and civil blasting applications, but have mostly been superseded by cheaper and safer compounds, largely due to the expense and exceptionally poisonous nature of the hydrazine component.

2 - Astrolite G

Astrolite G , the most common type of Astrolite, is a mixture of ammonium nitrate and hydrazine at a ratio of 2:1, measured in weight, forming a clear, viscous liquid approximately the consistency of motor oil. It is a relatively stable (secondary) high explosive compound, requiring a blasting cap to detonate. It has a detonation velocity of approximately 8,600 m/s. It has been widely referred to as the "world's most powerful non-nuclear explosive", caused largely by a comparison of Astrolite G's detonation velocity to that of first and second-generation high explosives such as nitroglycerine and TNT. Current-generation high explosive compounds such as PETN and RDX can feature comparable detonation velocities and brisance to Astrolite G.

3 - Astrolite A

Astrolite A, a secondary (and less common) type of Astrolite, is synthesized by the addition of finely powdered aluminium to the Astrolite G mixture. Though it has a lower detonation velocity (approximately 7,600 m/s) than Astrolite G, the addition of the aluminium increases both its density and brisance, moderately increasing its overall effectiveness.

4 – Persistency

A notable characteristic of the Astrolite family is its remarkable degree of persistency for a liquid explosive compound. Due to its low volatility, it can be dispersed in an area, be absorbed by the soil, and still retain its full explosive characteristics for a period of approximately 4 days. This has shown to be true even when rainwater had also been absorbed by the soil.

Asymmetric War Fare

Contents

1 - Introduction

Asymmetric warfare is war between belligerents whose relative military power differs significantly, or whose strategy or tactics differ significantly.

Asymmetric warfare can describe a conflict in which the resources of two belligerents differ in essence and in the struggle, interact and attempt to exploit each other's characteristic weaknesses. Such struggles often involve strategies and tactics of unconventional warfare, the weaker combatants attempting to use strategy to offset deficiencies in quantity or quality . Such strategies may not necessarily be militarized. This is in contrast to *symmetric warfare*, where two powers have similar military power and resources and rely on tactics that are similar overall, differing only in details and execution.

The term is frequently used to describe what is also called "guerrilla warfare", "insurgency", "terrorism", "counterinsurgency", and "counterterrorism", essentially violent conflict between a formal military and an informal, less equipped and supported, undermanned but resilient opponent.

2 -Definition and differences[edit]

The popularity of the term dates from Andrew J. R. Mack's 1975 article "Why Big Nations Lose Small Wars" in *World Politics*, in which "asymmetric" referred simply to a significant disparity in power between opposing actors in a conflict. "Power," in this sense, is broadly understood to mean material power, such as a large army, sophisticated weapons, an advanced economy, and so on. Mack's analysis was largely ignored in its day, but the end of the Cold War sparked renewed interest among academics. By the late 1990s, new research building on Mack's insights was beginning to mature, and, after 2004, the U.S. military began once again to seriously consider the problems associated with asymmetric warfare .

Discussion since 2004 has been complicated by the tendency of academic and military communities to use the term in different ways, and by its close association with guerrilla warfare, insurgency, terrorism, counterinsurgency, and counterterrorism. Military authors tend to use the term "asymmetric" to refer to the indirect nature of the strategies many weak actors adopt, or even to the nature of the adversary itself (e.g., "asymmetric adversaries can be expected to ...") rather than to the correlation of forces .

Academic authors tend to focus more on explaining the puzzle of weak actor victory in war: if "power," conventionally understood, conduces to victory in war, then how is the victory of the "weak" over the "strong" explained? Key explanations include :

(1) strategic interaction;
(2) willingness of the weak to suffer more or bear higher costs;
(3) external support of weak actors;
(4) reluctance to escalate violence on the part of strong actors;
(5) internal group dynamics and
(6) inflated strong actor war aims. Asymmetric conflicts include both interstate and civil wars, and over the past two hundred years have generally been won by strong actors. Since 1950, however, weak actors have won a majority of all asymmetric conflicts.

3 - Strategic basis

In most conventional warfare, the belligerents deploy forces of a similar type and the outcome can be predicted by the quantity of the opposing forces or by their quality, for example better command and control of their forces (c2). There are times where this is not true because the composition or strategy of the forces makes it impossible for either side to close in battle with the other. An example of this is the standoff between the continental land forces of the French army and the maritime forces of the United Kingdom's Royal Navy during the French Revolutionary and Napoleonic Wars. In the words of Admiral Jervis during the campaigns of 1801, "I do not say, my Lords, that the French will not come. I say only they will not come by sea",[5] and a confrontation that Napoleon Bonaparte described as that between the elephant and the whale.

4 - Tactical basis

The tactical success of asymmetric warfare is dependent on at least some of the following assumptions:

One side can have a technological advantage which outweighs the numerical advantage of the enemy; the decisive English longbow at the Battle of Crécy is an example.

Technological inferiority usually is cancelled by more vulnerable infrastructure which can be targeted with devastating results. Destruction of multiple electric lines, roads or water supply systems in highly populated areas could have devastating effects on economy and morale, while the weaker side may not have these structures at all .

Training and tactics as well as technology can prove decisive and allow a smaller force to overcome a much larger one. For example, for several centuries the Greek hoplite's (heavy infantry) use of phalanx made them far superior to their enemies. The Battle of Thermopylae, which also involved good use of terrain, is a well-known example.

If the inferior power is in a position of self - defense; i.e., under attack or occupation, it *may* be possible to use unconventional tactics, such as hit-and-run and selective battles in which the superior power is weaker, as an effective means of harassment without violating the laws of war. Perhaps the classical historical examples of this doctrine may be found in the American Revolutionary War, movements in World War II, such as the French Resistance and Soviet and Yugoslav partisans. Against democratic aggressor nations, this strategy can be used to play on the electorate's patience with the conflict (as in the Vietnam War, and others since) provoking protests, and consequent disputes among elected legislators .

If the inferior power is in an aggressive position, however, and/or turns to tactics prohibited by the laws of war (*jus in bello*), its success depends on the superior power's refraining from like tactics. For example, the law of land warfare prohibits the use of a flag of truce or clearly marked medical vehicles as cover for an attack or ambush, but an asymmetric combatant using this prohibited tactic to its advantage depends on the superior power's obedience to the corresponding law. Similarly, laws of warfare prohibit combatants from using civilian settlements, populations or facilities as military bases, but when an inferior power uses this tactic, it depends on the premise that the superior power will respect the law that the other is violating, and will not attack that civilian target, or if they do the propaganda advantage will outweigh the material loss. As seen in most conflicts of the 20th and 21st centuries, this is highly unlikely as the propaganda advantage has always outweighed adherence to international law, especially by dominating sides of any conflict .

5 - Use of terrain

Terrain can be used as a force multiplier by the smaller force and as a force inhibitor against the larger force. Such terrain is called **difficult terrain**.

The contour of the land is an aid to the army; sizing up opponents to determine victory, assessing dangers and distance. "Those who do battle without knowing these will lose." — Sun Tzu, *The Art of War*

The guerrillas must move amongst the people as a fish swims in the sea. — Mao Zedong.

A good example of this type of strategy is the Battle of Thermopylae, where the narrow terrain of a defile was used to funnel the Persian forces, who were numerically superior, to a point where they could not use their size as an advantage.

For a detailed description of the advantages for the weaker force in the use of built-up areas when engaging in asymmetric warfare, see the article on urban warfare.

6 - War by proxy

Where asymmetric warfare is carried out (generally covertly) by allegedly non-governmental actors who are connected to or sympathetic to a particular nation's (the "state actor's") interest, it may be deemed *war by proxy*. This is typically done to give *deniability* to the state actor. The deniability can be important to keep the state actor from being tainted by the actions, to allow the state actor to negotiate in apparent good faith by claiming they are not responsible for the actions of parties who are merely sympathizers, or to avoid being accused of belligerent actions or war crimes. If proof emerges of the true extent of the state actor's involvement, this strategy can backfire; for example see Iran - contra and Philip Agee.

7 - Asymmetric warfare and terrorism

There are two different view points on the relationship between asymmetric warfare and terrorism. In the modern context, asymmetric warfare is increasingly considered a component of fourth generation warfare. When practiced outside the laws of war, it is often defined as terrorism, though rarely by its practitioners or their supporters.[7] For example, terrorists often use women and children as human shields,[8] which practise is not considered either moral or part of traditional symmetrical warfare.

The other view is that asymmetric warfare does not coincide with terrorism. The use of terror by the much lesser Mongol forces in the creation and control of the Mongol empire could be viewed as asymmetric warfare. The other is the use of state terrorism by the superior Nazi forces in the Balkans, in an attempt to suppress the resistance movement.

8 – Examples

8 – 1- American Revolutionary War

From its initiation, the American Revolutionary War was, necessarily, a showcase for asymmetric techniques. In the 1920s, Harold Murdock of Boston attempted to solve the puzzle of the first shots fired on Lexington Green, and came to the suspicion that the few score militia men who gathered before sunrise to await the arrival of hundreds of well-prepared British soldiers were sent specifically to provoke an incident which could be used for propaganda purposes . The return of the British force to Boston following the search operations at Concord was subject to constant skirmishing, using partisan forces gathered from communities all along the route, making maximum use of the terrain (particularly trees and stone field walls) to overcome the limitations of their weapons- muskets with an effective range of only about 50–70 metres. Throughout the war, skirmishing tactics against British troops on the move continued to be a key factor in the Patriots' success; however, they may also have encouraged the occasional incidents, particularly in the later stages, where British troops used alleged surrender violations as a justification for killing large numbers of captives (e.g., Waxhaw and Groton Heights).

Another feature of the long march from Concord was the urban warfare technique of using buildings along the route as additional cover for snipers. When revolutionary forces forced their way into Norfolk, Virginia, and used waterfront buildings as cover for shots at British vessels out in the river, the response of destruction of those buildings was ingeniously used to the advantage of the rebels, who encouraged the spread of fire throughout the largely Loyalist town, and spread propaganda blaming it on the British. Shortly afterwards they destroyed the remaining houses, on the grounds that they might provide cover for British soldiers. On the subject of propaganda, it should be borne in mind that, contrary to the impression given in the popular American film *The Patriot*, British forces never adopted a popular response to partisan-style asymmetric warfare — retribution massacres of groups selected on a semi-random basis from the population at large.

The rebels also adopted a form of asymmetric sea warfare, by using small, fast vessels to avoid the Royal Navy, and capturing or sinking large numbers of merchant ships; however the British responded by issuing letters of marque permitting private armed vessels to undertake reciprocal attacks on enemy shipping. John Paul Jones became notorious in Britain for his expedition from France in the little sloop of war *Ranger* in April 1778, during which, in addition to his attacks on merchant shipping, he made two landings on British soil. The effect of these raids, particularly when coupled with his capture of the Royal Navy's *HMS Drake* — the first such success in British waters, but not Jones's last — was to force the British government to increase resources for coastal defence, and to create a climate of fear among the British public which was subsequently fed by press reports of his preparations for the 1779 *Bonhomme Richard* mission.

From 1776, the conflict turned increasingly into a proxy war on behalf of France, following a strategy proposed in the 1760s but initially resisted by the idealistic young King Louis XVI, who came to the throne at the age of 19 a few months before Lexington. France also encouraged proxy wars against the British in India, but ultimately drove itself to the brink of state bankruptcy by entering the war(s) directly, on several fronts throughout the world.

8 – 2 - American Civil War

The American Civil War saw the rise of asymmetric warfare in the Border States, and in particular on the US Western Territorial Border after the Kansas-Nebraska Act of 1854 opened the territories to voting on the expansion of slavery beyond the Missouri Compromise lines. Political implications of this broken 1820s compromise were nothing less than the potential expansion of slavery all across the North American continent, including the northern reaches of the annexed Mexican territories to

California and Oregon. So the stakes were high and it caused a flood of immigration to the border: some to grab land and expand slavery west, others to grab land and vote down the expansion of slavery. The pro-slavery land grabbers began asymmetric violent attacks against the more pacifist abolitionists who had settled Lawrence and other territorial towns for suppressing slavery. John Brown travelled to Osawatomie in the Kansas Territory expressly to foment retaliatory attacks back against the pro-slavery guerrillas who, by 1858, had twice ransacked both Lawrence and Osawatomie (where one of Brown's sons was shot dead). The abolitionists would not return the attacks and Brown theorized that a violent spark set off on "the Border" would be a way to finally ignite his long hoped - for slave rebellion . Brown had broad - sworded slave owners at Potawatomi Creek, so the bloody civilian violence was initially symmetrical; however, once the American Civil War ignited in 1861, and when the state of Missouri voted overwhelmingly not to secede from the Union, the pro-slavers on the MO - KS border were driven either south to Arkansas and Texas, or underground — where they became guerrilla fighters and "Bushwhackers" living in the brushy ravines throughout northwest Missouri across the (now) state line from Kansas. The bloody "Border War" lasted all during the Civil War (and long after with guerrilla partisans like the James brothers cynically robbing and murdering, aided and abetted by lingering lost - causers . Tragically the Western Border War was an asymmetric war: pro - slavery guerrillas and paramilitary partisans on the pro - Confederate side attacking pro - Union townspeople and commissioned Union military units; with the Union army trying to keep both in check: blocking Kansans and pro-Union Missourians from organizing militarily against the marauding Bushwhackers. The worst act of domestic terror in US history came in August 1863 when paramilitary guerrillas amassed 350 strong and rode all night 50 miles across eastern Kansas to the abolitionist stronghold of Lawrence (purely a political target) and destroyed the town, gunning down on their front porches 150 civilians. The Confederate officer whose company had joined Quantrill's gang that day witnessed the civilian slaughter and forbade his soldiers from joining in the carnage. The commissioned officer refused to participate in Quantrill's asymmetric warfare on civilians.

8 – 3 - 20 th century

8 – 3 - 1 - Second Boer War

Asymmetric warfare featured prominently during the Second Boer War. After an initial phase, which was fought by both sides as a conventional war, the British captured Johannesburg, the Boers' largest city, and captured the capitals of the two Boer Republics. The British then expected the Boers to accept peace as dictated by the victors in the traditional European way. However instead of capitulating , the Boers fought a protracted guerrilla war. Between twenty and thirty thousand Boer commandos were only defeated after the British brought to bear four hundred and fifty thousand troops, about ten times as many as were used in the conventional phase of the war. During this phase the British introduced internment in concentration camps for the Boer civilian population and also implemented a scorched earth policy. Later, the British began using blockhouses built within machine gun range of one another and flanked by barbed wire to slow the Boers' movement across the countryside and block paths to valuable targets. Such tactics eventually evolved into today's counter insurgency tactics.

The Boer commando raids deep into the Cape Colony, which were organized and commanded by Jan Smuts, resonated throughout the century as the British and others adopted and adapted the tactics used by the Boer commandos in later conflicts.

8 – 3 - 2 - World War I

Lawrence of Arabia and British support for the Arab uprising against the Ottoman Empire. The Ottomans were the stronger power, the Arabs the weaker.

Austria - Hungary vs. Serbia, August 1914. Austria-Hungary was the stronger power, Serbia the weaker.

Germany vs. Belgium, August 1914. Germany was the stronger power, Belgium the weaker.

8 – 3 - 3 - Between the World Wars

Abd el - Krim led resistance in Morocco from 1920 to 1924 against French and Spanish colonial armies ten times as strong as the guerilla force, led by General Philippe Pétain.

TIGR, the first anti-fascist national - defensive organization in Europe, fought against Benito Mussolini's regime in northeast Italy.

Anglo - Irish War (Irish War of Independence) fought between the Irish Republican Army and the Black and Tans/Auxiliaries. Lloyd George (British Prime Minister at the time) attempted to persuade other nations that it was not a war by refusing to use the army and using the Black and Tans instead but the conflict was conducted as an asymmetric guerrilla war and was registered as a war with the League of Nations by the Irish Free State.

8 – 3 - 4 - World War II

Winter War – Finland opposed an invasion by the Soviet Union

Soviet partisans – resistance movement which fought in the German occupied parts of the Soviet Union.

Warsaw Uprising – Poland (Home Army, Armia Krajowa) rose up against the German occupation.

Germany in Yugoslavia, 1941–45 (Germany vs. Tito's Partisans and Mihailović's Chetniks).

8 – 3 - 4 – 1 - Britain

British Commandos and European coastal raids. German countermeasures and the notorious Commando Order

Long Range Desert Group and the Special Air Service in Africa and later in Europe.

South East Asian Theatre: Wingate, Chindits, Force 136, V Force

Special Operations Executive (SOE)

British Armed Forces against the Provisional Irish Republican Army in the Northern Campaign

8 – 3 - 4 – 2 - United States

Office of Strategic Services (OSS)

China Burma India Theatre: Merrill's Marauders and OSS Detachment 101

8 - 4 – After World War II

United States Military Assistance Command Studies and Observations Group (US MAC-V SOG) in Vietnam

United States support of the Nicaraguan Contras

8 – 4 – 1 - Cold War

The end of World War II established the two most powerful victors, the United States of America (USA, or just the United States) and the Union of Soviet Socialist Republics (USSR, or just the Soviet Union) as the two dominant world superpowers.

8 – 4 – 2 - Cold War examples of proxy wars

In Southeast Asia , specifically Vietnam, the Viet Cong and other communist insurgencies engaged in asymmetrical guerilla warfare with France, at first, then, later, the United States during the period of the Vietnam War.

Likewise, the war between the mujahideen and the Red Army during the Soviet war in of Afghanistan has been claimed as the source of the term "asymmetric warfare" , although this war occurred years after Mack wrote of "asymmetric conflict," it is notable that the term became well known in the West only in the 1990s.[15] The aid given by the U.S. to the mujahadeen during the war was only covert at the tactical level, the Reagan Administration told the world that it was helping the "freedom-loving people of Afghanistan". This proxy war was aided by many countries including the USA against the USSR during the Cold War. It was considered cost effective and politically successful , as it gave the USSR a military defeat which was a contributing factor to its collapse .

8 – 5 – 21 st century

Israel / Palestinians

The ongoing battle between the Israelis and some Palestinian organizations (such as Hamas and Islamic Jihad) is a classic case of asymmetric warfare. Israel has a powerful army, air force and navy, while the Palestinian organisations have no access to large-scale military equipment with which to conduct operations; instead, they utilize asymmetric tactics, such as: small gunfights, cross-border sniping, rocket attacks[17] and suicide bombing.

8 – 5 – 2 - Sri Lanka

The Sri Lankan Civil War, which raged on and off from 1983 to 2009, between the Sri Lankan government and the Liberation Tigers of Tamil Eelam (LTTE) saw large - scale asymmetric warfare. The war started as an insurgency and progressed to a large-scale conflict with the mixture of guerrilla and conventional warfare. The LTTE pioneered the use of suicide bombing and perfected it with the use of male/female suicide bombers both on and off battlefield; use of explosive-filled boats for suicide attacks on military shipping; use of light aircraft targeting military installations.

8 – 5 – 3 - Kashmir

Pakistan claims territorial rights to the region of Kashmir, where it has been engaged in a proxy war with India since 1988.

8 – 5 – 4 - Iraq

The victory by the US - led coalition forces in the 1991 Persian Gulf War and the 2003 invasion of Iraq, demonstrated that training, tactics and technology can provide overwhelming victories in the field of battle during modern conventional warfare. After Saddam Hussein's regime was removed from power, the Iraq campaign moved into a different type of asymmetric warfare where the coalition's use of superior conventional warfare training, tactics and technology were of much less use against continued opposition from the various partisan groups operating inside Iraq.

8 – 5 – 6 - Syria

Much of the 2012 - 2013 Syrian civil war has been fought asymmetrically. The Syrian National Coalition along with the Mujahideen and Kurdish Democratic Union Party, has been engaging with the forces of the Syrian government through asymmetric means. The conflict has seen large - scale asymmetric warfare across the country, with the forces opposed to the government unable to engage symmetrically with the Syrian government so other tactics such as suicide bombings[19][20] and targeted assassinations have been put to effective use.

Advanced Tactical Fighter

The YF-22 (fore ground) and YF-23 (back ground)

Project for	Air superiority fighter
Requirement	Advanced Tactical Fighter Statement of Operational Need (November 1984)
Issued by	United States Air Force
Value	$ US 86.6 billion when winner was selected
Date initiated	June 1981 (RFI)
Proposals	proposals from Boeing, General Dynamics, Lockheed, Northrop, and McDonnell Douglas
Prototypes	Lockheed YF - 22 , Northrop YF- 23
Date concluded	August 1991
Outcome	F- 22 selected for production
Related programs	JAFE, NATF, Have Dash II

Contents

1 - Introduction

The **Advanced Tactical Fighter** (**ATF**) was a demonstration and validation program undertaken by the United States Air Force to develop a next-generation air superiority fighter to counter emerging worldwide threats, including Soviet Sukhoi Su - 27 and Mikoyan MiG - 29 fighters under development in the 1980s. Lockheed and Northrop were selected in 1986 to develop the YF - 22 and the YF-23 technology demonstrator aircraft. These aircraft were evaluated in 1991 and the Lockheed YF-22 was selected and later developed into the F-22 Raptor.

2 – History

2 – 1 – Back ground

In 1981, US AF began forming requirements for a new air superiority fighter intended to replace the capability of the F-15 Eagle. In June 1981 a request for information (RFI) for the Advanced Tactical Fighter (ATF) was published by the Air Force. Design concepts were provided by defense contractors. The common areas among the concepts were Stealth, STOL and supercruise . It was envisioned that the ATF would incorporate emerging technologies including advanced alloys and composite material, advanced fly - by - wire flight control systems, higher power propulsion systems, and low - observable, or stealth technology.

In September 1983, study contracts were awarded to seven airframe manufacturers for further definition of their designs. By late 1984, ATF requirements had settled on a fighter with a maximum takeoff weight of 23,000 kg , a mission radius of 1,300 km , supercruise speed of Mach 1.4-1.5 and the ability to use a 610 m runway.[6] A request for proposals (RFP) for the fighter's engine, called the Joint Advanced Fighter Engine (JAFE), was released in May 1983. Pratt & Whitney and General Electric received contracts for the development and production of prototype engines in September 1983.

2 – 2 - Request for proposals

A request for proposals (RFP) for the fighter was issued in September 1985.[5][8] In May 1986, the Air Force changed the RFP so that final selection would involve flying prototypes.[9] In July 1986, proposals were provided by Boeing , General Dynamics, Lockheed, Northrop, and McDonnell Douglas . Two contractors, Lockheed and Northrop were selected in October 1986 to undertake a 50 month demonstration / validation phase, culminating in the flight test of two technology demonstrator prototypes, the YF - 22 and the YF- 23. Under terms of agreements between Lockheed, General Dynamics, and Boeing, the companies agreed to participate in the development jointly if only one company's design was selected. Northrop and McDonnell Douglas had a similar agreement.

Because of the added weight for thrust vectoring/reversing nozzles and related systems on the F-15 S/MTD research aircraft, the Air Force changed the runway length requirement to 910 m and removed the thrust reversers on the ATF in late 1987 . Two examples of each prototype were built for the Demonstration - Validation phase: one with General Electric YF120 engines, the other with Pratt & Whitney YF119 engines.

The first YF - 23 made its maiden flight on 27 August 1990 and the first YF - 22 first flew on 29 September 1990 . Flight testing began afterwards and added the second aircraft for each competitor in late October 1990.[15] The first YF - 23 with P&W engines supercruised at Mach 1.43 on 18 September 1990 and the second YF - 23 with GE engines reached Mach 1.6 on 29 November 1990 . The YF-22 with GE engines achieved Mach 1.58 in supercruise . Flight testing continued until December 1990. Following flight testing, the contractor teams submitted proposals for ATF production.

2 – 3 – Selection

Following a review of the flight test results and proposals, the Air Force announced the Lockheed YF - 22 with Pratt & Whitney engines as the competition winner on 23 April 1991. The YF - 23 design was more stealthy and faster, but the YF - 22 was more agile . The US Navy had begun considering a version of the ATF called Navy Advanced Tactical Fighter (NATF) in 1986 . It has been speculated in the aviation press that the YF - 22 was also seen as more adaptable to the NATF . The Navy abandoned NATF by 1992.

The Lockheed team was awarded the contract to develop and build the Advanced Tactical Fighter in August 1991. The YF - 22 was modified into the production F - 22 Raptor version.[22] The Northrop YF- 23 design was later considered by the company for modification as a bomber,[17] but the proposals have not come to fruition.

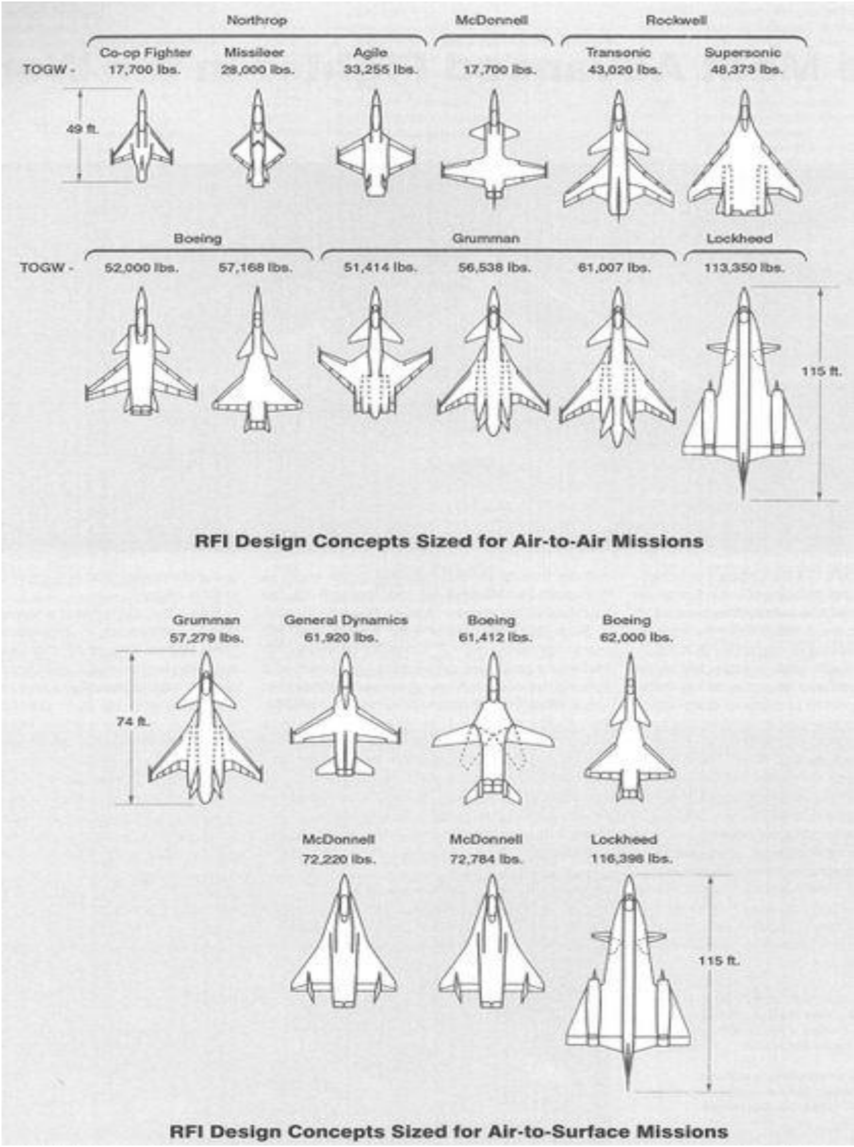
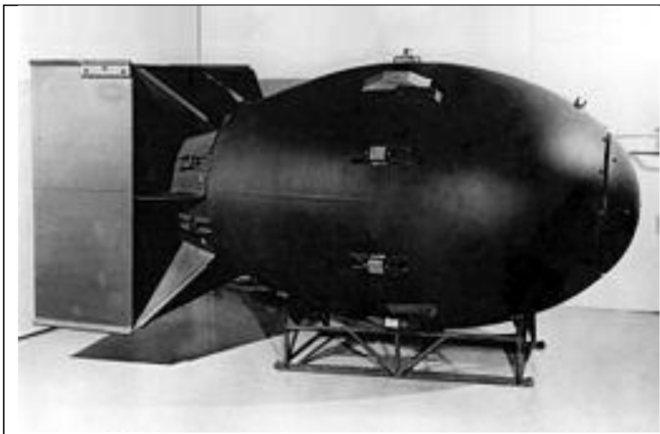
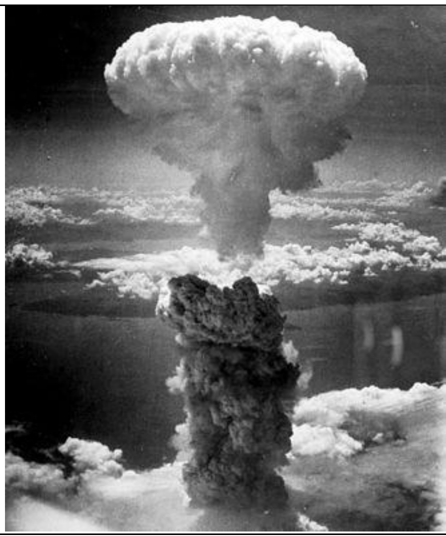


Diagram of several designs submitted for request for information (RFI)

Nuclear Weapon





The mushroom cloud of the atomic bombing of Nagasaki, Japan on August 9, 1945 rose some 18 km) above the bomb's hypocenter.

Background : History - Warfare - Arms race - Design - Testing - Ethics - Effects - Delivery - Espionage - Proliferation - Arsenals - Terrorism - Opposition

Nuclear - armed states : - *NPT recognized* - United States - Russia - United Kingdom - France - China

Others : India - Israel (undeclared) - Pakistan - North Korea

Weapons of mass destruction

By type : Biological - Chemical

Nuclear : Radiological

By country : Albania - Algeria - Argentina - Australia - Brazil - Bulgaria - Burma - Canada - China - Egypt - France - Germany - India - Iran - Iraq - Israel - Japan - Libya - Mexico - Netherlands - North Korea - Pakistan - Poland - Romania - Russia - Saudi Arabia - South Africa - South Korea - Spain - Sweden - Syria - Taiwan - Ukraine - United Kingdom - United States

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1 - Introduction

A **nuclear weapon** is an explosive device that derives its destructive force from nuclear reactions, either fission or a combination of fission and fusion . Both reactions release vast quantities of energy from relatively small amounts of matter . The first fission ("atomic") bomb test released the same amount of energy as approximately 20,000 tons of TNT . The first thermonuclear ("hydrogen") bomb test released the same amount of energy as approximately 10,000,000 tons of TNT.

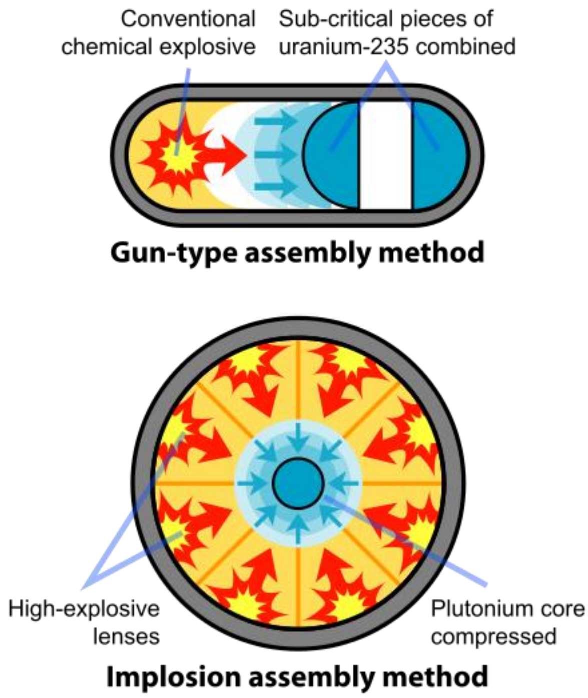
A thermonuclear weapon weighing little more than 1,100 kg can produce an explosive force comparable to the detonation of more than 1.2 million tons of TNT. Thus, even a small nuclear device no larger than traditional bombs can devastate an entire city by blast, fire, and radiation . Nuclear weapons are considered weapons of mass destruction , and their use and control have been a major focus of international relations policy since their debut.

As of 2014, only two nuclear weapons have been used in the course of warfare, both times by the United States near the end of World War II. On 6 August 1945, a uranium gun-type fission bomb code-named "Little Boy" was detonated over the Japanese city of Hiroshima. Three days later, on 9 August, a plutonium implosion-type fission bomb code-named "Fat Man" was exploded over the Japanese city of Nagasaki. These two bombings resulted in the deaths of approximately 200,000 civilians and military personnel from acute injuries sustained from the explosions.[3] The role of the bombings in Japan's surrender, and their ethical status, remain the subject of scholarly and popular debate.

Since the bombings of Hiroshima and Nagasaki, nuclear weapons have been detonated on over two thousand occasions for testing purposes and demonstrations. Only a few nations possess such weapons or are suspected of seeking them. The only countries known to have detonated nuclear weapons — and that acknowledge possessing such weapons — are (chronologically by date of first test) the United States, the Soviet Union (succeeded as a nuclear power by Russia), the United Kingdom, France, the People's Republic of China, India, Pakistan, and North Korea. Israel is also widely believed to possess nuclear weapons, though it does not acknowledge having them . One state, South Africa, fabricated nuclear weapons in the past, but as its apartheid regime was coming to an end, it disassembled its arsenal, acceded to the Nuclear Non - Proliferation Treaty, and accepted full - scope international safeguards. The Federation of American Scientists estimates there are more than 17,000 nuclear warheads in the world as of 2012, with around 4,300 of them considered "operational", ready for use.[4]

2 - Types

There are two basic types of nuclear weapons: those that derive the majority of their energy from nuclear fission reactions alone, and those that use fission reactions to begin nuclear fusion reactions that produce a large amount of the total energy output.



The two basic fission weapon designs

2 – 1 - Fission weapons

All existing nuclear weapons derive some of their explosive energy from nuclear fission reactions. Weapons whose explosive output is exclusively from fission reactions are commonly referred to as **atomic bombs** or **atom bombs** (abbreviated as **A – bombs**). This has long been noted as something of a misnomer, as their energy comes from the nucleus of the atom, just as it does with fusion weapons.

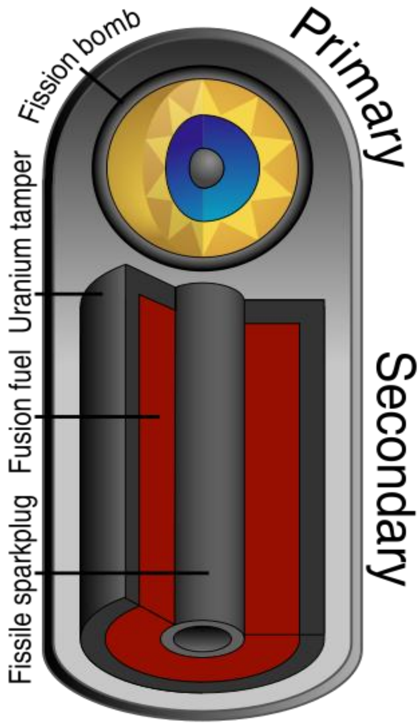
In fission weapons, a mass of fissile material (enriched uranium or plutonium) is assembled into a supercritical mass — the amount of material needed to start an exponentially growing nuclear chain reaction — either by shooting one piece of sub - critical material into another (the "gun" method) or by compressing using explosive lenses a sub-critical sphere of material using chemical explosives to many times its original density (the "implosion" method). The latter approach is considered more sophisticated than the former and only the latter approach can be used if the fissile material is plutonium.

A major challenge in all nuclear weapon designs is to ensure that a significant fraction of the fuel is consumed before the weapon destroys itself. The amount of energy released by fission bombs can range from the equivalent of just under a ton of TNT, to upwards of 500,000 tons of TNT.

All fission reactions necessarily generate fission products, the radioactive remains of the atomic nuclei split by the fission reactions. Many fission products are either highly radioactive (but short-lived) or moderately radioactive (but long-lived), and as such are a serious form of radioactive contamination if not fully contained. Fission products are the principal radioactive component of nuclear fallout.

The most commonly used fissile materials for nuclear weapons applications have been uranium - 235 and plutonium-239. Less commonly used has been uranium - 233. Neptunium - 237 and some isotopes of americium may be usable for nuclear explosives as well, but it is not clear that this has ever been implemented, and even their plausible use in nuclear weapons is a matter of scientific dispute.

2 – 2 - Fusion weapons



The basics of the Teller– Ulam design for a hydrogen bomb: a fission bomb uses radiation to compress and heat a separate section of fusion fuel.

The other basic type of nuclear weapon produces a large proportion of its energy in nuclear fusion reactions. Such fusion weapons are generally referred to as **thermo nuclear weapons** or more colloquially as **hydrogen bombs** (abbreviated as **H – bombs**), as they rely on fusion reactions between isotopes of hydrogen (deuterium and tritium). All such weapons derive a significant portion, and sometimes a majority, of their energy from fission. This is because a fission weapon is required as a "trigger" for the fusion reactions, and the fusion reactions can themselves trigger additional fission reactions.

Only six countries — United States, Russia, United Kingdom, People's Republic of China, France and India — have conducted thermonuclear weapon tests. (Whether India has detonated a "true", multi-staged thermonuclear weapon is contro versial) . Thermonuclear weapons are considered much more difficult to successfully design and execute than primitive fission weapons. Almost all of the nuclear weapons deployed today use the thermonuclear design because it is more efficient.

Thermo nuclear bombs work by using the energy of a fission bomb to compress and heat fusion fuel. In the Teller-Ulam design, which accounts for all multi-megaton yield hydrogen bombs, this is accomplished by placing a fission bomb and fusion fuel (tritium , deuterium , or lithium deuteride) in proximity within a special, radiation-reflecting container. When the fission bomb is detonated, gamma rays and X - rays emitted first compress the fusion fuel, then heat it to thermonuclear temperatures. The ensuing fusion reaction creates enormous numbers of high - speed neutrons, which can then induce fission in materials not normally prone to it, such as depleted uranium. Each of these components is known as a "stage", with the fission bomb as the "primary" and the fusion capsule as the "secondary". In large, megaton-range hydrogen bombs, about half of the yield comes from the final fissioning of depleted uranium.

Virtually all thermonuclear weapons deployed today use the "two-stage" design described above, but it is possible to add additional fusion stages — each stage igniting a larger amount of fusion fuel in the next stage. This technique can be used to construct thermonuclear weapons of arbitrarily large yield, in contrast to fission bombs, which are limited in their explosive force. The largest nuclear weapon ever detonated—the Tsar

Bomba of the USSR, which released an energy equivalent of over 50 million tons (50 megatons) of TNT — was a three-stage weapon. Most thermonuclear weapons are considerably smaller than this, due to practical constraints from missile warhead space and weight requirements.

Edward Teller, often referred to as the "father of the hydrogen bomb"

Fusion reactions do not create fission products, and thus contribute far less to the creation of nuclear fallout than fission reactions, but because all thermonuclear weapons contain at least one fission stage, and many high - yield thermonuclear devices have a final fission stage, thermonuclear weapons can generate at least as much nuclear fallout as fission - only weapons.

2 – 3 - Other types

There are other types of nuclear weapons as well. For example, a boosted fission weapon is a fission bomb that increases its explosive yield through a small amount of fusion reactions, but it is not a fusion bomb. In the boosted bomb, the neutrons produced by the fusion reactions serve primarily to increase the efficiency of the fission bomb.

Some weapons are designed for special purposes; a neutron bomb is a thermonuclear weapon that yields a relatively small explosion but a relatively large amount of neutron radiation; such a device could theoretically be used to cause massive casualties while leaving infrastructure mostly intact and creating a minimal amount of fallout. The detonation of any nuclear weapon is accompanied by a blast of neutron radiation. Surrounding a nuclear weapon with suitable materials (such as cobalt or gold) creates a weapon known as a salted bomb. This device can produce exceptionally large quantities of radioactive contamination.

Research has been done into the possibility of pure fusion bombs: nuclear weapons that consist of fusion reactions without requiring a fission bomb to initiate them. Such a device might provide a simpler path to thermonuclear weapons than one that required development of fission weapons first, and pure fusion weapons would create significantly less nuclear fallout than other thermonuclear weapons, because they would not disperse fission products. In 1998, the United States Department of Energy divulged that the United States had, "...made a substantial investment" in the past to develop pure fusion weapons, but that, "The U.S. does not have and is not developing a pure fusion weapon", and that, "No credible design for a pure fusion weapon resulted from the DOE investment".

Most variation in nuclear weapon design is for the purpose of achieving different yields for different situations, and in manipulating design elements to attempt to minimize weapon size.

Antimatter, which consists of particles resembling ordinary matter particles in most of their properties but having opposite electric charge, has been considered as a trigger mechanism for nuclear weapons.[14] A major obstacle is the difficulty of producing antimatter in large enough quantities, and there is no evidence that it is feasible beyond the military domain.[15] However, the U.S. Air Force funded studies of the physics of antimatter in the Cold War, and began considering its possible use in weapons, not just as a trigger, but as the explosive itself.[16] A fourth generation nuclear weapon design is related to, and relies upon, the same principle as Antimatter-catalyzed nuclear pulse propulsion.

3 - Weapons delivery

The first nuclear weapons were gravity bombs, such as this "Fat Man" weapon dropped on Nagasaki, Japan. They were very large and could only be delivered by heavy bomber aircraft

A demilitarized and commercial launch of the Russian Strategic Rocket Forces R-36 ICBM ; also known by the NATO reporting name: SS - 18 Satan. Upon its first fielding in the late 1960s, the SS - 18 remains the single highest throw weight missile delivery system ever built.

Nuclear weapons delivery — the technology and systems used to bring a nuclear weapon to its target — is an important aspect of nuclear weapons relating both to nuclear weapon design and nuclear strategy. Additionally, development and maintenance of delivery options is among the most resource - intensive aspects of a nuclear weapons program: according to one estimate, deployment costs accounted for 57 % of the total financial resources spent by the United States in relation to nuclear weapons since 1940.

Historically the first method of delivery, and the method used in the two nuclear weapons used in warfare, was as a gravity bomb, dropped from bomber aircraft. This is usually the first method that countries developed, as it does not place many restrictions on the size of the weapon and *weapon miniaturization* requires considerable weapons design knowledge. It does, however, limit attack range, response time to an impending attack , and the number of weapons that a country can field at the same time.

With the advent of miniaturization, nuclear bombs can be delivered by both strategic bombers and tactical fighter-bombers, allowing an air force to use its current fleet with little or no modification. This method may still be considered the primary means of nuclear weapons delivery; the majority of U.S. nuclear warheads, for example, are free-fall gravity bombs, namely the B61.

More preferable from a strategic point of view is a nuclear weapon mounted onto a missile, which can use a ballistic trajectory to deliver the warhead over the horizon. Although even short-range missiles allow for a faster and less vulnerable attack, the development of long-range intercontinental ballistic missiles (ICBMs) and submarine-launched ballistic missiles (SLBMs) has given some nations the ability to plausibly deliver missiles anywhere on the globe with a high likelihood of success.

More advanced systems, such as multiple independently targetable reentry vehicles (MIRVs), can launch multiple warheads at different targets from one missile, reducing the chance of a successful missile defense. Today, missiles are most common among systems designed for delivery of nuclear weapons. Making a warhead small enough to fit onto a missile, though, can be difficult.

Tactical weapons have involved the most variety of delivery types, including not only gravity bombs and missiles but also artillery shells, land mines, and nuclear depth charges and torpedoes for anti-submarine warfare. An atomic mortar was also tested at one time by the United States. Small, two-man portable tactical weapons (somewhat misleadingly referred to as suitcase bombs), such as the Special Atomic Demolition Munition, have been developed, although the difficulty of combining sufficient yield with portability limits their military utility.

4 - Nuclear strategy

Nuclear warfare strategy is a set of policies that deal with preventing or fighting a nuclear war. The policy of trying to prevent an attack by a nuclear weapon from another country by threatening nuclear retaliation is known as the strategy of nuclear deterrence. The goal in deterrence is to always maintain a second strike capability (the ability of a country to respond to a nuclear attack with one of its own) and potentially to strive for first strike status (the ability to completely destroy an enemy's nuclear forces before they could retaliate) . During the Cold War, policy and military theorists in nuclear-enabled countries worked out models of what sorts of policies could prevent one from ever being attacked by a nuclear weapon, and developed weapon game theory models that create the greatest and most stable deterrence conditions.

The now decommissioned United States' Peacekeeper missile was an ICBM developed to entirely replace the minuteman missile in the late 1980s. Each missile, like the heavier lift Russian SS - 18 Satan, could contain up to ten nuclear warheads (shown in red), each of which could be aimed at a different target. A factor in the development of MIRVs was to make complete missile defense very difficult for an enemy country.

Different forms of nuclear weapons delivery (see above) allow for different types of nuclear strategies. The goals of any strategy are generally to make it difficult for an enemy to launch a pre-emptive strike against the weapon system and difficult to defend against the delivery of the weapon during a potential conflict. Sometimes this has meant keeping the weapon locations hidden, such as deploying them on submarines or land mobile transporter erector launchers whose locations are very hard for an enemy to track, and other times, this means protecting them by burying them in hardened missile silo bunkers.

Other components of nuclear strategies have included using missile defense (to destroy the missiles before they land) or implementation of civil defense measures (using early-warning systems to evacuate citizens to safe areas before an attack).

Note that weapons designed to threaten large populations, or to generally deter attacks are known as *strategic weapons*. Weapons designed for use on a battlefield in military situations are called *tactical weapons*.

There are critics of the very idea of nuclear strategy for waging nuclear war who have suggested that a nuclear war between two nuclear powers would result in mutual annihilation. From this point of view, the significance of nuclear weapons is purely to deter war because any nuclear war would immediately escalate out of mutual distrust and fear, resulting in mutually assured destruction. This threat of national, if not global, destruction has been a strong motivation for anti - nuclear weapons activism.

Critics from the peace movement and within the military establishment[*citation needed*] have questioned the usefulness of such weapons in the current military climate. According to an advisory opinion issued by the International Court of Justice in 1996, the use of (or threat of use of) such weapons would generally be contrary to the rules of international law applicable in armed conflict, but the court did not reach an opinion as to whether or not the threat or use would be lawful in specific extreme circumstances such as if the survival of the state were at stake.

Another deterrence position in nuclear strategy is that nuclear proliferation can be desirable. This view argues that, unlike conventional weapons, nuclear weapons successfully deter all-out war between states, and they succeeded in doing this during the Cold War between the U.S. and the Soviet Union . In the late 1950s and early 1960s, Gen. Pierre Marie Gallois of France, an adviser to Charles DeGaulle, argued in books like *The Balance of Terror: Strategy for the Nuclear Age* (1961) that mere possession of a nuclear arsenal, what the French called the *force de frappe*, was enough to ensure deterrence, and thus concluded that the spread of nuclear weapons could increase international stability. Some very prominent neo-realist scholars, such as the late Kenneth Waltz, formerly a

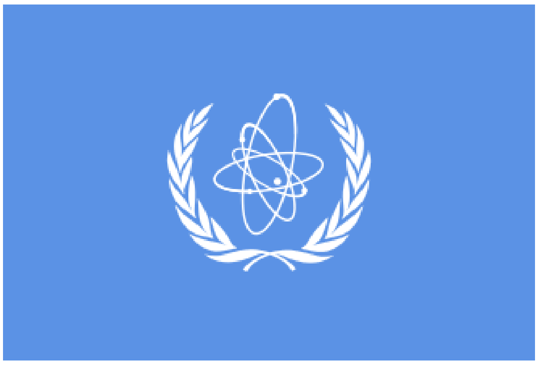
Political Science at UC Berkeley and Adjunct Senior Research Scholar at Columbia University, and John Mearsheimer of University of Chicago, have also argued along the lines of Gallois. Specifically, these scholars have advocated some forms of nuclear proliferation, arguing that it would decrease the likelihood of total war, especially in troubled regions of the world where there exists a unipolar nuclear weapon state. Aside from the public opinion that opposes proliferation in any form, there are two schools of thought on the matter: those, like Mearsheimer, who favor selective proliferation , and those of Kenneth Waltz, who was somewhat more non-interventionist.

The threat of potentially suicidal terrorists possessing nuclear weapons (a form of nuclear terrorism) complicates the decision process. The prospect of mutually assured destruction may not deter an enemy who expects to die in the confrontation. Further, if the initial act is from a stateless terrorist instead of a sovereign nation, there is no fixed nation or fixed military targets to retaliate against. It has been argued by the New York Times, especially after the September 11, 2001 attacks, that this complication is the sign of the next age of nuclear strategy, distinct from the relative stability of the Cold War. In 1996, the United States adopted a policy of allowing the targeting of its nuclear weapons at terrorists armed with weapons of mass destruction.

Robert Gallucci, president of the John D. and Catherine T. MacArthur Foundation, argues that although traditional deterrence is not an effective approach toward terrorist groups bent on causing a nuclear catastrophe, Gallucci believes that “the United States should instead consider a policy of expanded deterrence, which focuses not solely on the would-be nuclear terrorists but on those states that may deliberately transfer or inadvertently lead nuclear weapons and materials to them. By threatening retaliation against those states, the United States may be able to deter that which it cannot physically prevent.”.

Graham Allison makes a similar case, arguing that the key to expanded deterrence is coming up with ways of tracing nuclear material to the country that forged the fissile material. “After a nuclear bomb detonates, nuclear forensics cops would collect debris samples and send them to a laboratory for radiological analysis. By identifying unique attributes of the fissile material, including its impurities and contaminants, one could trace the path back to its origin."[26] The process is analogous to identifying a criminal by fingerprints. "The goal would be twofold: first, to deter leaders of nuclear states from selling weapons to terrorists by holding them accountable for any use of their own weapons; second, to give leader every incentive to tightly secure their nuclear weapons and materials."

5 – Governance , control , and law



The International Atomic Energy Agency was created in 1957 to encourage peaceful development of nuclear technology while providing international safeguards against nuclear proliferation.

Because of the immense military power they can confer, the political control of nuclear weapons has been a key issue for as long as they have existed; in most countries the use of nuclear force can only be authorized by the head of government or head of state.

In the late 1940s, lack of mutual trust was preventing the United States and the Soviet Union from making ground towards international arms control agreements. The Russell – Einstein Manifesto was issued in London on July 9, 1955 by Bertrand Russell in the midst of the Cold War. It highlighted the dangers posed by nuclear weapons and called for world leaders to seek peaceful resolutions to international conflict. The signatories included eleven pre-eminent intellectuals and scientists, including Albert Einstein, who signed it just days before his death on April 18, 1955. A few days after the release, philanthropist Cyrus S. Eaton offered to sponsor a conference — called for in the manifesto — in Pugwash , Nova Scotia , Eaton's birthplace. This conference was to be the first of the Pugwash Conferences on Science and World Affairs, held in July 1957.

By the 1960s steps were being taken to limit both the proliferation of nuclear weapons to other countries and the environmental effects of nuclear testing. The Partial Test Ban Treaty (1963) restricted all nuclear testing to underground nuclear testing, to prevent contamination from nuclear fallout, whereas the Nuclear Non-Proliferation Treaty (1968) attempted to place restrictions on the types of activities signatories could participate in, with the goal of allowing the transference of non-military nuclear technology to member countries without fear of proliferation.

In 1957, the International Atomic Energy Agency (IAEA) was established under the mandate of the United Nations to encourage development of peaceful applications for nuclear technology, provide international safeguards against its misuse, and facilitate the application of safety measures in its use. In 1996, many nations signed the Comprehensive Test Ban Treaty,[28] which prohibits all testing of nuclear weapons. A testing ban imposes a significant hindrance to nuclear arms development by any complying country . The Treaty requires the ratification by 44 specific states before it can go into force; as of 2012, the ratification of eight of these states is still required.

Additional treaties and agreements have governed nuclear weapons stockpiles between the countries with the two largest stockpiles, the United States and the Soviet Union, and later between the United States and Russia. These include treaties such as SALT II (never ratified), START I (expired), INF, START II (never ratified), SORT, and New START, as well as non-binding agreements such as SALT I and the Presidential Nuclear Initiatives[30] of 1991. Even when they did not enter into force, these agreements helped limit and later reduce the numbers and types of nuclear weapons between the United States and the Soviet Union/Russia.

Nuclear weapons have also been opposed by agreements between countries. Many nations have been declared Nuclear-Weapon-Free Zones, areas where nuclear weapons production and deployment are prohibited, through the use of treaties. The Treaty of Tlatelolco (1967) prohibited any production or deployment of nuclear weapons in Latin America and the

Caribbean, and the Treaty of Pelindaba (1964) prohibits nuclear weapons in many African countries. As recently as 2006 a Central Asian Nuclear Weapon Free Zone was established amongst the former Soviet republics of Central Asia prohibiting nuclear weapons.

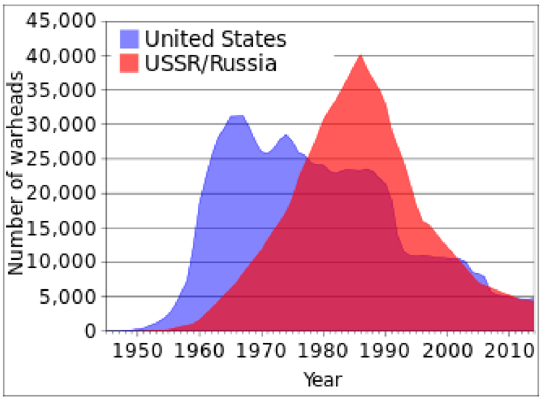
In the middle of 1996, the International Court of Justice, the highest court of the United Nations, issued an Advisory Opinion concerned with the "Legality of the Threat or Use of Nuclear Weapons". The court ruled that the use or threat of use of nuclear weapons would violate various articles of international law, including the Geneva Conventions, the Hague Conventions, the UN Charter, and the Universal Declaration of Human Rights. In view of the unique, destructive characteristics of nuclear weapons, the International Committee of the Red Cross calls on States to ensure that these weapons are never used, irrespective of whether they consider them lawful or not.

Additionally, there have been other, specific actions meant to discourage countries from developing nuclear arms. In the wake of the tests by India and Pakistan in 1998, economic sanctions were (temporarily) levied against both countries, though neither were signatories with the Nuclear Non-Proliferation Treaty. One of the stated *casus belli* for the initiation of the 2003 Iraq War was an accusation by the United States that Iraq was actively pursuing nuclear arms (though this was soon discovered not to be the case as the program had been discontinued). In 1981, Israel had bombed a nuclear reactor being constructed in Osirak, Iraq, in what it called an attempt to halt Iraq's previous nuclear arms ambitions; in 2007, Israel bombed another reactor being constructed in Syria.

In 2013, Mark Diesendorf says that governments of France, India, North Korea, Pakistan, UK, and South Africa have used nuclear power and/or research reactors to assist nuclear weapons development or to contribute to their supplies of nuclear explosives from military reactors.[32]

5 – 1 - Disarmament.

Nuclear disarmament refers to both the act of reducing or eliminating nuclear weapons and to the end state of a nuclear-free world, in which nuclear weapons are completely eliminated.



The USSR and USA nuclear weapon stockpiles throughout the cold war until 2005, with a precipitous drop in total numbers following the end of the cold war in 1991

Beginning with the 1963 Partial Test Ban Treaty and continuing through the 1996 Comprehensive Test Ban Treaty, there have been many treaties to limit or reduce nuclear weapons testing and stockpiles. The 1968 Nuclear Non - Proliferation Treaty has as one of its explicit conditions that all signatories must "pursue negotiations in good faith" towards the long-term goal of "complete disarmament". The nuclear weapon states have largely treated that aspect of the agreement as "decorative" and without force.

Only one country — South Africa — has ever fully renounced nuclear weapons they had independently developed. The former Soviet republics of Belarus, Kazakhstan, and Ukraine returned Soviet nuclear arms stationed in their countries to Russia after the collapse of the USSR.

Proponents of nuclear disarmament say that it would lessen the probability of nuclear war occurring, especially accidentally. Critics of nuclear disarmament say that it would undermine the present nuclear peace and deterrence and would lead to increased global instability. Various American elder statesmen , who were in office during the Cold War period, have been advocating the elimination of nuclear weapons. These officials include Henry Kissinger, George Shultz, Sam Nunn, and William Perry. In January 2010, Lawrence M. Krauss stated that "no issue carries more importance to the long - term health and security of humanity than the effort to reduce, and perhaps one day, rid the world of nuclear weapons".

In the years after the end of the Cold War, there have been numerous campaigns to urge the abolition of nuclear weapons, such as that organized by the Global Zero movement, and the goal of a "world without nuclear weapons" was advocated by United States President Barack Obama in an April 2009 speech in Prague.[36] A CNN poll from April 2010 indicated that the American public was nearly evenly split on the issue.

Some analysts have argued that nuclear weapons have made the world relatively safer, with peace through deterrence and through the stability–instability paradox, including in south Asia.[38][39] Kenneth Waltz has argued that nuclear weapons have helped keep an uneasy peace, and further nuclear weapon proliferation might even help avoid the large scale conventional wars that were so common prior to their invention at the end of World War II. But former Secretary Henry Kissinger says there is a new danger, which cannot be addressed by deterrence: "The classical notion of deterrence was that there was some consequences before which aggressors and evildoers would recoil. In a world of suicide bombers, that calculation doesn't operate in any comparable way". George Shultz has said, "If you think of the people who are doing suicide attacks, and people like that get a nuclear weapon, they are almost by definition not deterrable".

5 – 2 - United Nations

The UN Office for Disarmament Affairs (UNODA) is a department of the United Nations Secretariat established in January 1998 as part of the United Nations Secretary - General Kofi Annan's plan to reform the UN as presented in his report to the General Assembly in July 1997.

Its goal is to promote nuclear disarmament and non-proliferation and the strengthening of the disarmament regimes in respect to other weapons of mass destruction, chemical and biological weapons. It also promotes disarmament efforts in the area of conventional weapons, especially land mines and small arms, which are often the weapons of choice in contemporary conflicts.

6 - Controversy

6 – 1 - Ethics

Even before the first nuclear weapons had been developed, scientists involved with the Manhattan Project were divided over the use of the weapon. The role of the two atomic bombings of the country in Japan's surrender and the U.S.'s ethical justification for them has been the subject of scholarly and popular debate for decades. The question of whether nations should have nuclear weapons, or test them, has been continually and nearly universally controversial.

6 – 2 - Notable nuclear weapons accidents

February 13, 1950: a Convair B-36B crashed in northern British Columbia after jettisoning a Mark IV atomic bomb. This was the first such nuclear weapon loss in history.

7 June 1960: the 1960 Fort Dix IM-99 accident destroyed a Boeing CIM-10 Bomarc nuclear missile and shelter and contaminated the BOMARC Missile Accident Site in New Jersey.

24 January 1961: the 1961 Goldsboro B - 52 crash occurred near Goldsboro, North Carolina. A B - 52 Stratofortress carrying two Mark 39 nuclear bombs broke up in mid-air, dropping its nuclear payload in the process.

1965 Philippine Sea A - 4 crash, where a Skyhawk attack aircraft with a nuclear weapon fell into the sea. The pilot, the aircraft, and the B43 nuclear bomb were never recovered . It was not until the 1980s that the Pentagon revealed the loss of the one-megaton bomb.

January 17, 1966: the 1966 Palomares B - 52 crash occurred when a B-52G bomber of the USAF collided with a KC - 135 tanker during mid-air refuelling off the coast of Spain. The KC - 135 was completely destroyed when its fuel load ignited, killing all four crew members. The B-52G broke apart, killing three of the seven crew members aboard . Of the four Mk 28 type hydrogen bombs the B - 52G carried , three were found on land near Almería, Spain. The non-nuclear explosives in two of the weapons detonated upon impact with the ground, resulting in the contamination of a 2 - square - kilometer area by radioactive plutonium.

The fourth, which fell into the Mediterranean Sea, was recovered intact after a 2½-month-long search.

January 21, 1968: the 1968 Thule Air Base B-52 crash involved a United States Air Force (USAF) B-52 bomber. The aircraft was carrying four hydrogen bombs when a cabin fire forced the crew to abandon the aircraft. Six crew members ejected safely, but one who did not have an ejection seat was killed while trying to bail out. The bomber crashed onto sea ice in Greenland, causing the nuclear payload to rupture and disperse, which resulted in widespread radioactive contamination.

6 – 3 - Nuclear fallout

Over 500 atmospheric nuclear weapons tests were conducted at various sites around the world from 1945 to 1980. Radioactive fallout from nuclear weapons testing was first drawn to public attention in 1954 when the Castle Bravo hydrogen bomb test at the Pacific Proving Grounds contaminated the crew and catch of the Japanese fishing boat *Lucky Dragon*.[52] One of the fishermen died in Japan seven months later, and the fear of contaminated tuna led to a temporary boycotting of the popular staple in Japan. The incident caused wide spread concern around the world, especially regarding the effects of nuclear fallout and atmospheric nuclear testing, and "provided a decisive impetus for the emergence of the anti-nuclear weapons movement in many countries".

As public awareness and concern mounted over the possible health hazards associated with exposure to the nuclear fallout, various studies were done to assess the extent of the hazard. A Centers for Disease Control and Prevention/ National Cancer Institute study claims that fallout from atmospheric nuclear tests would lead to perhaps 11,000 excess deaths amongst people alive during atmospheric testing in the United States from all forms of cancer, including leukemia, from 1951 to well into the 21st century . As of March 2009, the U.S. is the only nation that compensates nuclear test victims. Since the Radiation Exposure Compensation Act of 1990, more than $1.38 billion in compensation has been approved. The money is going to people who took part in the tests, notably at the Nevada Test Site, and to others exposed to the radiation.

6 – 4 - Public opposition

Peace movements emerged in Japan and in 1954 they converged to form a unified "Japanese Council Against Atomic and Hydrogen Bombs". Japanese opposition to nuclear weapons tests in the Pacific Ocean was widespread, and "an estimated 35 million signatures were collected on petitions calling for bans on nuclear weapons".

In the United Kingdom, the first Aldermaston March organised by the Campaign for Nuclear Disarmament(CND) took place at Easter 1958, when, according to the CND, several thousand people marched for four days from Trafalgar Square, London, to the Atomic Weapons Research Establishment close to Aldermaston in Berkshire, England, to demonstrate their opposition to nuclear weapons . The Aldermaston marches continued into the late 1960s when tens of thousands of people took part in the four-day marches.

In 1959, a letter in the *Bulletin of Atomic Scientists* was the start of a successful campaign to stop the Atomic Energy Commission dumping radioactive waste in the sea 19 kilometres from Boston . In 1962, Linus Pauling won the Nobel Peace Prize for his work to stop the atmospheric testing of nuclear weapons, and the "Ban the Bomb" movement spread.

In 1963, many countries ratified the Partial Test Ban Treaty prohibiting atmospheric nuclear testing. Radioactive fallout became less of an issue and the anti - nuclear weapons movement went into decline for some years. A resurgence of interest occurred amid European and American fears of nuclear war in the 1980s.

7 - Costs and technology spin - offs

According to an audit by the Brookings Institution, between 1940 and 1996, the U.S. spent $ 8.75 trillion in present day terms[63] on nuclear weapons programs. 57 percent of which was spent on building nuclear weapons delivery systems. 6.3 percent of the total, $ 549 billion in present day terms, was spent on environmental remediation and nuclear waste management, for example cleaning up the Hanford site, and 7 percent of the total, $ 615 billion was spent on making nuclear weapons themselves.

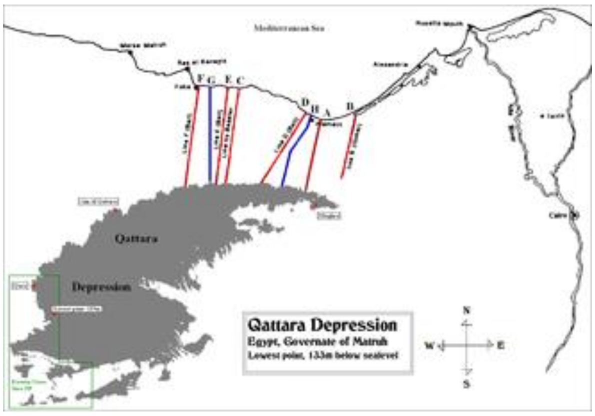
8 – Non - weapons uses

8 – 1 - Civil engineering and energy production

The 1962 Sedan nuclear test formed a crater 100 m deep with a diameter of about 390 m , as a means of investigating the possibilities of using peaceful nuclear explosions for large-scale earth moving. The 140 kiloton Soviet Chagan (nuclear test), comparable in yield to the Sedan test of 104 kt, formed Lake Chagan, reportedly used as a watering hole for cattle and human swimming.

Apart from their use as weapons, nuclear explosives have been tested and used for various non - military uses. These have included large-scale earth moving and the creation of artificial bays. Due to the inability of the physicists to reduce the fission fraction of small, approximately 1 kiloton, yield nuclear devices that would have been required for many civil engineering projects, when long term health and clean-up costs from fission products were included in the cost, there was virtually no economic advantage over conventional explosives, except for potentially the very largest of projects.

At the peak of the Atomic Age, the United States Federal government initiated Operation Plowshare, involving "peaceful nuclear explosions". The United States Atomic Energy Commission chairman announced that the Plowshares project was intended to "highlight the peaceful applications of nuclear explosive devices and thereby create a climate of world opinion that is more favorable to weapons development and tests". The Operation Plowshare program included 27 nuclear tests designed towards investigating these non-weapons uses from 1961 through 1973.



Map of all proposed routes for a tunnel and / or canal route from the Mediterranean Sea to the Qattara Depression.
No route was shorter than 55 kilometers in length.

The Qattara Depression Project, as developed by Professor Friedrich Bassler who during his appointment to the West German ministry of economics in 1968 put forth a plan to create a Saharan lake and hydroelectric power station by blasting a tunnel between the Mediterranean sea and the Qattara Depression in Egypt, an area that lies below sea level. The core problem of the entire project was the water supply to the depression. Calculations by Bassler showed that digging a canal or tunnel would be too expensive, therefore Bassler determined that the use of nuclear explosive devices, to excavate the canal or tunnel, would be the most economical. The Egyptian government declined to pursue the idea.

The Soviet Union's Nuclear Explosions for the National Economy was a program in the Soviet Union that investigated non - weapons uses of nuclear explosions. These included one 30 kiloton explosion being used to close the Uzbekistani *Urtabulak* gas well in 1966 that had been blowing since 1963, and a few months later a 47 kiloton explosive was used to seal a higher pressure blowout at the nearby *Pamuk* gas field.

The public records for devices that produced the highest proportion of their yield via fusion-only reactions are possibly the Soviet peaceful nuclear explosions of the 1970s, with 98% of their 15 kiloton explosive yield being derived from fusion reactions, a total fission fraction of 0.3 kilotons in a 15 kt device.

The repeated detonation of nuclear devices underground in salt domes, in a somewhat analogous manner to the explosions that power a car internal combustion engine (in that it would be a heat engine) has also been proposed as a means of fusion power, in what is termed PACER. Other investigated uses for peaceful nuclear explosions were underground detonations to stimulate, by a process analogous to fracking, the flow of petroleum and natural gas in tight formations, this was most developed in the Soviet Union, with an increase in the production of many well heads being reported.

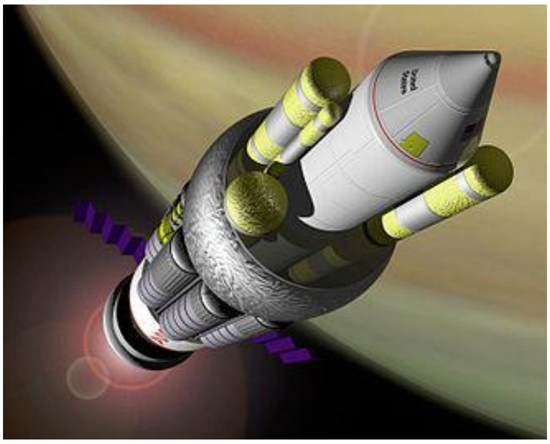
8 – 2 – Physics

The discovery and synthesis of new chemical elements by nuclear transmutation, and their production in the necessary quantities to allow the studying of their properties, was carried out in nuclear explosive device testing. For example, the discovery of the short lived einsteinium and fermium, both created under the intense neutron flux environment within thermonuclear explosions, followed the first Teller - Ulam thermonuclear device test - Ivy Mike. The rapid capture of so many neutrons required in the synthesis of einsteinium would provide the needed direct experimental confirmation of the so - called r-process, the multiple neutron absorptions needed to explain the cosmic nucleosynthesis (production) of all heavy chemical elements heavier than nickel on the periodic table, in supernova explosions , before beta decay, with the r - process explaining the existence of many stable elements in the universe.

The worldwide presence of new isotopes from atmospheric testing beginning in the 1950s led to the 2008 development of a reliable way to detect art forgeries. Paintings created after that period may contain traces of caesium - 137 and strontium - 90, isotopes that did not exist in nature before 1945. (Fission products were produced in the natural nuclear fission reactor at Oklo about 1.7 billion years ago, but these decayed away before the earliest known human painting.) .

Both climatology and particularly aerosol science, a subfield of atmospheric science, were largely created to answer the question of how far and wide fallout would travel. Similar to radioactive tracers used in hydrology and materials testing, fallout and the neutron activation of nitrogen gas served as a radioactive tracer that was used to measure and then help model global circulations in the atmosphere by following the movements of fallout aerosols.

After the Van Allen Belts surrounding Earth were published about in 1958, James Van Allen suggested that a nuclear detonation would be one way of probing the magnetic phenomenon, data obtained from the August 1958 Project Argus test shots, a high altitude nuclear explosion investigation, were vital to the early understanding of Earth's magnetosphere.

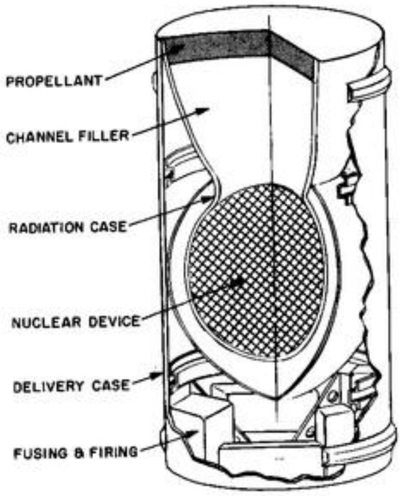


An artist's conception of the NASA reference design for the Project Orion spacecraft powered by nuclear pulse propulsion.

Soviet nuclear physicist and Nobel peace prize recipient Andrei Sakharov also proposed the idea that earthquakes could be mitigated and particle accelerators could be made by utilizing nuclear explosions,[82][83] with the latter created by connecting a nuclear explosive device with another of his inventions, the explosively pumped flux compression generator,[84] to accelerate protons to collide with each other to probe their inner workings, an endeavor that is now done at much lower energy levels with non-explosive superconducting magnets in CERN. Sakharov suggested to replace the copper coil in his MK generators by a big superconductor solenoid to magnetically compress and focus underground nuclear explosions into a shaped charge effect. He theorized this could focus 10^{23} positively charged protons per second on a 1 mm^2 surface, then envisaged making two such beams collide in the form of a supercollider.

Under ground nuclear explosive data from peaceful nuclear explosion test shots have been used to investigate the composition of Earth's mantle, analogous to the exploration geophysics practice of mineral prospecting with chemical explosives in "deep seismic sounding" reflection seismology.

Project A119, proposed in the 1960s, which as Apollo scientist Gary Latham explained, would have been the detonating of a "smallish" nuclear device on the Moon in order to facilitate research into its geologic make-up.[89] Analogous in concept to the comparatively low yield explosion created by the water prospecting (LCROSS)Lunar Crater Observation and Sensing Satellite mission, which launched in 2009 and released the "Centaur" kinetic energy impactor, an impactor with a mass of 2,305 kg . and an impact velocity of about 9,000 km / h . releasing the kinetic energy equivalent of detonating approximately 2 tons of TNT .



A nuclear shaped charge design that was to provide nuclear pulse propulsion to the Project Orion vehicle.

Propulsion use

Although likely never achieving orbit due to aerodynamic drag, the first macroscopic object to obtain Earth orbital velocity was a "manhole cover" propelled by the detonation of test shot Pascal-B, before sputnik obtained orbital velocity, and also successfully became the first satellite, in October 1957. The use of a subterranean shaft and nuclear device to propel an object to escape velocity has since been termed a "thunder well".

The direct use of nuclear explosives, by using the impact of propellant plasma from a nuclear shaped charge acting on a pusher plate, has also been seriously studied as a potential propulsion mechanism for space travel .

Edward Teller, in the United States, proposed the use of a nuclear detonation to power an explosively pumped *soft* X-ray laser as a component of a ballistic missile defense shield, this would destroy missile components by transferring momentum to the vehicles surface by laser ablation. This ablation process is one of the damage mechanisms of a laser weapon, but it is also the basis of pulsed laser propulsion for space craft.

Ground flight testing by Professor Leik Myrabo, using a non-nuclear, conventionally powered pulsed laser test - bed, successfully lifted a light craft 72 meters in altitude by a method similar to ablative laser propulsion in 2000.

A powerful solar system based *soft* X-ray, to ultraviolet, laser system has been calculated to be capable of propelling an interstellar spacecraft, by the light sail principle, to 11 % of the speed of light.[93] In 1972 it was also calculated that a 1 Terawatt, 1- km diameter x - ray laser with 1 angstrom wavelength impinging on a 1-km diameter sail, could propel a spacecraft to Alpha Centauri in 10 years.

8 – 4 - Asteroid impact avoidance

A proposed means of averting an asteroid impacting with Earth, assuming low lead times between detection and Earth impact, is to detonate one, or a series, of nuclear explosive devices, on, in, or in a stand-off proximity orientation with the asteroid, with the latter method occurring far enough away from the incoming threat to prevent the potential fracturing of the near - Earth object, but still close enough to generate a high thrust laser ablation effect.

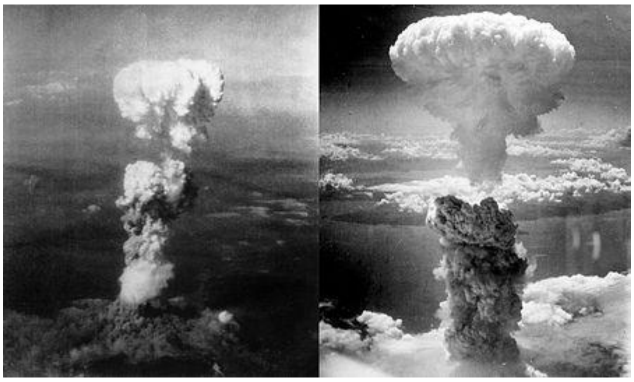
A 2007 NASA analysis of impact avoidance strategies using various technologies stated:

Nuclear stand - off explosions are assessed to be 10 - 100 times more effective than the non - nuclear alternatives analyzed in this study. Other techniques involving the surface or subsurface use of nuclear explosives may be more efficient, but they run an increased risk of fracturing the target near - Earth object. They also carry higher development and operations risks.

Analysis of the uncertainty involved in nuclear device asteroid deflection shows that the ability to protect the planet does not imply the ability to also target the planet, which is the case with all non-nuclear alternatives, such as the controversial gravity tractor technology. A nuclear explosion that changed an asteroid's velocity by 10 m / s (± 20 %) would be adequate to push it out of an Earth-impacting orbit. However, if the uncertainty of the velocity change is more than a few plus or minus percent, there would be no chance of directing the asteroid to a particular target.

However, if the need arises to use nuclear explosive devices to prevent an asteroid impact event, it may face the legal issue that the United Nations Committee on the Peaceful Uses of Outer Space and the 1996 Comprehensive Nuclear – Test - Ban Treaty ban nuclear weapons in space

Atomic Bombings of Hiroshima and Nagasaki



Atomic bomb mushroom clouds over Hiroshima (left) and Nagasaki (right)

Atomic bombings of Hiroshima and Nagasaki	
Part of the Pacific War, World War II	
Date	August 6 and 9, 1945
Location	Hiroshima and Nagasaki, Japan
Result	Allied victory
Belligerents	
United States United Kingdom	Japan
Commanders and leaders	
William S. Parsons Paul W. Tibbets, Jr.	Shunroku Hata
Units involved	
Manhattan District: 50 U.S., 2 British 509th Composite Group: 1,770 U.S.	Second General Army: Hiroshima: 40,000 Nagasaki: 9,000
Casualties and losses	
20 U.S., Dutch, British prisoners of war killed	90,000 – 166,000 killed in Hiroshima 39,000 – 80,000 killed in Nagasaki Total: 129,000 – 246,000 + killed

Contents

1 - Introduction

The atomic bombings of the cities of Hiroshima and Nagasaki in Japan were conducted by the United States during the final stages of

World War II in August 1945. The two bombings were the first and remain the only use of nuclear weapons in warfare.

As the Second World War entered its sixth and final year, the Allies had begun to prepare for, what was anticipated to be, a very costly invasion of the Japanese mainland. This was preceded by an immensely destructive firebombing campaign that obliterated many Japanese cities. The war in Europe had concluded when Nazi Germany signed its instrument of surrender on May 8, 1945, but with the Japanese refusal to accept the Allies' demands for unconditional surrender, the Pacific War dragged on. Together with the United Kingdom and China, the United State's calls for the unconditional surrender of the Japanese armed forces in the Potsdam Declaration on July 26, 1945 was buttressed with the threat of "prompt and utter destruction".

By August 1945, the Allied Manhattan Project had successfully detonated an atomic device and subsequently produced atomic weapons based on two alternate designs. The 509th Composite Group of the U.S. Army Air Forces was equipped with a Silverplate Boeing B-29 Superfortress that could deliver them from Tinian in the Mariana Islands. A uranium gun - type atomic bomb (Little Boy) was dropped on Hiroshima on August 6, 1945, followed by a plutonium implosion-type bomb (Fat Man) on the city of Nagasaki on August 9. Within the first two to four months of the bombings, the acute effects of the atomic bombings killed 90,000 – 166,000 people in Hiroshima and 60,000–80,000 in Nagasaki; roughly half of the deaths in each city occurred on the first day. During the following months, large numbers died from the effect of burns, radiation sickness, and other injuries, compounded by illness and malnutrition. In both cities, most of the dead were civilians, although Hiroshima had a sizable military garrison.

On August 15, just days after the bombing of Nagasaki and the Soviet Union's declaration of war, Japan announced its surrender to the Allies. On September 2, it signed the instrument of surrender, effectively ending World War II. The bombings' role in Japan's surrender and their ethical justification are still debated.

2 – Back ground

2 – 1 - Pacific War

In 1945, the Pacific War between the Empire of Japan and the Allies entered its fourth year. Of the 1.25 million battle casualties incurred by the United States in World War II, including both military personnel killed in action and wounded in action, nearly one million occurred in the twelve-month period from June 1944 to June 1945. December 1944 saw American battle casualties hit an all-time monthly high of 88,000 as a result of the German Ardennes Offensive. In the Pacific the Allies returned to the Philippines, recaptured Burma , and invaded Borneo. Offensives were undertaken to reduce the Japanese forces remaining in Bougainville, New Guinea and the Philippines . In April 1945, American forces landed on Okinawa, where heavy fighting continued until June. Along the way, the ratio of Japanese to American casualties dropped from 5:1 in the Philippines to 2:1 on Okinawa.

As the Allied advance moved inexorably towards Japan, conditions became steadily worse for the Japanese people. Japan's merchant fleet declined from 5,250,000 gross tons in 1941 to 1,560,000 tons in March 1945, and 557,000 tons in August 1945. Lack of raw materials forced the Japanese war economy into a steep decline after the middle of 1944. The civilian economy, which had slowly deteriorated throughout the war, reached disastrous levels by the middle of 1945. The loss of shipping also affected the fishing fleet, and the 1945 catch was only 22 % of that in 1941. The 1945 rice harvest was the worst since 1909, and hunger and malnutrition became widespread. In February 1945, Prince Fumimaro Konoe advised the Emperor Hirohito that defeat was inevitable, and urged him to abdicate.

2 – 2 - Preparations to invade Japan

Even before the surrender of Nazi Germany on May 8, 1945, plans were underway for the largest operation of the Pacific War, Operation Downfall, the invasion of Japan . The operation had two parts: Operations Olympic and Coronet. Set to begin in October 1945, Olympic involved a series of landings by the U.S. Sixth Army intended to capture the southern third of the southernmost main Japanese island, Kyūshū . Operation Olympic was to be followed in March 1946 by Operation Coronet, the capture of the Kantō Plain, near Tokyo on the main Japanese island of

Honshū by the U.S. First, Eighth and Tenth Armies. The target date was chosen to allow for Olympic to complete its objectives, for troops to be redeployed from Europe, and the Japanese winter to pass.

U.S. Army poster prepares the public for the invasion of Japan after ending war on Germany and Italy

Japan's geography made this invasion plan obvious to the Japanese; they were able to predict the Allied invasion plans accurately and thus adjust their defensive plan, Operation Ketsugō, accordingly. The Japanese planned an all-out defense of Kyūshū, with little left in reserve for any subsequent defense operations . Four veteran divisions were withdrawn from the Kwantung Army in Manchuria in March 1945 to strengthen the forces in Japan, and 45 new divisions were activated between February and May 1945. Most were immobile formations for coastal defense, but 16 were high quality mobile divisions. In all, there were 2.3 million Japanese Army troops prepared to defend the home islands, backed by a civilian militia of 28 million men and women. Casualty predictions varied widely, but were extremely high. The Vice Chief of the Imperial Japanese Navy General Staff, Vice Admiral Takijirō Ōnishi, predicted up to 20 million Japanese deaths.

A study from June 15 , 1945 , by the Joint War Plans Committee,[14] who provided planning information to the Joint Chiefs of Staff, estimated that Olympic would result in between 130,000 and 220,000 U.S. casualties of which U.S. dead would be the range from 25,000 to 46,000. Delivered on June 15, 1945, after insight gained from the Battle of Okinawa, the study noted Japan's inadequate defenses due to the very effective sea blockade and the American firebombing campaign. The Chief of Staff of the United States Army, General of the Army George Marshall, and the Army Commander in Chief in the Pacific, General of the Army Douglas MacArthur, signed documents agreeing with the Joint War Plans Committee estimate.

The Americans were alarmed by the Japanese buildup, which was accurately tracked through Ultra intelligence . Secretary of War Henry L. Stimson was sufficiently concerned about high American estimates of probable casualties to commission his own study by Quincy Wright and William Shockley. Wright and Shockley spoke with Colonels James McCormack and Dean Rusk, and examined casualty forecasts by Michael E. DeBakey and Gilbert Beebe. Wright and Shockley estimated the invading Allies would suffer between 1.7 and 4 million casualties in such a scenario, of whom between 400,000 and 800,000 would be dead, while Japanese casualties would have been around 5 to 10 million.

Marshall began contemplating the use of a weapon which was "readily available and which assuredly can decrease the cost in American lives": poison gas. Quantities of phosgene, mustard gas, tear gas and cyanogen chloride were moved to Luzon from stockpiles in Australia and New Guinea in preparation for Operation Olympic, and MacArthur ensured that Chemical Warfare Service units were trained in their use. Consideration was also given to using biological weapons against Japan.

2 – 3 - Air raids on Japan

While the United States had developed plans for an air campaign against Japan prior to the Pacific War, the capture of Allied bases in the western Pacific in the first weeks of the conflict meant that this offensive did not begin until mid - 1944 when the long - ranged Boeing B - 29 Super fortress became ready for use in combat. Operation Matterhorn involved India - based B - 29s staging through bases around Chengdu in China to make a series of raids on strategic targets in Japan. It had failed to achieve the strategic objectives that the planners had intended, largely because of logistical problems, the bomber's mechanical difficulties, the vulnerability of Chinese staging bases, and the extreme range required to reach key Japanese cities.

United States Army Air Forces (USAAF) Brigadier General Haywood S. Hansell determined that Guam, Tinian, and Saipan in the Mariana Islands would better serve as B - 29 bases, but they were in Japanese hands. Strategies were shifted to accommodate the air war, and the islands were captured between June and August 1944. Air bases were developed , and B - 29 operations commenced from the Marianas in October 1944. These bases were easily resupplied by cargo ships . The XXI Bomber Command began missions against Japan on November 18, 1944.

The early attempts to bomb Japan from the Marianas proved just as ineffective as the China - based B - 29s had been. Hansell continued the practice of conducting so - called high - altitude precision bombing even after these tactics had not produced acceptable results . These efforts proved unsuccessful due to logistical difficulties with the remote location, technical problems with the new and advanced aircraft, unfavorable weather conditions, and enemy action.

Hansell's successor, Major General Curtis LeMay, assumed command in January 1945 and initially continued to use the same tactics, with equally unsatisfactory results. Under pressure from USAAF headquarters in Washington, LeMay changed tactics and decided that low-level incendiary raids against Japanese cities were the only way to destroy their production capabilities, shifting from precision bombing to area bombardment with incendiaries. The attacks initially targeted key industrial facilities but from March 1945 , they were frequently directed against urban areas. Much of the manufacturing process was carried out in small workshops and private homes.

Like most strategic bombing during World War II, the aim of the USAAF offensive against Japan was to destroy the enemy's war industries, kill or disable civilian employees of these industries, and undermine civilian morale. Civilians who took part in the war effort through such activities as building fortifications and manufacturing munitions and other war materials in factories and workshops were considered combatants in a legal sense and therefore liable to be attacked.

Over the next six months, the XXI Bomber Command under LeMay firebombed 67 Japanese cities. The firebombing of Tokyo, codenamed Operation Meetinghouse, on March 9 – 10 killed an estimated 100,000 people and destroyed 41 km^2 of the city and 267,000 buildings in a single night — the deadliest bombing raid of the war — at a cost of 20 B-29s shot down by flak and fighters.[40] By mid - June, Japan's six largest cities had been devastated . The end of the fighting on Okinawa that month provided airfields even closer to the Japanese mainland, allowing the bombing campaign to be further escalated. Aircraft flying from Allied aircraft carriers and the Ryukyu Islands also regularly struck targets in Japan during 1945 in preparation for Operation Down fall . Firebombing switched to smaller cities, with populations ranging from 60,000 to 350,000. These raids were also very successful.

The Japanese military was unable to stop the Allied attacks and the country's civil defense preparations proved inadequate. Japanese fighters and antiaircraft guns had difficulty engaging bombers flying at high altitude . From April 1945, the Japanese interceptors also had to face American fighter escorts based on Iwo Jima and Okinawa . That month, the Imperial Japanese Army Air Service and Imperial Japanese Navy Air Service stopped attempting to intercept the air raids in order to preserve fighter aircraft to counter the expected invasion . By mid-1945 the Japanese only occasionally scrambled aircraft to intercept individual B-29s conducting reconnaissance sorties over the country, in order to conserve supplies of fuel . By July 1945, the Japanese had stock piled 1,156,000 US barrels (137,800,000 l; 36,400,000 US gal; 30,300,000 imp gal) of avgas for the invasion of Japan . While the Japanese military decided to resume attacks on Allied bombers from late June, by this time there were too few operational fighters available for this change of tactics to hinder the Allied air raids.

2 – 4 - Atomic bomb development

Working in collaboration with the United Kingdom and Canada, with their respective projects Tube Alloys and Chalk River Laboratories , the Manhattan Project, under the direction of Major General Leslie R. Groves, Jr., of the U.S. Army Corps of Engineers, designed and built the first atomic bombs . Preliminary research began in 1939, originally in fear that the German atomic bomb project would develop atomic weapons first .

With the defeat of Germany in May 1945, plans shifted to using the bomb against Japan.

Two types of bombs were eventually devised by scientists and technicians at Los Alamos under the leadership of American physicist J. Robert Oppenheimer. The Hiroshima bomb, known as a Little Boy, was a gun - type fission weapon that used uranium - 235, a rare isotope of uranium extracted in giant factories at Oak Ridge , Tennessee . The other was a more powerful and efficient but more complicated implosion-type nuclear weapon using plutonium - 239, a synthetic element created in nuclear reactors at Hanford , Washington. A test implosion weapon, the gadget, was detonated at Trinity Site, on July 16, 1945, near Alamogordo, New Mexico . The Nagasaki bomb, a Fat Man, was a similar device .

There was a Japanese nuclear weapon program, but it lacked the human, mineral and financial resources of the Manhattan Project, and never made much progress towards developing an atomic bomb.

3 - Preparations

3 – 1 - Organization and training

The 509 th Composite Group was constituted on December 9 , 1944, and activated on December 17, 1944, at Wendover Army Air Field, Utah, commanded by Colonel Paul Tibbets . Tibbets was assigned to organize and command a combat group to develop the means of delivering an atomic weapon against targets in Germany and Japan. Because the flying squadrons of the group consisted of both bomber and transport aircraft, the group was designated as a "composite" rather than a "bombardment" unit.

Working with the Manhattan Project at Los Alamos, Tibbets selected Wendover for his training base over Great Bend, Kansas, and Mountain Home, Idaho, because of its remoteness . Each bombardier completed at least 50 practice drops of inert pumpkin bombs and Tibbets declared his group combat - ready.

The 509th Composite Group had an authorized strength of 225 officers and 1,542 enlisted men, almost all of whom eventually deployed to Tinian. In addition to its authorized strength, the 509 th had attached to it on Tinian 51 civilian and military personnel from Project Alberta , known as the 1st Technical Detachment . The 509th Composite Group's 393d Bombardment Squadron was equipped with 15 Silverplate B-29s. These aircraft were specially adapted to carry nuclear weapons, and were equipped with fuel - injected engines, Curtiss Electric reversible-pitch propellers, pneumatic actuators for rapid opening and closing of bomb bay doors and other improvements.

The ground support echelon of the 509th Composite Group moved by rail on April 26, 1945, to its port of embarkation at Seattle, Washington. On May 6 the support elements sailed on the SS Cape Victory for the Marianas, while group materiel was shipped on the SS Emile Berliner. The Cape Victory made brief port calls at Honolulu and Eniwetok but the passengers were not permitted to leave the dock area. An advance party of the air echelon, consisting of 29 officers and 61 enlisted men flew by C-54 to North Field on Tinian, between May 15 and 22.

There were also two representatives from Washington, D.C., Brigadier General Thomas Farrell, the deputy commander of the Manhattan Project, and Rear Admiral William R. Purnell of the Military Policy Committee , who were on hand to decide higher policy matters on the spot. Along with Captain William S. Parsons, the commander of Project Alberta, they became known as the "Tinian Joint Chiefs".

3 – 2 - Choice of targets

In April 1945, Marshall asked Groves to nominate specific targets for bombing for final approval by himself and Stimson. Groves formed a Target Committee chaired by himself, that included Farrell, Major John A. Derry, Colonel William P. Fisher, Joyce C. Stearns and David M. Dennison from the USAAF; and scientists John von Neumann, Robert R. Wilson and William Penney from the Manhattan Project. The Target Committee met in Washington on April 27 ; at Los Alamos on May 10, where it was able to talk to the scientists and technicians there; and finally in Washington on May 28, where it was briefed by Tibbets and Commander Frederick Ashworth from Project Alberta, and the Manhattan Project's scientific advisor, Richard C. Tolman.

The Target Committee nominated five targets: Kokura, the site of one of Japan's largest munitions plants; Hiroshima, an embarkation port and industrial center that was the site of a major military headquarters; Yokohama, an urban center for aircraft manufacture, machine tools, docks, electrical equipment and oil refineries; Niigata, a port with industrial facilities including steel and aluminum plants and an oil refinery; and Kyoto, a major industrial center. The target selection was subject to the following criteria:

The target was larger than 4.8 km in diameter and was an important target in a large urban area.

The blast would create effective damage.

The target was unlikely to be attacked by August 1945.

These cities were largely untouched during the nightly bombing raids and the Army Air Forces agreed to leave them off the target list so accurate assessment of the weapon could be made. Hiroshima was described as "an important army depot and port of embarkation in the middle of an urban industrial area. It is a good radar target and it is such a size that a large part of the city could be extensively damaged. There are adjacent hills which are likely to produce a focusing effect which would considerably increase the blast damage. Due to rivers it is not a good incendiary target."

The Target Committee stated that "It was agreed that psychological factors in the target selection were of great importance. Two aspects of this are (1) obtaining the greatest psychological effect against Japan and (2) making the initial use sufficiently spectacular for the importance of the weapon to be internationally recognized when publicity on it is released. Kyoto had the advantage of being an important center for military industry, as well an intellectual center and hence a population better able to appreciate the significance of the weapon. The Emperor's palace in Tokyo has a greater fame than any other target but is of least strategic value " .

Edwin O. Reischauer, a Japan expert for the U.S. Army Intelligence Service, was incorrectly said to have prevented the bombing of Kyoto. In his autobiography, Reischauer specifically refuted this claim:

... the only person deserving credit for saving Kyoto from destruction is Henry L. Stimson, the Secretary of War at the time, who had known and admired Kyoto ever since his honeymoon there several decades earlier.

On May 30, Stimson asked Groves to remove Kyoto from the target list, but Groves pointed to its military and industrial significance . Stimson then approached President Harry S. Truman about the matter. Truman agreed with Stimson, and Kyoto was temporarily removed from the target list. Groves attempted to restore Kyoto to the target list in July, but Stimson remained adamant . On July 25, Nagasaki was put on the target list in place of Kyoto . Orders for the attack were issued to General Carl Spaatz on July 25 under the signature of General Thomas T. Handy, the acting Chief of Staff, since Marshall was at the Potsdam Conference with Truman.[76] That day, Truman noted in his diary that:

This weapon is to be used against Japan between now and August 10th . I have told the Sec. of War, Mr. Stimson, to use it so that military objectives and soldiers and sailors are the target and not women and children. Even if the Japs are savages, ruthless, merciless and fanatic, we as the leader of the world for the common welfare cannot drop that terrible bomb on the old capital [Kyoto] or the new [Tokyo]. He and I are in accord. The target will be a purely military one.

3 – 3 - Proposed demonstration

In early May 1945, the Interim Committee was created by Stimson at the urging of leaders of the Manhattan Project and with the approval of Truman to advise on matters pertaining to nuclear energy . During the meetings on May 31 and June 1 , scientist Ernest Lawrence had suggested giving the Japanese a non - combat demonstration . Arthur Compton later recalled that :

It was evident that everyone would suspect trickery. If a bomb were exploded in Japan with previous notice, the Japanese air power was still adequate to give serious interference. An atomic bomb was an intricate device, still in the developmental stage. Its operation would be far from routine. If during the final adjustments of the bomb the Japanese defenders should attack, a faulty move might easily result in some kind of failure. Such an end to an advertised demonstration of power would be much worse than if the attempt had not been made. It was now evident that when the time came for the bombs to be used we should have only one of them available, followed afterwards by others at all – too - long intervals. We could not afford the chance that one of them might be a dud. If the test were made on some neutral territory, it was hard to believe that Japan's determined and fanatical military men would be impressed. If such an open test were made first and failed to bring surrender, the chance would be gone to give the shock of surprise that proved so effective. On the contrary, it would make the Japanese ready to interfere with an atomic attack if they could. Though the possibility of a demonstration that would not destroy human lives was attractive, no one could suggest a way in which it could be made so convincing that it would be likely to stop the war.

The possibility of a demonstration was raised again in the Franck Report issued by physicist James Franck on June 11 and the Scientific Advisory Panel rejected his report on June 16, saying that "we can propose no technical demonstration likely to bring an end to the war; we see no acceptable alternative to direct military use ." Franck then took the report to Washington, D.C., where the Interim Committee met on June 21 to re-examine its earlier conclusions; but it reaffirmed that there was no alternative to the use of the bomb on a military target.

Like Compton, many U.S. officials and scientists argued that a demonstration would sacrifice the shock value of the atomic attack, and the Japanese could deny the atomic bomb was lethal, making the mission less likely to produce surrender. Allied prisoners of war might be moved to the demonstration site and be killed by the bomb. They also worried that the bomb might be a dud since the Trinity test was of a stationary device, not an air-dropped bomb. In addition, only two bombs would be available at the start of August, although more were in production, and they cost billions of dollars, so using one for a demonstration would be expensive.

3 – 4 – Leaflets

For several months, the U.S. had dropped more than 63 million leaflets across Japan warning civilians of air raids. Many Japanese cities suffered terrible damage from aerial bombings, some were as much as 97% destroyed. LeMay thought that this would increase the psychological impact of bombing, and reduce the stigma of area bombing cities. Even with the warnings, Japanese opposition to the war remained ineffective. In general, the Japanese regarded the leaflet messages as truthful, but anyone who was caught in possession of one was arrested.[84][85] Leaflet texts were prepared by recent Japanese prisoners of war because they were thought to be the best choice "to appeal to their compatriots".

In preparation for dropping an atomic bomb on Hiroshima, U.S. military leaders decided against a demonstration bomb, and against a special leaflet warning, in both cases because of the uncertainty of a successful detonation, and the wish to maximize psychological shock . No warning was given to Hiroshima that a new and much more destructive bomb was going to be dropped . Various sources give conflicting information about when the last leaflets were dropped on Hiroshima prior to the atomic bomb. Robert Jay Lifton writes that it was July 27,[88] and Theodore H. McNelly that it was July 3.[87] The USAAF history notes eleven cities were targeted with leaflets on July 27, but Hiroshima was not one of them, and there were no leaflet sorties on July 30.[85] Leaflet sorties were undertaken on August 1 and 4. It is very likely that Hiroshima was leafleted in late July or early August, as survivor accounts talk about a delivery of leaflets a few days before the atomic bomb was dropped.[88] One such leaflet lists twelve cities targeted for firebombing: Otaru, Akita, Hachinohe, Fukushima, Urawa, Takayama, Iwakuni, Tottori, Imabari, Yawata, Miyakonojo, and Saga. Hiroshima was not listed.

3 – 5 - Potsdam ultimatum

On July 26, Allied leaders issued the Potsdam Declaration outlining terms of surrender for Japan. It was presented as an ultimatum and stated that without a surrender, the Allies would attack Japan, resulting in "the inevitable and complete destruction of the Japanese armed forces and just as inevitably the utter devastation of the Japanese homeland". The atomic bomb was not mentioned in the communiqué. On July 28, Japanese papers reported that the declaration had been rejected by the Japanese government. That afternoon, Prime Minister Suzuki Kantarō declared at a press conference that the Potsdam Declaration was no more than a rehash (yakinaoshi) of the Cairo Declaration and that the government intended to ignore it (mokusatsu, "kill by silence") . The statement was taken by both Japanese and foreign papers as a clear rejection of the declaration.

Emperor Hirohito, who was waiting for a Soviet reply to non - committal Japanese peace feelers, made no move to change the government position.

Under the 1943 Quebec Agreement with the United Kingdom, the United States had agreed that nuclear weapons would not be used against another country without mutual consent. In June 1945 the head of the British Joint Staff Mission , Field Marshal Sir Henry Maitland Wilson, agreed that the use of nuclear weapons against Japan would be officially recorded as a decision of the Combined Policy Committee . At Potsdam, Truman agreed to a request from Winston Churchill that Britain be represented when the atomic bomb was dropped . William Penney and Group Captain Leonard Cheshire were sent to Tinian, but found that LeMay would not let them accompany the mission. All they could do was send a strongly worded signal back to Wilson.

3 – 1 - Bombs

The Little Boy bomb, except for the uranium payload, was ready at the beginning of May 1945 . The uranium - 235 projectile was completed on June 15 , and the target on July 24. The target and bomb pre-assemblies (partly assembled bombs without the fissile components) left Hunters Point Naval Shipyard , California, on July 16 aboard the cruiser USS Indianapolis, arriving July 26 . The target inserts followed by air on July 30.

The first plutonium core, along with its polonium-beryllium urchin initiator, was transported in the custody of Project Alberta courier Raemer Schreiber in a magnesium field carrying case designed for the purpose by Philip Morrison. Magnesium was chosen because it does not act as a tamper . The core departed from Kirtland Army Air Field on a C-54 transport aircraft of the 509th Composite Group's 320th Troop Carrier Squadron on July 26, and arrived at North Field July 28 . Three Fat Man high-explosive pre - assemblies , designated F31, F32, and F33, were picked up at Kirtland on July 28 by three B-29s, from the 393d Bombardment Squadron, plus one from the 216th Army Air Force Base Unit, and transported to North Field, arriving on August 2.

4 – Hiroshima

4 – 1 - Hiroshima during World War II

The Enola Gay dropped the "Little Boy" atomic bomb on Hiroshima. In this photograph are five of the aircraft's ground crew with mission commander Paul Tibbets in the center.

At the time of its bombing, Hiroshima was a city of both industrial and military significance. A number of military units were located nearby, the most important of which was the headquarters of Field Marshal Shunroku Hata's Second General Army, which commanded the defense of all of southern Japan , and was located in Hiroshima Castle. Hata's command consisted of some 400,000 men, most of whom were on Kyushu where an Allied invasion was correctly anticipated . Also present in Hiroshima were the headquarters of the 59th Army, the 5th Division and the 224th Division, a recently formed mobile unit . The city was defended by five batteries of 7 - and - 8 - centimeter anti - aircraft guns of the 3rd Anti – Air craft Division , including units from the 121st and 122 nd Anti -Aircraft Regiments and the 22 nd and 45 th Separate Anti-Aircraft Battalions. In total, over 40,000 military personnel were stationed in the city.

Hiroshima was a minor supply and logistics base for the Japanese military, but it also had large stockpiles of military supplies . The city was a communications center, a key port for shipping and an assembly area for troops . It was also the second largest city in Japan after Kyoto that was still undamaged by air raids , due to the fact that it lacked the aircraft manufacturing industry that was the XXI Bomber Command's priority target. On July 3, the Joint Chiefs of Staff placed it off limits to bombers, along with Kokura, Niigata and Kyoto.

The center of the city contained several reinforced concrete buildings and lighter structures. Outside the center, the area was congested by a dense collection of small wooden workshops set among Japanese houses. A few larger industrial plants lay near the outskirts of the city. The houses were constructed of wood with tile roofs, and many of the industrial buildings were also built around wood frames. The city as a whole was highly susceptible to fire damage .

The population of Hiroshima had reached a peak of over 381,000 earlier in the war but prior to the atomic bombing, the population had steadily decreased because of a systematic evacuation ordered by the Japanese government. At the time of the attack, the population was approximately 340,000 – 350,000 . Residents wondered why Hiroshima had been spared destruction by firebombing . Some speculated that the city was to be saved for U.S. occupation headquarters, others thought perhaps their relatives in Hawaii and California had petitioned the U.S. government to avoid bombing Hiroshima . More realistic city officials had ordered buildings torn down to create long, straight firebreaks, beginning in 1944. Firebreaks continued to be expanded and extended up to the morning of August 6, 1945.

4 – 2 - The bombing

Hiroshima was the primary target of the first nuclear bombing mission on 6 August, with Kokura and Nagasaki as alternative targets. The 393d Bombardment Squadron B - 29 Enola Gay, piloted by Tibbets, took off from North Field, Tinian, about six hours' flight time from Japan. The Enola Gay (named after Tibbets' mother) was accompanied by two other B-29s. The Great Artiste, commanded by Major Charles Sweeney, carried instrumentation, and a then-nameless aircraft later called Necessary Evil, commanded by Captain George Marquardt, served as the photography aircraft.

After leaving Tinian the aircraft made their way separately to Iwo Jima to rendezvous with Sweeney and Marquardt at 05:55 at 2,800 m , and set course for Japan. The aircraft arrived over the target in clear visibility at 9,470 m . Parsons, who was in command of the mission, armed the bomb during the flight to minimize the risks during takeoff. He had witnessed four B-29s crash and burn at takeoff, and feared that a nuclear explosion would occur if a B-29 crashed with an armed Little Boy on board . His assistant, Second Lieutenant Morris R. Jeppson, removed the safety devices 30 minutes before reaching the target area.

During the night of August 5 – 6, Japanese early warning radar detected the approach of numerous American aircraft headed for the southern part of Japan. Radar detected 65 bombers headed for Saga, 102 bound for Maebashi, 261 en route to Nishinomiya, 111 headed for Ube and 66 bound for Imabari. An alert was given and radio broadcasting stopped in many cities, among them Hiroshima. The all - clear was sounded in Hiroshima at 00:05 . About an hour before the bombing, the air raid alert was sounded again, as Straight Flush flew over the city. It broadcast a short message which was picked up by Enola Gay. It read: "Cloud cover less than 3/10th at all altitudes. Advice: bomb primary ". The all - clear was sounded over Hiroshima again at 07:09.

At 08:09 Tibbets started his bomb run and handed control over to his bombardier, Major Thomas Ferebee . The release at 08:15 (Hiroshima time) went as planned, and the Little Boy containing about 64 kg (141 lb) of uranium-235 took 44.4 seconds to fall from the aircraft flying at about 9,400 m to a detonation height of about 580 m above the city. Enola Gay traveled 18.5 km before it felt the shock waves from the blast.

People on the ground reported seeing a pika or brilliant flash of light followed by a don, a loud booming sound . Some 70,000 – 80,000 people, of whom 20,000 were soldiers, or around 30% of the population of Hiroshima, were killed by the blast and resultant firestorm , and another 70,000 injured .

5 - Events on the ground

Some of the reinforced concrete buildings in Hiroshima had been very strongly constructed because of the earthquake danger in Japan, and their framework did not collapse even though they were fairly close to the blast center. Since the bomb detonated in the air, the blast was directed more downward than side ways, which was largely responsible for the survival of the Prefectural Industrial Promotional Hall, now commonly known as the Genbaku (A-bomb) dome. This building was designed and built by the Czech architect Jan Letzel, and was only 150 m from ground zero. The ruin was named Hiroshima Peace Memorial and was made a UNESCO World Heritage Site in 1996 over the objections of the United States and China, which expressed reservations on the grounds that other Asian nations were the ones who suffered the greatest loss of life and property, and a focus on Japan lacked historical perspective .

The Americans estimated that 4.7 square miles (12 km2) of the city were destroyed. Japanese officials determined that 69% of Hiroshima's buildings were destroyed and another 6 –7 % damaged.[137] The bombing started fires that spread rapidly through wood and paper homes. As in other Japanese cities, the firebreaks proved ineffective.

Eizō Nomura was the closest known survivor, who was in the basement of a reinforced concrete building (it remained as the Rest House after the war) only 170 metres from ground zero (the hypocenter) at the time of the attack . He lived into his 80s . Akiko Takakura was among the closest survivors to the hypocenter of the blast. She had been in the solidly built Bank of Hiroshima only 300 meters from ground - zero at the time of the attack .

Over 90 % of the doctors and 93 % of the nurses in Hiroshima were killed or injured — most had been in the downtown area which received the greatest damage . The hospitals were destroyed or heavily damaged. Only one doctor, Terufumi Sasaki, remained on duty at the Red Cross Hospital. Nonetheless, by early afternoon, the police and volunteers had established evacuation centres at hospitals, schools and tram stations, and a morgue was established in the Asano library.

Most elements of the Japanese Second General Army headquarters were at physical training on the grounds of Hiroshima Castle, barely 820 m from the hypocenter. The attack killed 3,243 troops on the parade ground . The communications room of Chugoku Military District Head quarters that was responsible for issuing and lifting air raid warnings was in a semi - basement in the castle. Yoshie Oka, a Hijiyama Girls High School student who had been mobilized to serve as a communications officer had just sent a message that the alarm had been issued for Hiroshima and Yamaguchi when the bomb exploded. She used a special phone to inform Fukuyama Headquarters that "Hiroshima has been attacked by a new type of bomb. The city is in a state of near-total destruction ".

Since Mayor Senkichi Awaya had been killed while eating breakfast with his son and granddaughter at the mayoral residence, Field Marshal Hata, who was only slightly wounded, took over the administration of the city, and coordinated relief efforts. Many of his staff had been killed or fatally wounded , including a Korean prince of the Joseon Dynasty, Yi Wu, who was serving as a lieutenant colonel in the Japanese Army. Hata's senior surviving staff officer was the wounded Colonel Kumao Imoto, who acted as his chief of staff. Hiroshima Ujina Harbor was undamaged, and soldiers from there used suicide boats intended to repel the American invasion to collect the wounded, and take them down the rivers to the military hospital at Ujina.[148] Trucks and trains brought in relief supplies and evacuated survivors from the city.

Twelve American airmen were imprisoned at the Chugoku Military Police Headquarters located about 400 m from the hypocenter of the blast . Most died instantly, although two were reported to have been executed by their captors, and two prisoners badly injured by the bombing were left next to the Aioi Bridge by the Kempei Tai, where they were stoned to death.

4 - 4 - Japanese realization of the bombing

The Tokyo control operator of the Japan Broadcasting Corporation noticed that the Hiroshima station had gone off the air. He tried to re-establish his program by using another telephone line, but it too had failed. About 20 minutes later the Tokyo railroad telegraph center realized that the main line telegraph had stopped working just north of Hiroshima. From some small railway stops within 16 km of the city came unofficial and confused reports of a terrible explosion in Hiroshima. All these reports were transmitted to the headquarters of the Imperial Japanese Army General Staff .

Military bases repeatedly tried to call the Army Control Station in Hiroshima. The complete silence from that city puzzled the General Staff; they knew that no large enemy raid had occurred and that no sizable store of explosives was in Hiroshima at that time. A young officer was instructed to fly immediately to Hiroshima, to land, survey the damage, and return to Tokyo with reliable information for the staff. It was felt that nothing serious had taken place and that the explosion was just a rumor.

The staff officer went to the airport and took off for the southwest. After flying for about three hours, while still nearly 160 km (99 mi) from Hiroshima, he and his pilot saw a great cloud of smoke from the bomb. In the bright afternoon, the remains of Hiroshima were burning. Their plane soon reached the city, around which they circled in disbelief. A great scar on the land still burning and covered by a heavy cloud of smoke was all that was left. They landed south of the city, and the staff officer, after reporting to Tokyo, began to organize relief measures.

5 - Events of August 7 – 9

After the Hiroshima bombing, Truman issued a statement announcing the use of the new weapon. He stated, "We may be grateful to Providence" that the German atomic bomb project had failed, and that the United States and its allies had "spent two billion dollars on the greatest scientific gamble in history — and won." Truman then warned Japan: "If they do not now accept our terms, they may expect a rain of ruin from the air, the like of which has never been seen on this earth. Behind this air attack will follow sea and land forces in such numbers and power as they have not yet seen and with the fighting skill of which they are already well aware."

The Japanese government did not react. Emperor Hirohito, the government, and the war council considered four conditions for surrender: the preservation of the kokutai (Imperial institution and national polity) , assumption by the Imperial Headquarters of responsibility for disarmament and demobilization, no occupation of the Japanese Home Islands, Korea, or Formosa, and delegation of the punishment of war criminals to the Japanese government.

The Soviet Foreign Minister Vyacheslav Molotov informed Tokyo of the Soviet Union's unilateral abrogation of the Soviet – Japanese Neutrality Pact on August 5. At two minutes past midnight on August 9, Tokyo time, Soviet infantry, armor, and air forces had launched the Manchurian Strategic Offensive Operation . Four hours later, word reached Tokyo of the Soviet Union's official declaration of war. The senior leadership of the Japanese Army began preparations to impose martial law on the nation, with the support of Minister of War Korechika Anami, in order to stop anyone attempting to make peace.

On August 7, a day after Hiroshima was destroyed, Dr. Yoshio Nishina and other atomic physicists arrived at the city, and carefully examined the damage. They then went back to Tokyo and told the cabinet that Hiroshima was indeed destroyed by an atomic bomb. Admiral Soemu Toyoda, the Chief of the Naval General Staff, estimated that no more than one or two additional bombs could be readied, so they decided to endure the remaining attacks, acknowledging "there would be more destruction but the war would go on ". American Magic codebreakers intercepted the cabinet's messages.

Purnell, Parsons, Tibbets, Spaatz, and LeMay met on Guam that same day to discuss what should be done next.[163] Since there was no indication of Japan surrendering , they decided to proceed with dropping another bomb. Parsons said that Project Alberta would have it ready by August 11, but Tibbets pointed to weather reports indicating poor flying conditions on that day due to a storm, and asked if the bomb could be readied by August 9. Parsons agreed to try to do so.

6 - Nagasaki

I realize the tragic significance of the atomic bomb ... It is an awful responsibility which has come to us ... We thank God that it has come to us, instead of to our enemies; and we pray that He may guide us to use it in His ways and for His purposes.

—President Harry S. Truman, August 9, 1945

6 – 1 - Nagasaki during World War II

The city of Nagasaki had been one of the largest seaports in southern Japan, and was of great wartime importance because of its wide-ranging industrial activity, including the production of ordnance, ships, military equipment, and other war materials. The four largest companies in the city were Mitsubishi Shipyards , Electrical Shipyards, Arms Plant, and Steel and Arms Works, which employed about 90 % of the city's labor force, and accounted for 90% of the city's industry. Although an important industrial city, Nagasaki had been spared from firebombing because its geography made it difficult to locate at night with AN / APQ -13 radar.

The Bockscar and its crew,
who dropped the Fat Man atomic bomb on Nagasaki

Unlike the other target cities, Nagasaki had not been placed off limits to bombers by the Joint Chiefs of Staff's July 3 directive , and was bombed on a small scale five times. During one of these raids on 1 August, a number of conventional high - explosive bombs were dropped on the city. A few hit the shipyards and dock areas in the southwest portion of the city, and several hit the Mitsubishi Steel and Arms Works.[166] By early August, the city was defended by the IJA 134th Anti - Aircraft Regiment of the 4th Anti - Aircraft Division with four batteries of 7 cm anti - aircraft guns and two searchlight batteries .

In contrast to Hiroshima, almost all of the buildings were of old-fashioned Japanese construction , consisting of wood or wood - frame buildings with wood walls (with or without plaster) and tile roofs. Many of the smaller industries and business establishments were also situated in buildings of wood or other materials not designed to withstand explosions.

Nagasaki had been permitted to grow for many years without conforming to any definite city zoning plan; residences were erected adjacent to factory buildings and to each other almost as closely as possible throughout the entire industrial valley. On the day of the bombing, an estimated 263,000 people were in Nagasaki, including 240,000 Japanese residents, 10,000 Korean residents , 2,500 conscripted Korean workers, 9,000 Japanese soldiers, 600 conscripted Chinese workers, and 400 Allied prisoners of war in a camp to the north of Nagasaki.

6 – 2 - The bombing

Responsibility for the timing of the second bombing was delegated to Tibbets. Scheduled for August 11 against Kokura, the raid was moved earlier by two days to avoid a five-day period of bad weather forecast to begin on August 10. Three bomb pre-assemblies had been transported to Tinian, labeled F-31, F-32, and F-33 on their exteriors. On August 8, a dress rehearsal was conducted off Tinian by Sweeney using Bockscar as the drop airplane. Assembly F-33 was expended testing the components and F-31 was designated for the August 9 mission.

At 03:49 on the morning of August 9, 1945, Bockscar, flown by Sweeney's crew, carried Fat Man, with Kokura as the primary target and Nagasaki the secondary target. The mission plan for the second attack was nearly identical to that of the Hiroshima mission, with two B-29s flying an hour ahead as weather scouts and two additional B-29s in Sweeney's flight for instrumentation and photographic support of the mission. Sweeney took off with his weapon already armed but with the electrical safety plugs still engaged.

During pre-flight inspection of Bockscar, the flight engineer notified Sweeney that an inoperative fuel transfer pump made it impossible to use 640 US gallons (2,400 l; 530 imp gal) of fuel carried in a reserve tank. This fuel would still have to be carried all the way to Japan and back, consuming still more fuel. Replacing the pump would take hours; moving the Fat Man to another aircraft might take just as long and was dangerous as well, as the bomb was live. Tibbets and Sweeney therefore elected to have Bockscar continue the mission .

This time Penney and Cheshire were allowed to accompany the mission, flying as observers on the third plane, Big Stink, flown by the group's operations officer, Major James I. Hopkins, Jr. Observers aboard the weather planes reported both targets clear. When Sweeney's aircraft arrived at the assembly point for his flight off the coast of Japan, Big Stink failed to make the rendezvous . According to Cheshire, Hopkins was at varying heights including 2,700 m higher than he should have been, and was not flying tight circles over Yakushima as previously agreed with Sweeney and Captain Frederick C. Bock, who was piloting the support B-29 The Great Artiste. Instead, Hopkins was flying 64 km dogleg patterns . Though ordered not to circle longer than fifteen minutes, Sweeney continued to wait for Big Stink, at the urging of Ashworth, the plane's weaponeer, who was in command of the mission.

After exceeding the original departure time limit by a half hour, Bockscar, accompanied by The Great Artiste, proceeded to Kokura, thirty minutes away. The delay at the rendezvous had resulted in clouds and drifting smoke from fires started by a major firebombing raid by 224 B-29s on nearby Yahata the previous day over Kokura. Additionally, the Yawata Steel Works intentionally burned coal tar, to produce black smoke. The clouds and smoke resulted in 70 % of the area over Kokura being covered, obscuring the aiming point. Three bomb runs were made over the next 50 minutes, burning fuel and exposing the aircraft repeatedly to the heavy defenses of Yawata, but the bombardier was unable to drop visually. By the time of the third bomb run, Japanese antiaircraft fire was getting close, and Second Lieutenant Jacob Beser, who was monitoring Japanese communications, reported activity on the Japanese fighter direction radio bands.

After three runs over the city, and with fuel running low because of the failed fuel pump, they headed for their secondary target, Nagasaki. Fuel consumption calculations made en route indicated that Bockscar had insufficient fuel to reach Iwo Jima and would be forced to divert to Okinawa. After initially deciding that if Nagasaki were obscured on their arrival the crew would carry the bomb to Okinawa and dispose of it in the ocean if necessary, Ashworth ruled that a radar approach would be used if the target was obscured.

At about 07:50 Japanese time, an air raid alert was sounded in Nagasaki, but the "all clear" signal was given at 08:30. When only two B-29 Superfortresses were sighted at 10:53, the Japanese apparently assumed that the planes were only on reconnaissance and no further alarm was given.

A few minutes later at 11:00, The Great Artiste dropped instruments attached to three parachutes. These instruments also contained an unsigned letter to Professor Ryokichi Sagane, a physicist at the University of Tokyo who studied with three of the scientists responsible for the atomic bomb at the University of California, Berkeley , urging him to tell the public about the danger involved with these weapons of mass destruction. The messages were found by military authorities but not turned over to Sagane until a month later. In 1949, one of the authors of the letter, Luis Alvarez, met with Sagane and signed the document.

At 11:01, a last-minute break in the clouds over Nagasaki allowed Bockscar's bombardier, Captain Kermit Beahan, to visually sight the target as ordered. The Fat Man weapon, containing a core of about 6.4 kg of plutonium, was dropped over the city's industrial valley at

Big Stink spotted the explosion from a hundred miles away, and flew over to observe.[187] Because of the delays in the mission and the inoperative fuel transfer pump, Bockscar did not have sufficient fuel to reach the emergency landing field at Iwo Jima, so Sweeney and Bock flew to Okinawa. Arriving there, Sweeney circled for 20 minutes trying to contact the control tower for landing clearance, finally concluding that his radio was faulty. Critically low on fuel, Bockscar barely made it to the runway on Okinawa's Yontan Airfield. With only enough fuel for one landing attempt, Sweeney and Albury brought Bockscar in at 150 miles per hour (240 km/h) instead of the normal 120 miles per hour (190 km/h), firing distress flares to alert the field of the uncleared landing. The number two engine died from fuel starvation as Bockscar began its final approach. Touching the runway hard, the heavy B-29 slewed left and towards a row of parked B-24 bombers before the pilots managed to regain control. The B-29's reversible propellers were insufficient to slow the aircraft adequately, and with both pilots standing on the brakes, Bockscar made a swerving 90 - degree turn at the end of the runway to avoid running off the runway. A second engine died from fuel exhaustion by the time the plane came to a stop. The flight engineer later measured fuel in the tanks and concluded that less than five minutes total remained.

Following the mission, there was confusion over the identification of the plane. The first eyewitness account by war correspondent William L. Laurence of the New York Times, who accompanied the mission aboard the aircraft piloted by Bock, reported that Sweeney was leading the mission in The Great Artiste. He also noted its "Victor" number as 77, which was that of Bockscar, writing that several personnel commented that 77 was also the jersey number of the football player Red Grange.[189] Laurence had interviewed Sweeney and his crew, and was aware that they referred to their airplane as The Great Artiste. Except for Enola Gay, none of the 393d's B-29s had yet had names painted on the noses, a fact which Laurence himself noted in his account. Unaware of the switch in aircraft, Laurence assumed Victor 77 was The Great Artiste,[190] which was in fact, Victor 89.

6 – 3 - Events on the ground

A photograph of Sumiteru Taniguchi's back injuries taken in January 1946 by a U.S. Marine photographer

Although the bomb was more powerful than the one used on Hiroshima, the effect was confined by hillsides to the narrow Urakami Valley . Of 7,500 Japanese employees who worked inside the Mitsubishi Munitions plant, including mobilized students and regular workers, 6,200 were killed. Some 17,000 – 22,000 others who worked in other war plants and factories in the city died as well . Casualty estimates for immediate deaths vary widely, ranging from 22,000 to 75,000 . In the days and months following the explosion, more people died from bomb effects. Because of the presence of undocumented foreign workers, and a number of military personnel in transit, there are great discrepancies in the estimates of total deaths by the end of 1945; a range of 39,000 to 80,000 can be found in various studies.

Unlike Hiroshima's military death toll, only 150 soldiers were killed instantly, including thirty - six from the IJA 134th AAA Regiment of the 4th AAA Division. At least eight known POWs died from the bombing and as many as 13 may have died, including a British citizen, Royal Air Force Corporal Ronald Shaw , and seven Dutch POWs . One American POW, Joe Kieyoomia, was in Nagasaki at the time of the bombing but survived, reportedly having been shielded from the effects of the bomb by the concrete walls of his cell . There were 24 Australian POWs in Nagasaki, all of whom survived.

The radius of total destruction was about 1.6 km , followed by fires across the northern portion of the city to 3.2 km south of the bomb . About 58 % of the Mitsubishi Arms Plant was damaged, and about 78 % of the Mitsubishi Steel Works. The Mitsubishi Electric Works only suffered 10% structural damage as it was on the border of the main destruction zone. The Mitsubishi - Urakami Ordnance Works, the factory that manufactured the type 91 torpedoes released in the attack on Pearl Harbor, was destroyed in the blast.

7 - Plans for more atomic attacks on Japan

Groves expected to have another atomic bomb ready for use on August 19, with three more in September and a further three in October.[83] On August 10, he sent a memorandum to Marshall in which he wrote that "the next bomb ... should be ready for delivery on the first suitable weather after 17 or 18 August." On the same day, Marshall endorsed the memo with the comment, "It is not to be released over Japan without express authority from the President." .

There was already discussion in the War Department about conserving the bombs then in production for Operation Downfall. "The problem now [August 13] is whether or not, assuming the Japanese do not capitulate, to continue dropping them every time one is made and shipped out there or whether to hold them ... and then pour them all on in a reasonably short time. Not all in one day, but over a short period. And that also takes into consideration the target that we are after. In other words, should we not concentrate on targets that will be of the greatest assistance to an invasion rather than industry, morale, psychology, and the like? Nearer the tactical use rather than other use."

Two more Fat Man assemblies were readied. The third core was scheduled to leave Kirtland Field for Tinian on August 15,[205] and Tibbets was ordered by LeMay to return to Utah to collect it.[206] Robert Bacher was packaging it for shipment in Los Alamos on August 14 when he received word from Groves that the shipment was suspended .

8 - Surrender of Japan and subsequent occupation

Until August 9, Japan's war council still insisted on its four conditions for surrender. On that day Hirohito ordered Kōichi Kido to "quickly control the situation ... because the Soviet Union has declared war against us." He then held an Imperial conference during which he authorized minister Shigenori Tōgō to notify the Allies that Japan would accept their terms on one condition, that the declaration "does not comprise any demand which prejudices the prerogatives of His Majesty as a Sovereign ruler " .

On August 12, the Emperor informed the imperial family of his decision to surrender. One of his uncles, Prince Asaka, then asked whether the war would be continued if the kokutai could not be preserved. Hirohito simply replied "Of course " . As the Allied terms seemed to leave intact the principle of the preservation of the Throne, Hirohito recorded on August 14 his capitulation announcement which was broadcast to the Japanese nation the next day despite a short rebellion by militarists opposed to the surrender.

In his declaration, Hirohito referred to the atomic bombings:

More over, the enemy now possesses a new and terrible weapon with the power to destroy many innocent lives and do incalculable damage. Should we continue to fight, not only would it result in an ultimate collapse and obliteration of the Japanese nation, but also it would lead to the total extinction of human civilization.

Such being the case, how are We to save the millions of Our subjects, or to atone Ourselves before the hallowed spirits of Our Imperial Ancestors? This is the reason why We have ordered the acceptance of the provisions of the Joint Declaration of the Powers.

In his "Rescript to the Soldiers and Sailors" delivered on August 17, he stressed the impact of the Soviet invasion and his decision to surrender, omitting any mention of the bombs . Hirohito met with General MacArthur on September 27 , saying to him that "[t]he peace party did not prevail until the bombing of Hiroshima created a situation which could be dramatized." Furthermore, the "Rescript to the Soldiers and Sailors" speech he told MacArthur about was just personal, not political, and never stated that the Soviet intervention in Manchuria was the main reason for surrender. In fact, a day after the bombing of Nagasaki and the Soviet invasion of Manchuria, Hirohito ordered his advisers, primarily Chief Cabinet Secretary Hisatsune Sakomizu, Kawada Mizuho, and Masahiro Yasuoka, to write up a surrender speech. In Hirohito's speech, days before announcing it on radio on August 15 , he gave three major reasons for surrender: Tokyo's defenses would not be complete before the American invasion of Japan, Ise Shrine would be lost to the Americans, and atomic weapons deployed by the Americans would lead to the death of the entire Japanese race. Despite the Soviet intervention, Hirohito did not mention the Soviets as the main factor for surrender.

9 – Depiction , public response and censor ship

During the war "annihilationist and exterminationalist rhetoric" was tolerated at all levels of U.S. society; according to the British embassy in Washington the Americans regarded the Japanese as "a nameless mass of vermin" . Caricatures depicting Japanese as less than human, e.g. monkeys, were common. A 1944 opinion poll that asked what should be done with Japan found that 13 % of the U.S. public were in favor of "killing off" all Japanese: men, women, and children.

After the Hiroshima bomb detonated successfully, Robert Oppenheimer addressed an assembly at Los Alamos "clasping his hands together like a prize-winning boxer" . The Vatican was less enthusiastic; its newspaper L'Osservatore Romano expressed regret that the bomb's inventors did not destroy the weapon for the benefit of humanity.[218] Nonetheless, news of the atomic bombing was greeted enthusiastically in the U.S.; a poll in Fortune magazine in late 1945 showed a significant minority of Americans (22.7 %) wishing that more atomic bombs could have been dropped on Japan . The initial positive response was supported by the imagery presented to the public (mainly the powerful images of the mushroom cloud) and the censorship of photographs that showed corpses and maimed survivors.

Wilfred Burchett was the first journalist to visit Hiroshima after the atom bomb was dropped, arriving alone by train from Tokyo on September 2, the day of the formal surrender aboard the USS Missouri. His Morse code dispatch was printed by the Daily Express newspaper in London on September 5, 1945, entitled "The Atomic Plague", the first public report to mention the effects of radiation and nuclear fallout.[221] Burchett's reporting was unpopular with the U.S. military. The U.S. censors suppressed a supporting story submitted by George Weller of the Chicago Daily News, and accused Burchett of being under the sway of Japanese propaganda. Laurence dismissed the reports on radiation sickness as Japanese efforts to undermine American morale, ignoring his own account of Hiroshima's radiation sickness published one week earlier.

A member of the U.S. Strategic Bombing Survey, Lieutenant Daniel McGovern, used a film crew to document the results in early 1946. The film crew's work resulted in a three-hour documentary entitled The Effects of the Atomic Bombs Against Hiroshima and Nagasaki. The documentary included images from hospitals showing the human effects of the bomb; it showed burned out buildings and cars, and rows of skulls and bones on the ground. It was classified "secret" for the next 22 years. During this time in America, it was a common practice for editors to keep graphic images of death out of films, magazines, and newspapers . The total of 27,000 m of film shot by McGovern's cameramen had not been fully aired as of 2009. According to Greg Mitchell, with the 2004 documentary film Original Child Bomb, a small part of that footage managed to reach part of the American public "in the unflinching and powerful form its creators intended".

Motion picture company Nippon Eigasha started sending cameramen to Nagasaki and Hiroshima in September 1945. On October 24, 1945, a U.S. military policeman stopped a Nippon Eigasha cameraman from continuing to film in Nagasaki. All Nippon Eigasha's reels were then confiscated by the American authorities. These reels were in turn requested by the Japanese government, declassified, and saved from oblivion. Some black – and - white motion pictures were released and shown for the first time to Japanese and American audiences in the years from 1968 to 1970 . The public release of film footage of the city post attack, and some research about the human effects of the attack, was restricted during the occupation of Japan , and much of this information was censored until the signing of the San Francisco Peace Treaty in 1951, restoring control to the Japanese .

Only the most sensitive and detailed weapons effects information was censored during this period. There was no censorship of the factually written accounts. For example, the book Hiroshima written by Pulitzer Prize winner John Hersey, which was originally published in article form in the popular magazine The New Yorker , on August 31, 1946, is reported to have reached Tokyo in English by January 1947, and the translated version was released in Japan in 1949 . The book narrates the stories of the lives of six bomb survivors from immediately prior, to months after, the dropping of the Little Boy bomb .

10 – Post - attack casualties

In the spring of 1948 , the Atomic Bomb Casualty Commission (ABCC) was established in accordance with a presidential directive from Truman to the National Academy of Sciences – National Research Council to conduct investigations of the late effects of radiation among the survivors in Hiroshima and Nagasaki . One of the early studies conducted by the ABCC was on the outcome of pregnancies occurring in Hiroshima and Nagasaki, and in a control city, Kure, located 18 mi (29 km) south of Hiroshima, in order to discern the conditions and outcomes related to radiation exposure . Dr. James V. Neel led the study which found that the number of birth defects was not significantly higher among the children of survivors who were pregnant at the time of the bombings . The National Academy of Sciences questioned Neel's procedure which did not filter the Kure population for possible radiation exposure . Among the observed birth defects there was a higher incidence of brain malformation in Nagasaki and Hiroshima, including microencephaly and anencephaly, about 2.75 times the rate seen in Kure.

In 1985, Johns Hopkins University human geneticist James F. Crow examined Neel's research and confirmed that the number of birth defects was not significantly higher in Hiroshima and Nagasaki . Many members of the ABCC and its successor Radiation Effects Research Foundation (RERF) were still looking for possible birth defects or other causes among the survivors decades later, but found no evidence that they were common among the survivors . Despite the insignificance of birth defects found in Neel's study, historian Ronald E. Powaski wrote that Hiroshima experienced "an increase in stillbirths, birth defects, and infant mortality" following the atomic bomb . Neel also studied the longevity of the children who survived the bombings of Hiroshima and Nagasaki, reporting that between 90 and 95 percent were still living 50 years later.

Around 1,900 cancer deaths can be attributed to the after-effects of the bombs. An epidemiology study by the RERF states that from 1950 to 2000, 46 % of leukemia deaths and 11 % of solid cancer deaths among the bomb survivors were due to radiation from the bombs, the statistical excess being estimated at 200 leukemia and 1700 solid cancers.

11 - Hibakusha

Panoramic view of the monument marking the hypocenter, or ground zero, of the atomic bomb explosion over Nagasaki

The survivors of the bombings are called hibakusha , a Japanese word that literally translates to "explosion - affected people." As of March 31, 2014 [update], 192,719 hibakusha were recognized by the Japanese government, most living in Japan . The government of Japan recognizes about 1 % of these as having illnesses caused by radiation . The memorials in Hiroshima and Nagasaki contain lists of the names of the hibakusha who are known to have died since the bombings. Updated annually on the anniversaries of the bombings, as of August 2014 [update] the memorials record the names of more than 450,000 hibakusha; 292,325 in Hiroshima and 165,409 in Nagasaki.

Hibakusha and their children were (and still are) victims of severe discrimination in Japan due to public ignorance about the consequences of radiation sickness, with much of the public believing it to be hereditary or even contagious . This is despite the fact that no statistically demonstrable increase of birth defects or congenital malformations was found among the later conceived children born to survivors of Hiroshima and Nagasaki . A study of the long - term psychological effects of the bombings on the survivors found that even 17 – 20 years after the bombings had occurred survivors showed a higher prevalence of anxiety and somatization symptoms.

11 – 1 - Double survivors

On March 24, 2009, the Japanese government officially recognized Tsutomu Yamaguchi as a double hibakusha. He was confirmed to be 3 km (1.9 mi) from ground zero in Hiroshima on a business trip when Little Boy was detonated. He was seriously burnt on his left side and spent the night in Hiroshima. He arrived at his home city of Nagasaki on August 8, the day before Fat Man was dropped, and he was exposed to residual radiation while searching for his relatives. He was the first officially recognized survivor of both bombings . He died on January 4 , 2010, at the age of 93, after a battle with stomach cancer . The 2006 documentary Twice Survived: The Doubly Atomic Bombed of Hiroshima and Nagasaki documented 165 nijū hibakusha (lit. double explosion-affected people), and was screened at the United Nations.

11 – 2 - Korean survivors

During the war, Japan brought as many as 670,000 Korean conscripts to Japan to work as forced labor . About 20,000 Koreans were killed in Hiroshima and another 2,000 died in Nagasaki. Perhaps one in seven of the Hiroshima victims were of Korean ancestry. For many years, Koreans had a difficult time fighting for recognition as atomic bomb victims and were denied health benefits. Most issues have been addressed in recent years through lawsuits.

12 - Debate over bombings

The atomic bomb was more than a weapon of terrible destruction; it was a psychological weapon.

Atomic Emission Spectroscopy

Contents

1 - Introduction

Atomic emission spectroscopy (AES) is a method of chemical analysis that uses the intensity of light emitted from a flame, plasma, arc, or spark at a particular wavelength to determine the quantity of an element in a sample. The wavelength of the atomic spectral line gives the identity of the element while the intensity of the emitted light is proportional to the number of atoms of the element.

2 - Flame emission spectroscopy

A sample of a material (analyte) is brought into the flame as either a gas, sprayed solution, or directly inserted into the flame by use of a small loop of wire, usually platinum. The heat from the flame evaporates the solvent and breaks chemical bonds to create free atoms. The thermal energy also excites the atoms into excited electronic states that subsequently emit light when they return to the ground electronic state. Each element emits light at a characteristic wave length, which is dispersed by a grating or prism and detected in the spectrometer.

A frequent application of the emission measurement with the flame is the regulation of alkali metals for pharmaceutical analytics.

3 - Inductively coupled plasma atomic emission spectroscopy

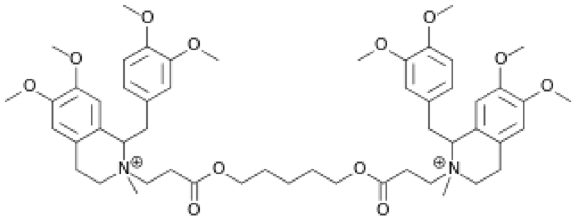
Inductively coupled plasma atomic emission spectroscopy (ICP – AES) uses an inductively coupled plasma to produce excited atoms and ions that emit electromagnetic radiation at wavelengths characteristic of a particular element.

Advantages of ICP-AES are excellent limit of detection and linear dynamic range, multi - element capability, low chemical interference and a stable and reproducible signal. Disadvantages are spectral interferences (many emission lines), cost and operating expense and the fact that samples typically must be in solution.

4 - Spark and arc atomic emission spectroscopy

Spark or arc atomic emission spectroscopy is used for the analysis of metallic elements in solid samples. For non-conductive materials, the sample is ground with graphite powder to make it conductive. In traditional arc spectroscopy methods, a sample of the solid was commonly ground up and destroyed during analysis. An electric arc or spark is passed through the sample, heating it to a high temperature to excite the atoms within it. The excited analyte atoms emit light at characteristic wavelengths that can be dispersed with a monochromator and detected. In the past, the spark or arc conditions were typically not well controlled, the analysis for the elements in the sample were qualitative. However, modern spark sources with controlled discharges can be considered quantitative. Both qualitative and quantitative spark analysis are widely used for production quality control in foundries and steel mills.

Atracurium Besilate



Contents

1 - Introduction

Atracurium besylate is a neuromuscular-blocking drug or skeletal muscle relaxant in the category of non - depolarizing neuromuscular-blocking drugs, used adjunctively in anesthesia to facilitate endotracheal intubation and to provide skeletal muscle relaxation during surgery or mechanical ventilation. Atracurium is classified as an intermediate-duration non - depolarizing neuromuscular-blocking agent.

It is on the World Health Organization's List of Essential Medicines, a list of the most important medication needed in a basic health system.[2]

2 - Neuromuscular function parameters

ED_{95}: the dose of any given neuromuscular - blocking agent required to produce 95 % suppression of muscle twitch (e.g., the *adductor pollicis*) response with balanced anesthesia

Clinical duration: difference in time between time of injection and time to 25 % recovery from neuromuscular block

Train – of - Four (TOF) response: stimulated muscle twitch response in trains of four when stimuli are applied in a burst of four as opposed to a single stimulus, equal depression in depolarising and fading response with non - depolarising blocker.

25 % -75 % recovery index: an indicator of the *rate* of skeletal muscle recovery - essentially, the difference in time between the time to recovery to 25 % and time to recovery to 75 % of baseline value

$T_4:T_1 \geq 0.7$: a 70 % ratio of the fourth twitch to the first twitch in a TOF - provides a measure of the recovery of neuromuscular function

$T_4:T_1 \geq 0.9$: a 90% ratio of the fourth twitch to the first twitch in a TOF - provides a measure of the full recovery of neuromuscular function

3 - Duration of action

Neuromuscular - blocking agents can be classified in accordance to their duration of pharmacological action, defined as follows :

Parameter	**Ultra-short Duration**	**Short Duration**	**Intermediate Duration**	**Long Duration**
Clinical Duration (Time from injection to $T_{25\%}$ recovery)	6-8	12-20	30-45	>60
Recovery Time (Time from injection to $T_{95\%}$ recovery)	<15	25-30	50-70	90-180
Recovery Index ($T_{25\%}$-$T_{75\%}$ recovery slope)	2-3	6	10-15	>30

4 - Preclinical pharmacology

Several publications describe the preclinical pharmacology of atracurium. Hughes and Payne described the preliminary pharmacology of atracurium in anesthethetized cats, dogs and rhesus monkeys . A ^{14}C radiolabeled metabolism study in cats confirmed the lack of hepatic or renal involvement in the metabolism of atracurium: radioactivity eliminated in bile and urine was predominantly from metabolites rather than the unchanged parent drug.

Chapple and Clarke reported on the neuromuscular and cardiovascular effects of the break down products of atracurium and related substances in anesthetized cats. They concluded that the metabolites were of low potencies, and quite likely that the quantities present either as an impurity or formed after administration of therapeutic doses of atracurium (0.3 – 0.6 mg kg - 1 i.v.) would be of no pharmacological importance. Laudanosine, the quaternary acid and metholaudanosine were devoid of neuromuscular blocking activity within the dose range 0.5 – 4 mg kg – 1 . However, within this dose range, they reported that the quaternary monoacrylate, the quaternary alcohol and the monoquaternary analogue produced a dose-dependent neuromuscular block. Administration of the quaternary mono acrylate, laudanosine, the quaternary alcohol, metholaudanosine and the monoquaternary analogue at 4 mg kg-1 doses resulted in a significant reduction in mean arterial pressure (by 30 – 70 mm Hg) . Significant sympathetic blockade after preganglionic nerve stimulation was observed only with the monoquaternary analogue at a dose of 4 mg kg-1, whereas significant vagal blockade occurred after 4 mg kg-1 of the quaternary monoacrylate, the quaternary acid, the quaternary alcohol, and the monoquaternary analogue.

5 - Clinical pharmacology

Atracurium is susceptible to degradation by Hofmann elimination and ester hydrolysis as components of the *in vivo* metabolic processes. The initial *in vitro* studies appeared to indicate a major role for ester hydrolysis[6] but, with accumulation of clinical data over time, the preponderence of evidence indicated that Hofmann elimination at physiological pH is the major degradation pathway vindicating the premise for the design of atracurium to undergo an organ-independent metabolism.

Hofmann elimination is a temperature- and pH - dependent process, and therefore atracurium's rate of degradation *in vivo* is highly influenced by body pH and temperature: An increase in body pH favors the elimination process , whereas a decrease in temperature slows down the process.[8] Otherwise, the *breakdown process* is unaffected by the level of plasma esterase activity, obesity , age , or by the status of renal[12][13][14][15] or hepatic function.[16] On the other hand, excretion of the metabolite, laudanosine, and, to a small extent, atracurium itself is dependent on hepatic and renal functions that tend to be less efficient in the elderly population . The pharmaceutical presentation is a mixture of all ten possible stereoisomers. Although there are four stereocentres, which could give 16 structures, there is a plane of symmetry running through the centre of the diester bridge, and so 6 meso structures (structures that can be superimposed by having the opposite configuration then 180° rotation) are formed. This reduces the number from sixteen to ten. There are three cis-cis isomers (an enantiomeric pair and a meso structure) , four cis-trans isomers (two enantiomeric pairs), and three trans - trans isomers (an enantiomeric pair and a meso structure). The proportions of cis − cis, cis−trans, and trans − trans isomers are in the ratio of 10.5 :6.2 :1. [cis-cis isomers ≈ 58 % cis - trans isomers ≈ 36 % trans - trans isomers ≈ 6 %]. One of the three cis-cis structures is marketed as a single-isomer preparation, cisatracurium (trade name Nimbex); it has the configuration 1R, 2R, 1′R, 2′R at the four stereocentres. The beta-blocking drug Nebivolol has ten similar structures with 4 stereocentres and a plane of symmetry, but only two are presented in the pharmaceutical preparation.

6 - Adverse effects

6 – 1 - Histamine release - hypotension, reflex tachycardia and cutaneous flush

The tetra hydro iso quinolinium class of neuromuscular blocking agents, *in general*, is associated with histamine release upon rapid administration of a bolus intravenous injection.[17] There are some exceptions to this rule; e.g., cisatracurium (Nimbex) is one such agent that does not elicit histamine release even up to 5xED_{95} doses.[*citation needed*] The liberation of histamine is a dose-dependent phenomenon such that, with increasing doses administered at the same rate, there is a greater propensity for eliciting histamine release and its ensuing sequelae.[*citation needed*] Most commonly, the histamine release following administration of these agents is associated with observable cutaneous flushing (facial face and arms, commonly), hypotension and a consequent reflex tachycardia.[*citation needed*] It should be noted though that these sequelae are very transient effects: The total duration of the cardiovascular effects is no more than one to two minutes, while the facial flush may take around 3 – 4 minutes to dissipate.[citation needed] Because these effects are so transient, there is no reason to administer adjunctive therapy to ameliorate either the cutaneous or the cardiovascular effects. Thus, in the fierce battle to win market share for sales of the "steroidal" *versus* the tera hydro iso quinolinium class of neuromuscular-blocking agents, fact and information pertaining to adverse events were distorted to suit taste, and, as a consequence, much misinformation was deliberately disseminated regarding histamine release and its effects: this was particularly so in the 1980s and 1990s shortly after the near simultaneous competitive clinical introduction of atracurium (Tracrium - a *bis* tetra hydro iso quinolinium neuro muscular - blocking agent marketed by Burroughs Wellcome Co., now subsumed into GlaxoSmithKline) and vecuronium (Norcuron - a steroidal neuromuscular-blocking agent marketed by Organon, now subsumed into Merck & Co. Inc.). The most common misinformation seeded into the minds of anesthesiologists was the failure to categorically state that the cardiovascular effects following histamine release were transient, and, instead, the marketing focus was single - mindedly to regurgitate and emphasize that the tetrahydroisoquinolinium class elicited histamine release that could prove to be a danger to the cardiovascular stability of the patient during surgical procedures. There was complete failure to disseminate the true picture that not only are these effects transient but that the extent of the hypotensive effect and the reflex tachycardia are rarely of clinical significance and therefore did not require adjunctive therapy, as evidenced by the complete lack of any clinical literature advocating the need for adjunctive antihistamine use concomitantly with the administration of tetra hydro iso quinolinium neuro muscular - blocking agents. However, these ill - willed beguiling notions have persisted through the decades and become ingrained with each successive generation of newly qualified anesthesiologists and CRNAs (certified registered nurse anesthetists) to the extent that the mere mention of "benzylisoquinolines" (the erroneous but commonly used class name for tetrahydroisoquinolinium neuromuscular-blocking agents) immediately conjures images of histamine release and generates serious anxiety.

6 – 2 - Bronchospasm - Pulmonary compliance

Bronchospasm has been reported on occasion with the use of atracurium . However, this particular undesirable effect does not appear to be observed nearly as often as that seen with rapacuronium, which led to the latter's withdrawal of approval for clinical use worldwide.

The issue of bronchospasm acquired considerable prominence in the neuromuscular-blocking agents arena after the spectacular failure of a clinically introduced neuromuscular - blocking agent, rapacuronium (Raplon - a steroidal neuromuscular - blocking agent marketed by Organon, now subsumed into Merck & Co. Inc.), which had to be withdrawn voluntarily during the week of March 19, 2001 from clinical use (< 2 years after its approval by the US FDA on August 18, 1999 - see NME Drug and New Biologic Approvals in 1999) after several serious events of bronchospasm , including five "unexplained" fatalities,[26] following its administration. That is not to say that bronchospasm was an unknown phenomenon prior to rapacuronium: Occasional reports of bronchospasm have been noted also with the prototypical agents, tubocurarine and succinylcholine , as well as alcuronium,[35] pancuronium , vecuronium,[38][39] and gallamine.

6 – 3 - Laudanosine – Epileptic foci

Because atracurium undergoes Hofmann elimination as a primary route of chemodegradation, one of the major metabolites from this process is laudanosine, a tertiary amino alkaloid reported to be a modest CNS stimulant with epileptogenic activity and cardiovascular effects such a hypotension and bradycardia.[42] As part of the then fierce marketing battle between the competing pharmaceutical companies (Burroughs Wellcome Co. and Organon, Inc.) with their respective products, erroneous information was quickly and subtly disseminated very shortly after the clinical introduction of atracurium that the clinical use of atracurium was likely to result in a terrible tragedy because of the significant clinical hazard by way of frank seizures induced by the laudanosine by-product[41] - the posited hypothesis being that the laudanosine produced from the chemodegradation of parent atracurium would cross the blood – brain barrier in sufficiently high enough concentrations that lead to epileptogenic foci . Fortunately, both for the public and for atracurium, rapid initial investigations irrefutably failed to find any overt or EEG evidence for a connection between atracurium administration and epileptogenic activity . Indeed, because laudanosine is cleared primarily via renal excretion, a cat study modelling anephric patients went so far as to corroborate that EEG changes, when observed, were evident only at plasma concentrations 8 to 10 times greater than those observed in humans during infusions of atracurium . Thus, the cat study predicted that, following atracurium administration in an anephric patient, laudanosine accumulation and related CNS or cardiovascular toxicity were unlikely - a prediction that correlated very well with a study in patients with renal failure and undergoing cadaveric renal transplantation.[47] Furthermore, almost a decade later, work by Cardone *et al* .. confirmed that, in fact, it is the steroidal neuromuscular - blocking agents pancuronium and vecuronium that, when introduced directly into the CNS, were likely to cause acute excitement and seizures, owing to accumulation of cytosolic calcium caused by activation of acetyl choline receptor ion channels. Unlike the two steroidal agents, neither atracurium nor laudanosine caused such accumulation of intracellular calcium. Just over two decades later with uninterrupted clinical availability of atracurium, there is now little doubt that laudanosine accumulation and related toxicity will likely ever be seen with the doses of atracurium that are administered in clinical practice.

Laudanosine is also a metabolite of cisatracurium that, because of its identical structure to atracurium, undergoes chemodegradation via Hofmann elimination *in vivo*. Plasma concentrations of laudanosine generated are lower when cisatracurium is used.

7 – History

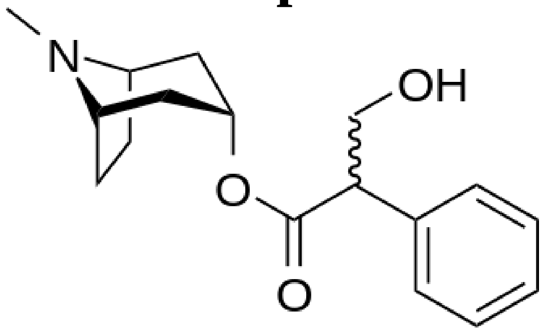
Atracurium besylate was first synthesized in 1974 by George H. Dewar,[49] a pharmacist and a medicinal chemistry doctoral candidate in John B. Stenlake's medicinal chemistry research group in the Department of Pharmacy at Strathclyde University, Scotland. Dewar first named this compound "33A74"[49] before its eventual emergence in the clinic as atracurium. Atracurium was the culmination of a rational approach to drug design to produce the first non - depolarizing non-steroidal skeletal muscle relaxant that undergoes chemodegradation *in vivo*. The term chemodegradation was coined by Roger D. Waigh, PhD , also a pharmacist and a postdoctoral researcher in Stenlake's research group. Atracurium was licensed by Strathclyde University to The Wellcome Foundation Ltd. UK, which developed the drug (then known as BW 33A[51]) and its introduction to first human trials in 1979 , and then eventually to its first introduction (as a mixture of all ten stereoisomers) into clinical anesthetic practice in the UK, in 1983, under the tradename of Tracrium.

The premise to the design of atracurium and several of its congeners stemmed from the knowledge that a *bis*-quaternary structure is essential for neuromuscular - blocking activity: ideally, therefore, a chemical entity devoid of this *bis* - quaternary structure via susceptibility to inactive breakdown products by enzymic - independent processes would prove to be invaluable in the clinical use of a drug with a predictable onset and duration of action. Hofmann elimination provided precisely this basis: It is a chemical process in which a suitably activated quaternary ammonium compound can be degraded by the mildly alkaline conditions present at physiological pH and temperature . In effect, Hofmann elimination is a retro-Michael addition chemical process. It is important to note here that the physiological process of Hofmann *elimination* differs from the non - physiological Hofmann *degradation* process: the latter is a chemical reaction in which a quaternary ammonium hydoxide solid salt is heated to 100 °C , or an aqueous solution of the salt is boiled. Regardless of which Hofmann process is referenced, the end - products in both situations will be the same: an alkene and a tertiary amine.

The approach to utilizing Hofmann elimination as a means to promoting biodegradation had its roots in much earlier observations that the quaternary alkaloid petaline (obtained from the Lebanese plant *Leontice leontopetalum*) readily underwent facile Hofmann elimination to a tertiary amine called leonticine upon passage through a basic (as opposed to an acidic) ion - exchange resin.[55] Stenlake's research group advanced this concept by systematically synthesizing numerous quaternary ammonium β – amino esters and β-aminoketones[60] and evaluated them for skeletal muscle relaxant activity: one of these compounds , initially labelled as 33 A 74 , eventually led to further clinical development, and came to be known as atracurium.

Atracurium's limited clinical utility for the future was presaged with the marketing approval of cisatracurium in 1995 under the tradename of Nimbex. Cisatracurium is the *R- cis R- cis* isomer component of the ten stereoisomers that comprise atracurium . The pharmacodynamic and adverse effects profile of cisatracurium proved to be superior to that of atracurium, which rapidly led to decline in the use of atracurium. The clinical development of cisatracurium was undertaken by Burroughs Wellcome Co. (and its parent The Wellcome Foundation Ltd.), from 1992 to 1994, and by the time of its approval for use in humans by the US Food and Drug Administration, Burroughs Wellcome Co. had merged with Glaxo Inc., and Nimbex was subsequently marketed worldwide by GlaxoWellcome Inc.

Atropine



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1 - Introduction

Atropine is a naturally occurring tropane alkaloid extracted from deadly night shade (*Atropa belladonna*), Jimson weed (*Datura stramonium*), mandrake (*Mandragora officinarum*) and other plants of the family Solanaceae. It is a secondary metabolite of these plants and serves as a drug with a wide variety of effects.

In general, atropine counters the "rest and digest" activity of glands regulated by the parasympathetic nervous system. This occurs because atropine is a competitive antagonist of the muscarinic acetyl choline receptors (acetyl choline being the main neurotransmitter used by the parasympathetic nervous system). Atropine dilates the pupils, increases heart rate, and reduces salivation and other secretions.

It is on the World Health Organization's List of Essential Medicines, a list of the most important medications needed in a basic health system.[1]

2 – Name

The species name "belladonna" ("beautiful woman" in Italian) comes from the original use of deadly nightshade to dilate the pupils of the eyes for cosmetic effect. Both atropine and the genus name for deadly nightshade derive from Atropos, one of the three Fates who, according to Greek mythology, chose how a person was to die.

3 - Medical uses

3 – 1 - Ophthalmic use

Topical atropine is used as a cycloplegic, to temporarily paralyze the accommodation reflex, and as a mydriatic, to dilate the pupils. Atropine degrades slowly, typically wearing off in 7 to 14 days, so it is generally used as a therapeutic mydriatic, whereas tropicamide (a shorter - acting cholinergic antagonist) or phenylephrine (an α - adrenergic agonist) is preferred as an aid to ophthalmic examination.

In refractive and accommodative amblyopia, when occlusion is not appropriate sometimes atropine is given to induce blur in the good eye.

3 – 2 - Heart medicine

Injections of atropine are used in the treatment of bradycardia (an extremely low heart rate).

Atropine was previously included in international resuscitation guidelines for use in cardiac arrest associated with asystole and PEA, but was removed from these guidelines in 2010 due to a lack of evidence.[3] For symptomatic bradycardia, the usual dosage is 0.5 to 1 mg IV push, may repeat every 3 to 5 minutes up to a total dose of 3 mg (maximum 0.04 mg / kg).

Atropine is also useful in treating second-degree heart block Mobitz Type 1 (Wenckebach block), and also third-degree heart block with a high

Purkinje or AV-nodal escape rhythm. It is usually not effective in second-degree heart block Mobitz type 2, and in third-degree heart block with a low Purkinje or ventricular escape rhythm.

3 – 3 - Secretions and bronchodilatation

Atropine's actions on the para sympathetic nervous system inhibit salivary and mucus glands. The drug may also inhibit sweating via the sympathetic nervous system. This can be useful in treating hyperhidrosis, and can prevent the death rattle of dying patients. Even though atropine has not been officially indicated for either of these purposes by the FDA, it has been used by physicians for these purposes.

3 – 4 – Organo phosphate and nerve agent poisoning[edit]

Atropine is not an actual antidote for organophosphate poisoning. However, by blocking the action of acetylcholine at muscarinic receptors, atropine also serves as a treatment for poisoning by organophosphate insecticides and nerve gases, such as tabun (GA), sarin (GB), soman (GD) and VX. Troops who are likely to be attacked with chemical weapons often carry autoinjectors with atropine and obidoxime, for rapid injection into the muscles of the thigh. Atropine is often used in conjunction with pralidoxime chloride.

Atropine is given as a treatment for SLUDGE syndrome (salivation, lacrimation, urination, diaphoresis, gastrointestinal motility, emesis) symptoms caused by organo phosphate poisoning. Another mnemonic is DUMBBELSS, which stands for diarrhea, urination, miosis, bradycardia, bronchoconstriction, excitation (as of muscle in the form of fasciculations and CNS), lacrimation, salivation, and sweating (only sympathetic innervation using Musc receptors).

Some of the nerve agents attack and destroy acetylcholinesterase by phosphorylation, so the action of acetylcholine becomes prolonged. Pralidoxime (2 – PAM) is the cure for organophosphate poisoning because it can cleave this phosphorylation. Atropine can be used to reduce the effect of the poisoning by blocking muscarinic acetylcholine receptors, which would otherwise be overstimulated by excessive acetylcholine accumulation.

4 – Side - effects and overdose

Adverse reactions to atropine include ventricular fibrillation, supraventricular or ventricular tachycardia, dizziness, nausea, blurred vision, loss of balance, dilated pupils, photophobia, dry mouth and potentially extreme confusion, dissociative hallucinations and excitation especially amongst the elderly. These latter effects are because atropine is able to cross the blood–brain barrier. Because of the hallucinogenic properties, some have used the drug recreationally, though this is potentially dangerous and often unpleasant.

In overdoses, atropine is poisonous. Atropine is sometimes added to potentially addictive drugs, particularly anti - diarrhea opioid drugs such as diphenoxylate or difenoxin, wherein the secretion - reducing effects of the atropine can also aid the anti - diarrhea effects.

Although atropine treats bradycardia (slow heart rate) in emergency settings, it can cause paradoxical heart rate slowing when given at very low doses (i.e. < 0.5 mg) , presumably as a result of central action in the CNS.[7] One proposed mechanism for atropine's paradoxical bradycardia effect at low doses involves blockade of inhibitory presynaptic muscarinic autoreceptors, thereby blocking a system that inhibits the parasympathetic response.

Atropine is incapacitating at doses of 10 to 20 mg per person. Its LD_{50} is estimated to be 453 mg per person (per oral) with a probit slope of 1.8. The antidote to atropine is physostigmine or pilocarpine.

A common mnemonic used to describe the physiologic manifestations of atropine overdose is: "hot as a hare, blind as a bat, dry as a bone, red as a beet, and mad as a hatter".[10] These associations reflect the specific changes of warm, dry skin from decreased sweating, blurry vision, decreased sweating/lacrimation, vasodilation, and central nervous system effects on muscarinic receptors, type 4 and 5. This set of symptoms is known as anticholinergic toxidrome, and may also be caused by other drugs with anticholinergic effects, such as scopolamine, diphenhydramine, phenothiazine antipsychotics and benztropine.

5 – Contraindications

Atropine is contraindicated in patients pre - disposed to narrow angle glaucoma.

6 - Mechanism of action

Atropine is a competitive antagonist for the muscarinic acetylcholine receptor types M1, M2, M3, M4 and M5.[12] It is classified as an anticholinergic drug (para sympatholytic) .

In cardiac uses, it works as a nonselective muscarinic acetylcholinergic antagonist, increasing firing of the sinoatrial node (SA) and conduction through the atrioventricular node (AV) of the heart, opposes the actions of the vagus nerve, blocks acetylcholine receptor sites, and decreases bronchial secretions.

In the eye, atropine induces mydriasis by blocking contraction of the circular pupillary sphincter muscle, which is normally stimulated by acetylcholine release, thereby allowing the radial pupillary dilator muscle to contract and dilate the pupil. Atropine induces cycloplegia by paralyzing the ciliary muscles, whose action inhibits accommodation to allow accurate refraction in children, helps to relieve pain associated with iridocyclitis, and treats ciliary block (malignant) glaucoma.

7 - Chemistry and pharmacology

Atropine is a racemic mixture of *d* - hyoscyamine and *l*-hyoscyamine, with most of its physiological effects due to *l*-hyoscyamine. Its pharmacological effects are due to binding to muscarinic acetylcholine receptors. It is an antimuscarinic agent. Significant levels are achieved in the CNS within 30 minutes to 1 hour and disappears rapidly from the blood with a half-life of 2 hours. About 60 % is excreted unchanged in the urine, most of the rest appears in urine as hydrolysis and conjugation products. Effects on the iris and ciliary muscle may persist for longer than 72 hours.

The most common atropine compound used in medicine is atropine sulfate (mono hydrate) ($C_{17} H_{23} NO_3$) $_2 \cdot H_2SO_4 \cdot H_2O$, the full chemical name is 1α H , 5α H –Tropan – 3 - α ol (±) – tropate (ester) , sulfate mono hydrate.

The vagus (para sympathetic) nerves that innervate the heart release acetylcholine (ACh) as their primary neuro transmitter. ACh binds to muscarinic receptors (M2) that are found principally on cells comprising the sinoatrial (SA) and atrioventricular (AV) nodes. Muscarinic receptors are coupled to the Gi - protein; therefore, vagal activation decreases cAMP. Gi - protein activation also leads to the activation of KACh channels that increase potassium efflux and hyperpolarizes the cells.

Increases in vagal activities to the SA node decreases the firing rate of the pacemaker cells by decreasing the slope of the pacemaker potential (phase 4 of the action potential) ; this decreases heart rate (negative chronotropy) . The change in phase 4 slope results from alterations in potassium and calcium currents, as well as the slow - inward sodium current that is thought to be responsible for the pacemaker current (If) . By hyperpolarizing the cells, vagal activation increases the cell's threshold for firing, which contributes to the reduction in the firing rate. Similar electrophysiological effects also occur at the AV node; however, in this tissue, these changes are manifested as a reduction in impulse conduction velocity through the AV node (negative dromotropy) . In the resting state, there is a large degree of vagal tone on the heart, which is responsible for low resting heart rates.

There is also some vagal innervation of the atrial muscle, and to a much lesser extent, the ventricular muscle. Vagus activation, therefore, results in modest reductions in atrial contractility (inotropy) and even smaller decreases in ventricular contractility.

Muscarinic receptor antagonists bind to muscarinic receptors thereby preventing ACh from binding to and activating the receptor. By blocking the actions of ACh, muscarinic receptor antagonists very effectively block the effects of vagal nerve activity on the heart. By doing so, they increase heart rate and conduction velocity.

8 – History

Mandragora (mandrake) was described by Theophrastus in the fourth century B.C. for treatment of wounds, gout, and sleeplessness, and as a love potion. By the first century A.D. Dioscorides recognized wine of mandrake as an anaesthetic for treatment of pain or sleeplessness, to be given prior to surgery or cautery . The use of Solanaceae containing tropane alkaloids for anesthesia, often in combination with opium, persisted throughout the Roman and Islamic Empires and continued in Europe until superseded by the use of ether, chloroform, and other modern anesthetics.

Atropine extracts from the Egyptian henbane were used by Cleopatra in the last century B.C. to dilate her pupils, in the hope that she would appear more alluring. In the Renaissance, women used the juice of the berries of *Atropa belladonna* to enlarge the pupils of their eyes, for cosmetic reasons. This practice resumed briefly in the late nineteenth- and early twentieth-century in Paris.

The mydriatic effects of atropine were studied among others by the German chemist Friedlieb Ferdinand Runge (1795 – 1867). In 1831, the German pharmacist Heinrich F. G. Mein (1799 – 1864) succeeded in preparing atropine in pure crystalline form . The substance was first synthesized by German chemist Richard Willstätter in 1901.

9 - Natural sources

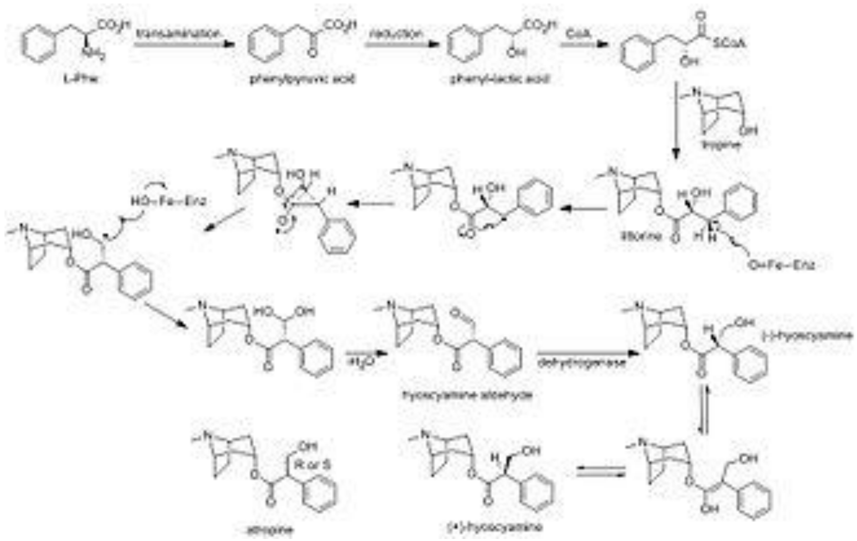
Atropine is found in many members of the Solanaceae family. The most commonly found sources are *Atropa belladonna*, *Datura inoxia*, *D. metel*, and *D. stramonium*. Other sources include members of the *Brugmansia* and *Hyoscyamus* genera. The *Nicotiana* genus (including the tobacco plant, *N. tabacum*) is also found in the Solanaceae family, but these plants do not contain atropine or other tropane alkaloids.

10 – Synthesis

Atropine can be synthesized by the reaction of tropine with tropic acid in the presence of hydrochloric acid.

11 – Biosynthesis

The biosynthesis of atropine starting from L-Phenylalanine first undergoes a transamination forming phenylpyruvic acid which is then reduced to phenyl-lactic acid.[16] Coenzyme A then couples phenyl-lactic acid with tropine forming littorine, which then undergoes a radical rearrangement initiated with a P450 enzyme forming hyoscyamine aldehyde. A dehydrogenase then reduces the aldehyde to a primary alcohol making (-)-hyoscamine, which upon racemization forms atropine.



Biosynthesis of atropine starting from L-Phenylalanine

12 - Research

Atropine eye drops have been shown to be effective in slowing the progression of myopia in children in several studies, but it is not available for this use, and side effects would limit its use.

Attrition War Fare

Contents

1 - Introduction

Attrition warfare is a military strategy in which a belligerent attempts to win a war by wearing down the enemy to the point of collapse through continuous losses in personnel andmateriel. The war will usually be won by the side with greater such resources. The word *attrition* comes from the Latin root *atterere* to rub against, similar to the "grinding down" of the opponent's forces in attrition warfare.

2 - Strategic considerations

Military theorists and strategists like Sun Tzu have viewed attrition warfare as something to be avoided. In the sense that attrition warfare represents an attempt to grind down an opponent through superior numbers, it represents the opposite of the usual principles of war, where one attempts to achieve decisive victories by using minimal necessary resources and in minimal amount of time, through maneuver, concentration of force, surprise, and the like.

On the other hand, a side which perceives itself to be at a marked disadvantage in maneuver warfare or unit tactics may deliberately seek out attrition warfare to neutralize its opponent's advantages. If the sides are nearly evenly matched, the outcome of a war of attrition is likely to be a Pyrrhic victory.

The difference between war of attrition and other forms of war is somewhat artificial, since war always contains an element of attrition. However, one can be said to pursue a strategy of attrition when one makes it the main goal to cause gradual attrition to the opponent eventually amounting to unacceptable or unsustainable levels for the opponent while limiting one's own gradual losses to acceptable and sustainable levels. This should be seen as opposed to other main goals such as the conquest of some resource or territory or an attempt to cause the enemy great losses in a single stroke (e.g., by encirclement and capture).

Historically, attritional methods are tried when other methods have failed or are obviously not feasible. Typically, when attritional methods have worn down the enemy sufficiently to make other methods feasible, attritional methods are abandoned in favor of other strategies. In World War I, improvements in firepower but not communications and mobility forced military commanders to rely on attrition, with terrible loss of life.

Attritional methods are in themselves usually sufficient to cause a nation to give up a non-vital ambition, but other methods are generally necessary to achieve unconditional surrender.

3 – History

French troopers using periscope, 1915

It is often argued that the best-known example of attrition warfare was during World War I on the Western Front . Both military forces found themselves in static defensive positions in trenches running from Switzerland to the English Channel. For years, without any opportunity for maneuvers, the only way the commanders thought they could defeat the enemy was to repeatedly attack head on, to grind the other down.

One of the most enduring examples of attrition warfare on the Western Front is the Battle of Verdun. Erich von Falkenhayn later claimed that his tactics at Verdun were designed not to take the city, but rather to destroy the French Army in its defense. In practice the German Offensive was intended to go as far as possible and had no obvious design to minimize German casualties and maximize French casualties. Falkenhayn is described as wanting to "bleed France white" and thus the attrition tactics were employed in the battle.

Attritional warfare in World War I has been shown by historians such as Hew Strachan to have been used as a post hoc excuse for failed offensives. The decision to launch a war of attrition at Verdun was also used to mask the failure of Falkenhayn 's original tactical plan.

Attrition to the enemy was easy to assert and difficult to refute, and thus may have been a convenient face - saving exercise in the wake of many indecisive battles. It is in many cases hard to see the logic of warfare by attrition because of the obvious uncertainty of the level of damage to the enemy, and of the damage that the attacking force may sustain to its own limited and expensive resources, while trying to achieve that damage.

That is not to say that a general will not be prepared to sustain high casualties while trying to reach an objective. An example in which one side used attrition warfare to neutralize the other side's advantage in maneuverability and unit tactics occurred during the latter part of the American Civil War, when Ulysses S. Grant pushed the Confederate Army continually, in spite of losses, confident that the Union's supplies and manpower would overwhelm the Confederacy even if the casualty ratio was unfavorable; this indeed proved to be the case.

3 – 1 - Other examples

The "delaying" tactics of Quintus Fabius Maximus "Cunctator" against Hannibal Barca during the Second Punic War.

Battle of Actium of 31 BC during the Roman civil wars

The Hungarian resistance against the Mongols 1241–1242

The Đại Việt Empire (now known as Vietnam), three repulsions of Kublai Khan (the grandson of Genghis Khan and the last Khan of the Mongol Empire) in 1258, 1285 and 1288

The American strategy during the American Revolutionary War

The French invasion of Russia by Napoleon Bonaparte in 1812

Trench warfare in the American Civil War, notably the Siege of Petersburg

Trench warfare in World War I, including the Battle of the Somme (1916), the Battle of Verdun and many others

The Spanish Civil War (1936 – 1939)

Tonnage war in the Atlantic and Pacific during World War II

The Air battle for Great Britain in World War II after the bombing of London

Static battles in World War II, including Soviet urban defense during the Battle of Stalingrad

Battles of Rzhev (1942 – 1943)

The final two years of the Korean War

The Vietnam War (Body count)

The "Long War" during the Provisional IRA's armed campaign against the British Army during the Troubles.

The Israeli - Egyptian War of Attrition from 1967 – 1970.

The Soviet war in Afghanistan

The later phases of the Iran – Iraq War

The War in Afghanistan (2001 – present)

Sri Lankan military's crushing of LTTE (2005 – 2009)

The 2011 Libyan civil war is arguably an example of attrition warfare.

The Mexican Drug War, where the Mexican government seeks to fatally weaken thecartels. Given the recent rise of irregular auto defensas militia units after a number of smaller attacks against cartels by irregulars possibly from the United States, this phase of warfare may be coming to an end.

The Syrian Civil War

History of the Arab – Israeli conflict

Contents

1 - Introduction

The Arab – Israeli conflict is a modern phenomenon, which has its roots in the end of the 19th century. The conflict became a major international issue with the birth of Israel in 1948. The Arab – Israeli conflict has resulted in at least five major wars and a number of minor conflicts. It has also been the source of two major Palestinian intifadas (uprisings).

2 – Background

2 – 1 - Ottoman era

Tensions between the Zionist movements and the Arab residents of Palestine started to emerge after the 1880s, when immigration of European Jews to Palestine increazed . This immigration increased the Jewish communities in Palestine, then part of the Ottoman Empire by the acquisition of land from Ottoman and individual Arab landholders, known as effendis, and establishment of Jewish agricultural settlements. At the time, Arabs lived in an almost feudal existence on the effendis' land . Demographer Justin McCarthy estimated from Ottoman census data that the population of Palestine in 1882 – 3 was about 468,000, consisting of 408,000 Muslims, 44,000 Christians and 15,000 Jews . By the eve of World War I, these numbers had increased to 602,000 Muslims, 81,000 Christians and 39,000 Jews, plus a similar but uncertain number of Jews who were not Ottoman citizens. The first Statistician General of Israel, Roberto Bachi, give similar numbers except for a lower count (525,000) of Muslims in 1914.

2 – 2 - British Mandate (1920 - 1948)

1918. Emir Faisal and Chaim Weizmann (left, also wearing Arab outfit)

During the time of the Mandatory Palestine, theBalfour Declaration signed in 1917, stated that the government of Great Britain supported the establishment of a "Jewish national home" in Palestine. This exacerbated tensions between the Arabs living in Mandate Palestine and the Jews who emigrated there during the Ottoman period. Signed in January 1919, the Faisal – Weizmann Agreementpromoted Arab - Jewish cooperation on the development of a Jewish national homeland in Palestine and an Arab nation in a large part of theMiddle East, though this event had little to no effect on the conflict.

In 1920, the San Remo conference largely endorsed the 1916 Anglo-French Sykes – Picot Agreement, allocating to Britain the area of present day Jordan, the area between the Jordan River and the Mediterranean Sea, and Iraq , while France received Syria and Lebanon . In 1922, the League of Nations formally established the British Mandate for Palestine and Transjordan, at least partially fulfilling Britain's commitments from the 1915–16McMahon–Hussein Correspondence by assigning all of the land east of the Jordan River to the Emirate of Jordan, ruled by Hashemite king Abdullah but closely dependent on Britain, leaving the remainder west of the Jordan as the League of Nations Mandatory Palestine. While the British had made promises to give both Arabs and Jews land, the British claimed they had never promised to give either side all of the land. Rising tensions had given way to violence, such as the 1920 Nebi Musa riots, and Jaffa riots of 1921. To assuage the Arabs, and due to British inability to control Arab violence in the Mandatory Palestine any other way, the semi-autonomous Arab Emirate of Transjordan was created in all Palestinian territory east of the Jordan river (roughly 77% of the mandate).

The conflicting forces of Arab nationalism and the Zionist movement created a situation which the British could neither resolve nor extricate themselves from. Pogroms in Russia and the Ukraine as well as Adolf Hitler's rise to power in Germany created a new urgency in the Zionist movement to create a Jewish state, and the evident intentions of the Zionists provoked increasingly fierce Arab resistance and attacks against the Jewish population (most notably in the preceding 1929 Hebron massacre, the activities of the Black Hand, and during the 1936 – 39 Arab revolt in Palestine). The British - appointed Grand Mufti of Jerusalem, Haj Amin al -Husseini, led opposition to the idea of turning part of Palestine into a Jewish state.

In search for help in expelling British forces from Palestine, thus removing the enforcer of the Zionist enterprise, the Grand Mufti sought alliance with the Axis Powers. The response of the British government was to banish the Mufti (where he spent much of World War II inGermany and helped form a Muslim SS division in the Balkans), curb Jewish immigration, and reinforce its police force. The Jewish leadership (*Yishuv*) "adopted a policy of restraint (*havlaga*) and static defense in response to Arab attacks"[6] and criticized the British for "what they regarded as Britain's retreat from the Balfour Declaration and its conciliation of Arab violence."[5] It was at this time that critics of this policy broke away from the *Hagana*(the self - defense organization of the *Yishuv*) and created the more right - wing militant *Irgun*, which would later be led by Menachem Begin in 1943. For a list of Irgun attacks on Palestinian civilians and policemen during this period, see List of Irgun attacks during the 1930s.

A British Royal Commission of Inquiry that came to be known as the Peel Commission was established in 1936. In its 1937 report, it proposed a two - state solution that gave the Arabs control over all of the Negev, much of the present-day West Bank, and Gaza and gave the Jews control over Tel Aviv, Haifa, present - day northern Israel, and surrounding areas. The British were to maintain control over Jaffa, Jerusalem, Bethlehem, and surrounding areas. The two main Jewish leaders, Chaim Weizmann and David Ben - Gurion had convinced theZionist Congress to approve equivocally the Peel recommendations as a basis for more negotiation.[7][8][9][10][11] The Arabs, however, rejected it while demanding "an end to Jewish immigration and land sales to Jews, calling for independence of Palestine as an independent Arab state."

Jewish violence against the Mandatory Palestine continued to mount throughout the later half of the 1940s, with attacks by the Irgun, assassination of British authorities officials by theLehi, and the 1946 King David Hotel bombing.

In 1947, the population was reported as 1,845,000, consisting of 608,000 Jews and 1,237,000 Arabs and others.

3 - War of 1948

The UN Partition Plan offered to both sides of the conflict before the 1948 war. The Jews accepted the plan while the Arabs rejected it.

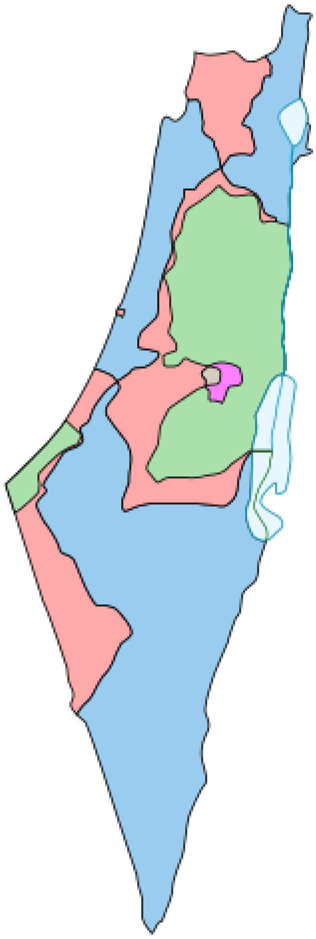
The 1948 Arab – Israeli War (1948 – 49) , known as the "War of Independence" by Israelis and al - Nakba ("the Catastrophe") by Palestinians, began after the UN Partition Plan and the subsequent 1947 – 48 Civil War in Mandatory Palestine in November 1947. The plan proposed the establishment of Arab and Jewish states in Palestine. The Arabs had rejected the plan while the Jews had accepted it. For four months, under continuous Arab provocation and attack, the Yishuv was usually on the defensive while occasionally retaliating. By March 1948 however, the United States was actively seeking a temporary UN approved trusteeship rather than immediatepartition, known as the Truman trusteeship proposal.[14] The Jewish leadership rejected this . By now, both Jewish[16] and Arab[17][18] militias had begun campaigns to control territory inside and outside the designated borders, and an open war between the two populations emerged.

Jordanian, Egyptian, Syrian, Lebanese , Iraqi and Saudi troops invaded Palestine subsequent to the British withdrawal and the declaration of the State of Israel on May 14, 1948. Israel, the US , the Soviet Union , and UN Secretary-General Trygve Lie called this illegal aggression, while China broadly backed the Arab claims. The Arab states proclaimed their aim of a "United State of Palestine"[22] in place of Israel and an Arab state. The Arab Higher Committee said, that in the future Palestine, the Jews will be no more than 1/7 of the population. i.e. only Jews that lived in Palestine before the British mandate. They did not specify what will happen to the other Jews They considered the UN Plan to be invalid because it was opposed by Palestine's Arab majority, and claimed that the British withdrawal led to an absence of legal authority, making it necessary for them to protect Arab lives and property.[24] About two thirds of Palestinian Arabs fled or were expelled from the territories which came under Jewish control; the rest became Arab citizens of Israel. All of the much smaller number of Jews in the territories captured by the Arabs, for example the Old City of Jerusalem, also fled or were expelled. The official United Nations estimate was that 711,000 Arabs became refugees during the fighting.

May 15 - June 10

The fighting ended with signing of the severalArmistice Agreements in 1949 between Israel and its warring neighbors (Egypt, Lebanon, Jordan, and Syria), which formalized Israeli control of the area allotted to the Jewish state plus just over half of thearea allotted to the Arab state. The Gaza Strip was occupied by Egypt and the West Bank by Jordanuntil June 1967 when they were seized by Israel during the Six-Day War.

3 – 1 - Aftermath of the 1948 war



Boundaries defined in the UN partition plan of 1947:

Area assigned for a Jewish state;

Area assigned for an Arab state;

Corpus separatum of Jerusalem (neither Jewish nor Arab).

Armistice Demarcation Lines of 1949:

Arab territory until 1967;

Israel

The about 711,000 Palestinians who fled or were expelled from the areas that became Israel were not allowed to return to their homes, and took up residence in refugee camps in surrounding countries, including Lebanon, Jordan, Syria, and the area that was later to be known as the Gaza Strip; they were usually not allowed to leave refugee camps and mix with the local Arab society either, leaving the Palestinian refugee problem unsolved even today. Around 400 Arab towns and villages were depopulated during the 1948 Palestinian exodus. The United Nations Relief and Works Agency for Palestine Refugees in the Near East was established to alleviate their condition.

After the war, "[the Arab states insisted on two main demands", neither of which were accepted by Israel :

1. Israel should with draw to the borders of the UN Partition Plan — Israel argued "that the new borders — which could be changed, under consent only — had been established as a result of war, and because the UN blueprint took no account of defense needs and was militarily untenable, there was no going back to that blueprint."

2. The Palestinian refugeesdeserved a full right of return back into Israel — Israel argued that this was "out of the question, not only because they were hostile to the Jewish state, but they would also fundamentally alter the Jewish character of the state " .

Over the next two decades after the 1948 war ended, between 700,000 and 900,000 Jews fled or were expelled from the Arab countries they were living in, in many cases owing to anti-Jewish sentiment, expulsion (in the case of Egypt) , or, in the case of Iraq, legal oppression but also quite often to promises of a better life from Israel; of this number, two - thirds ended up in refugee camps in Israel, while the remainder migrated to France, the United States and other Western or Latin American countries. The Jewish refugee camps in Israel were evacuated with time and the refugees were eventually integrated in the Jewish Israeli society (which in fact consisted almost entirely of refugees from Arab and European states). Israel argued that this and the Palestinian exodus represented a population exchange between Arab nations and the Jewish nation .

For the 19 years from the end of the Mandate until the Six-Day War, Jordan controlled the West Bank and Egypt controlled the Gaza Strip. In 1950, Jordan annexed the West Bank, but this annexation was recognized only by the United Kingdom. Both territories were conquered (but not annexed) from Jordan and Egypt by Israel in the Six-Day War. Neither Jordan nor Egypt allowed the creation of a Palestinian state in these territories. The effect this had on Israel during this period "were frequent border clashes ... terror and sabotage acts by individuals and small groups of Palestinian Arabs " .

4 - War of 1956

The 1956 Suez War was a joint Israeli-British-French operation, in which Israel invaded theSinai Peninsula and British and French forces landed at the port of Suez, ostensibly to separate the warring parties, though the real motivation of Great Britain and France was to protect the interests of investors in those countries who were affected by Egyptian PresidentNasser's decision to nationalize the Suez Canal. Israel justified its invasion of Egypt as an attempt to stop attacks (see the Fedayeen) upon Israeli civilians, and to restore Israeli shipping rights through the Straits of Tiran, which Egypt claimed was within its territorial waters. The invading forces agreed to withdraw under U.S. and international pressure, and Israel withdrew from the Sinai as well, in return for the installation of United Nations Emergency Forces and guarantees of Israeli freedom of shipment. The canal was left in Egyptian (rather than British and French) hands.

5 - Between 1956 and 1967

This period saw the rise of Nasserism; the founding of the United Arab Republic in 1958 and its collapse in 1961; Syrian plans for the diversion of water from the Jordan River; continuedfedayeen raids, mostly from Syria and Jordan, and Israeli reprisals; and the increasing alignment of the Arab states with the Soviet Union, who became their largest arms supplier.

In 1964, the PLO was established by mostly Palestinian refugees mostly from Jordan . The Article 24 of the Palestinian National Charter of 1964 stated: "This Organization does not exercise any territorial sovereignty over the West Bank in the Hashemite Kingdom of Jordan, on the Gaza Strip or in the Himmah Area."

6 - War of 1967

The background from which erupted the Six - Day War was caused by an erroneous information given to Nasser from the Soviet intelligence services that Israel was amassing troops near the Israeli-Syrian border. The state of conflict was also very tense after increased conflicts between Israel and Syria and Israel and Jordan - i.e. the Samu incident. On 14 May 1967 Mohamed Fawzi (general) left for Syria for one day tour, verified that the Soviet report was false and reported that there were no Israeli armed forces near the Syrian border Still, Nasser declared full mobilisation in Egypt as of 14 May 1967, citing the joint defence agreement with Syria . The Egyptian further steps were stationing of 100,000 Egyptian troops at the Sinai Peninsula, expulsion of UNEF peacekeeping forces (UNEF II) from the Sinai Peninsula along the border with Israel, and closure of the Straits of Tiran on May 21 – 22, 1967 (thus "blocking all shipping to and from Eilat ... a *casus belli*" according to a possible interpretation of international law) . The Israeli army had a potential strength, including the not fully mobilized reserves, of 264,000 troops.

Following the breakdown of international diplomatic efforts to solve the crisis, the fighting in the Six-Day War of 1967 began on 6 June 1967 with a surprising Israeli air strikes that destroyed the entire Egyptian air force while it was still on the ground. In spite of Israel's request to Jordan to desist from attacking it, Jordan along with Syria began to shell Israeli targets. In addition, Hussein, reluctant at first, sent ineffective bomber strikes because of Nasser's requests and affirmation of a sound Egyptian victory. Attacks on other Arab air forces took place later in the day as hostilities broke out on other fronts. A subsequent ground invasion into Egyptian territory led to Israel's conquest of the Gaza Strip and theSinai Peninsula. With the rapid and rather unexpected success on the Egyptian front, Israel decided to attack and successfully captured the West Bank from Jordan on June 7, and theGolan Heights from Syria on June 9.

6 – 1 - Khartoum Resolution, UN Resolution 242, and peace proposals

The **Khartoum Resolution** of September 1, 1967 was issued at the conclusion of 1967 Arab League summit convened in the wake of the Six-Day War, in Khartoum, the capital ofSudan. The summit lasted from August 29 to September 1 and was attended by eight Arab heads of state . The resolution called for: a continued state of belligerency with Israel, ending the Arab oil boycott declared during the Six-Day War, an end to the North Yemen Civil War, and economic assistance for Egypt and Jordan. It is famous for containing (in the third paragraph) what became known as the "Three No's": "no peace with Israel, no recognition of Israel, no negotiations with it..."

Following the Six - Day War, the United Nations Security Council adopted Resolution 242which proposed a peaceful solution to the Arab-Israeli conflict. The resolution was accepted by Israel, Jordan, and Egypt, but rejected by Syria until 1972 – 73 and the Yom Kippur War. To this day, Resolution 242 remains controversial due to conflicting interpretations over how much territory Israel would be required to withdraw from in order to conform with the resolution. Also, after the Israeli occupation of the West Bank following the war, Palestinian nationalism substantially increased. Armed resistance was encouraged from within the newlyoccupied territories and from the Arab nations that lost in the war.

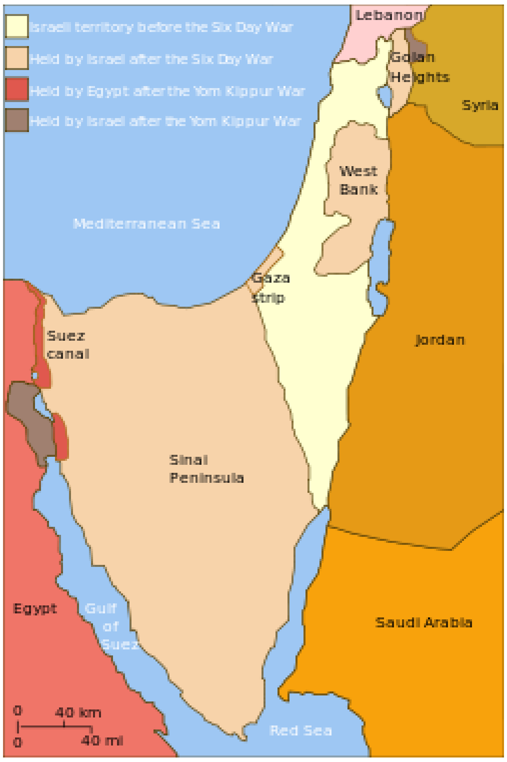
U.S. Secretary of State William P. Rogers proposed the Rogers Plan, which called for a 90-day ceasefire, a military standstill zone on each side of the Suez Canal, and an effort to reach agreement in the framework of UN Resolution 242. The Egyptian governmentaccepted the Rogers Plan even before Anwar Sadat became president. Israel refused to enter negotiations with Egypt based on the Rogers peace plan. Nasser forestalled any movement toward direct negotiations with Israel. In dozens of speeches and statements, Nasser posited the equation that any direct peace talks with Israel were tantamount to surrender.[32] No breakthrough occurred even after President Sadat in 1972 surprised everyone by suddenly expelling Soviet advisers from Egypt and again signaled to the United States government his willingness to negotiate.

7 - War of 1967-1970

The War of Attrition was a limited war fought between Egypt and Israel from 1967 to 1970. It was initiated by Egypt to damage Israel's morale and economy after its victory in the Six-Day War.[34] The war ended with a ceasefire signed between the countries in 1970 with frontiers at the same place as when the war started.

8 - Palestinian insurgency in South Lebanon

9 - War of 1973



When the ceasefire came into effect, Israel had lost ground on the east side of the Suez Canal to Egypt (shown in red) but gained ground west of the canal and in the Golan Heights (shown in gray / brown)

The 1973 Yom Kippur War began when Egypt and Syria launched a surprise joint attack, on the Jewish day of fasting, in the Sinai Peninsula and Golan Heights. The Egyptians and Syrians advanced during the first 24 – 48 hours, after which momentum began to swing in Israel's favor. By the second week of the war, the Syrians had been pushed entirely out of the Golan Heights. In the Sinai to the south, the Israelis had struck at the "hinge" between two invading Egyptian armies, crossed the Suez Canal (where the old ceasefire line had been) , and cut off an entire Egyptian army just as aUnited Nations ceasefire came into effect. During this time, the United States airlifted military supplies to Israel while the Soviet Union airlifted military supplies to Egypt.

Israeli troops eventually withdrew from the west of the Canal and the Egyptians kept their positions on a narrow strip on the east allowing them to re - open the Suez Canal and claim victory According to *The Continuum Political Encyclopedia of the Middle East* (ed. Sela, 2002), Israel clearly had the military victory over both Syria and Egypt, but it suffered a large blow to morale as well as substantial human casualties. The outcome of the Yom Kippur War set the stage for "a new phase in Israeli - Egyptian relations" ending ultimately in the signing of the Camp David Accords .

10 - South Lebanon

10 – 1 - 1978 conflict

Operation Litani was the official name of Israel's 1978 invasion of Lebanon up to the Litaniriver. The invasion was a military success, as PLO forces were pushed north of the river. However, international outcry led to the creation of the UNIFIL peacekeeping force and a partial Israeli retreat.

10 – 2 - 1982 Lebanon War

The 1982 Lebanon War began when Israel attacked Lebanon, justified by Israel as an attempt to remove the Fatah militants led by Yasser Arafat from Southern Lebanon (where they had established, during the country's civil war, a semi-independent enclave used to launch attacks on Israel) . The invasion was widely criticized both in and outside Israel , especially after the Israeli-backed Phalangist Christian militia's Sabra and Shatila massacre, and ultimately led to the death of roughly 1,000 Palestinians. Although through the war, Israel succeeded in exiling the PLO military personnel, including Arafat to Tunisia, it became entangled with various local Muslim militias (particularly Hezbollah) , which fought to end the Israeli occupation.

10 – 3 - 1982 – 2000 conflict

By 1985, Israel retreated from all but a narrow stretch of Lebanese territory designated by Israel as the Israeli Security Zone. UN Security Council Resolution 425 (calling on Israel to completely withdraw from Lebanon) was not completely fulfilled until 16 June 2000 . Despite UN Security Council resolutions 1559 and 1583 , Hezbollah continues to have a military wing.

11 - Intifada of 1987-1993

The First Intifada, 1987 – 1993, began as an uprising of Palestinians, particularly the young, against the Israeli military occupation of the West Bank and Gaza Strip after the failure of the PLO to achieve any kind of meaningful diplomatic solution to the Palestinian issue. The exiled PLO leadership in Tunisia quickly assumed a role in the *intifada*, but the uprising also brought a rise in the importance of Palestinian national and Islamic movements, and helped lead to the Palestinian Declaration of Independence in 1988. The *intifada* was started by a group of young Palestinians who began throwing rocks at the Israeli occupying forces inJabalia (Gaza Strip) in December 1987. In May 1989, the government of Yitzhak Shamir, theprime minister of Israel at the time, "suggested that violence cease, and that elections should be held in the West Bank and Gaza for a political delegation with whom Israel would come to terms regarding the implementation of Palestinian interim self-governing authority in these areas " . These elections however never materialized.

During the Gulf War, 1990 – 1991, Iraq tried draw Israel into the confrontation and thereby make it difficult for Arab regimes to remain in the coalition. During the war, the Palestinian Liberation Organization (PLO) and King Hussein of Jordan supported Iraq's invasion of Kuwait, while PLO chairman Yasser Arafat had allegedly received $100 million from Saddam Hussein. However, under strong pressure from the US, which feared direct Israeli involvement would threaten the unity of the coalition, Israel did not retaliate against Iraq and the multinational coalition ousted Iraqi forces from Kuwait. The defeat of Saddam Hussein in the Gulf War " was a devastating blow to ... the Palestinians " . After the Gulf War, Kuwaiti authorities forcibly pressured nearly 200,000 Palestinians to leave Kuwait.[37] The policy which partly led to this exodus was a response to the alignment of PLO leader Yasser Arafatwith Saddam Hussein. They also withdrew their financial support from the Palestinian cause due to PLO support of Saddam Hussein. It was this political environment that allowed for the PLO to begin talks with the United States and Israel. The First Palestinian Intifada ended with the Madrid Conference of 1991 and the signing of the Oslo Accords by Israel and the PLO in 1993.

12 - Oslo peace process (1993 – 2000)

In September 1993, Israeli Prime Minister Yitzhak Rabin and PLO Chairman Yasser Arafat signed the Declaration of Principles (DOP) which "shaped the principles for a prospective process of the establishment of a five-year interim self-governing authority" in the Palestinian territories.[4] In May 1994, the first stage of the DOP was implemented, Arafat arrived in the Gaza Strip, and financial aid started pouring in from the parts of the Western world andJapan. Unfortunately, "the new trend in Israeli-Palestinian relations also entailed a wave of violence by religious fanatics."[4] In September 1996, after the opening of some ancient tunnels near the Temple Mount, a small wave of violence occurred. This frightened many Israelis into believing that "the new reality created by the Oslo Agreements, namely the presence of an armed police force of approximately 30,000 Palestinians, ... could easily shift from cooperation to hostility."

In October 1998, Arafat and then Israeli Prime Minister Benjamin Netanyahu signed the Wye Memorandum which "called for the implementation of Israel's first and second redeployments according to the DOP in three phases " · Shortly after, Netanyahu's government fell and the Labor Party (under Ehud Barak) won control of the Knesset . Barak's election campaign was mostly geared toward a lasting peace in the Middle East by further implementation of the Wye Memorandum and the Oslo Accord.

13 - Intifada of 2000

The al - Aqsa Intifada, or Second Intifada, began in late September 2000, around the time Israeli opposition leader Ariel Sharon and a large contingent of armed bodyguards visited theTemple Mount (Haram al – Sharif) complex in Jerusalem and declared the area as an eternal Israeli territory. Widespread riots and attacks broke out among Palestinians and Arab citizens of Israel in Jerusalem and many major Israeli cities, and spread throughout the West Bank and Gaza Strip. The Palestinian Authority (PA) involvement in the Intifada was handled by the Tanzim organization, which was the secret armed branch of Arafat's Fatah party within the PLO. In January 2002, the "PA's direct involvement in the Intifada was confirmed ... when the IDF intercepted a cargo ship in the Red Sea carrying tons of rockets, mortars, and other weapons and ammunition from Iran, earmarked for smuggling into PA [Palestinian Authority] areas."[4] In March 2002, just prior to the Arab Peace Initiative, suicide bombingscommitted by Palestinians against Israeli civilians "intensified ... in buses, restaurants, coffee shops, and other public places in Israel " · An Israeli human rights group, B'Tselem, estimated the death toll to be 3,396 Palestinians and 994 Israelis , although this number is criticized for not showing the whole picture, and not differentiating between combatants and civilians (suicide bombers, for example, are counted in that death toll) . The Intifada also created "heavy economic losses to both sides" of the conflict.

13 – 1 - Arab Peace Initiative of 2002

In 2002, Saudi Arabia offered a peace plan in *The New York Times* and at a summit meeting of the Arab League in Beirut. The plan is based on, but goes beyond UN Security Council Resolution 242 and Resolution 338. It essentially calls for full withdrawal, solution of therefugee problem through the Palestinian "right of return", a Palestinian state with its capital inEast Jerusalem in return for fully normalized relations with the whole Arab world. This proposal was the first to receive the unanimous backing of the Arab League.

In response, Israeli Foreign Minister Shimon Peres said: "... the details of every peace plan must be discussed directly between Israel and the Palestinians, and to make this possible, the Palestinian Authority must put an end to terror, the horrifying expression of which we witnessed just last night in Netanya", referring to the Netanya suicide attack.

In 2005, the United States Congress acknowledged that Saudi Arabia has been funding toHamas and other Palestinian insurgency groups.

14 - Israel's Disengagement of 2005

In 2005 Israel unilaterally evacuated settlements, and military outposts from the Gaza Strip and the northern West Bank.

The Disengagement Plan was a proposal by Israeli Prime Minister Ariel Sharon, adopted by the government and enacted in August 2005, to remove a permanent Israeli presence from the Gaza Strip and from four Israeli settlements in the northern West Bank. The civilians were evacuated (many forcibly) and the residential buildings demolished after August 15, and the disengagement from the Gaza Strip was completed on 12 September 2005, when the last Israeli soldier left. The military disengagement from the northern West Bank was completed ten days later.

15 - Israel - Lebanon conflict of 2006

The 2006 Lebanon War began on 12 July 2006, with an attack by Hezbollah on Israel. Three Israeli soldiers were killed, and two were kidnapped and taken prisoner into Lebanon. In a search and rescue operation to return the captured soldiers, a further five Israeli Defense Forces troops were killed. It marked the beginning of a new wave of clashes between Israel and Hezbollah which saw the Lebanese capital, the sole Lebanese international airport, and much of southern Lebanon attacked by the Israelis, while Lebanese militias, presumably Hezbollah, bombarded northern Israeli cities, striking as far south as the city of Haifa. The conflict killed more than a thousand people, most of whom were Lebanese civilians and Hezbollah fighters; and displaced 974,184 Lebanese and 300,000 - 500,000 Israelis . Fears were growing that the situation could deteriorate further , with the possibility of either Syria or Iran becoming involved. But a ceasefire was signed, and went into effect 14 August.

16 - Recent developments

From the election of Mahmud Ahmedinijad as Iranian President, the Islamic State of Iran has actively supported numerous Arab organizations opposing Israel and has also actively called for waging war against it. Iran was widely referred as attempting to create a Shi'a Islam dominated axis, including the Syrian Ba'athist regime, dominated by Alawites, Lebanon with Hezbollah dominance and making a strategic alliance with Sunni Hamas in Gaza Strip, which lasted until 2012 (terminating due to Shi'a - Sunni discourse in the Syrian civil war). In January 2007, concerns increased among Israel's leaders that President Mahmoud Ahmadinejad of Iran might be planning some sort of nuclear arms buildup, which might be considered for use in opposition to Israel . The Security Council voted to put sanctions on Iran for its pursuit of nuclear technology.[45] There was evidence that international sanctions were creating discontent among Iranians with Ahmadinejad's policies.

16 – 1 – Syria

Some Israeli officials asserted in January 2007 that there had been some constructive progress in unpublicized talks with Syria Syria has repeatedly requested that Israel re - commence peace negotiations with the Syrian government . There is an on - going internal debate within the Israeli government regarding the seriousness of this Syrian invitation for negotiations. The United States demanded that Israel desist from even exploratory contacts with Syria to test whether Damascus is serious in its declared intentions to hold peace talks with Israel. U.S. Secretary of State Condoleezza Rice was forceful in expressing Washington's view on the matter to Israeli officials that even exploratory negotiations with Syria are not to be attempted. Israel has thus far obeyed Washington's demand to desist.

In May 2008 Israel and Syria officially confirmed that negotiations are taking place with Turkey serving as a mediator .These negotiations are preparing the grounds for direct Israeli-Syrian negotiations that will start in the second half of 2008 .

16 – 2 – Lebanon

In Jan. 2007, thousands gathered in Lebanon in a rally to support Hezbollah, and to celebrate the resignation of Israel's top military commander, Dan Halutz . How ever, in some Lebanese communities, Hezbollah lost popularity, for opposing Lebanon's national government.

16 – 3 - Palestinians

16 – 3 - 1 – Palestinian Authority

16 – 3 - 2 – Gaza Strip

In January 2006, elections were held for the Palestinian Legislative Council. Hamas won these elections, and thus secured a majority of seats. Due to the nature of theirParliamentary system, this meant they also controlled the executive posts of the Palestinian Authority, including the Prime Minister's post, and the cabinet. Ismail Haniyeh became Prime Minister. Mahmoud Abbas of Fatah remained as President.

Hamas gained popular support because it appeared much more efficient and much less corrupt than Fatah. It built various institutions and social services. Hamas openly declared that it did not intend to accept any recognition of Israel. It stated it would not accept the Oslo Accords, and would not accept or recognize any negotiations with Israel .Throughout previous years, it had openly stated that it encouraged and organized attacks against Israel. This created a major change in previous Israeli-Palestinian interactions, which had previously been going through various periods of negotiations.

Most Western nations and international organizations did not give the Hamas lead government official recognition and responded by cutting off funds and imposing other sanctions. Mahmoud Abbas, the Palestinian President and head of Fatah, met with Khaled Meshal, the exiled head of Hamas, in Syria, in an effort to resolve differences over the direction of the Palestinian Authority and negotiations with Israel and to try to form a unity government with Hamas. The two parties did not reach a resolution.

In a meeting between Ehud Olmert and Egyptian President Hosni Mubarak in January 2007, the latter called on Israel to pursue peace more actively, but also stated that Egypt would seek to block the flow of illegal arms being smuggled into the Gaza Strip.

In June 2007, Hamas took control of Gaza, violently routing the forces of Fatah. This effectively severed control of the Palestinian territories. Those in the West Bank were underFatah's control, with those in Gaza under the control of Hamas. Mahmoud Abbas, the Palestinian president, dissolved the government. The fighting had numerous casualties, and gave rise to refugees, who fled to Egypt and other countries. During the conflict between Hamas and Fatah, Egypt granted safe haven to several Fatah officials who fled Gaza . Egypt also stated it would help in policing the border, and impeding the flow of illegal arms .

Arab – Israeli Conflict

Contents

Arab – Israeli Conflict	
Date	May 1948 – present Main phase: 1948 – 1973
Location	Middle East
Result	Ongoing Egypt – Israel Peace Treaty Oslo Accords Israel – Jordan peace treaty UNSC 1701
Territorial changes	Israeli occupation of the Sinai Peninsula (1956 – 57; 1967–1982), West Bank (1967 – present) , Gaza Strip (1967 – 2005), Golan Heights (1967 – present) and South Lebanon (1982 – 2000)

Belligerents	
Israel	Palestinians: AHW (1947 – 1949) Fedayeen (1949 – 1964) PLO (1964 – 2005) Gaza Strip (2005 –) Jordan (1948 – 1994) Egypt (1948 – 1978) Iraq (1948 –) Syria (1948 –) Lebanon (1948 –) Hezbollah (1982 –)
Suez Crisis: (1956) United Kingdom France **South Lebanon Conflict :** SLA (1978–2000)	**War of Attrition:** (1967 –70) Soviet Union
Supported by:	**Supported by:**
Commanders and leaders	
David Ben - Gurion Chaim Weizmann Yigael Yadin Yaakov Dori David Shaltiel Yitzhak Rabin Ariel Sharon Ehud Barak Isser Be'eri Moshe Dayan Yisrael Galili Yigal Allon Shimon Avidan Yitzhak Pundak Yisrael Amir	John Bagot Glubb Habis al - Majali Abd al-Q. Al - Husayni † Hasan Salama † Fawzi Al - Qawuqji Ahmed Ali al - Mwawi Haj Amin Al - Husseini King Farouk I Ahmad Ali al - Mwawi Muhammad Naguib Saad El Shazly
Casualties and losses	

≈22,570 military deaths ≈1,723 civilian deaths	90,785 total Arab deaths
Both sides: 74,000 military deaths 18,000 civilian deaths (1945 – 1995)	

1 - Introduction

The **Arab – Israeli conflict** (الصراع العربي الإسرائيلي) refers to the political tension and military conflicts between certain Arab countries and Israel. The roots of the modern Arab – Israeli conflict are bound in the rise of Zionismand Arab nationalism towards the end of the 19th century. Territory regarded by the Jewish people as their historical homeland is also regarded by the Pan - Arab movement as historically and presently belonging to the Palestinian Arabs , and in the Pan - Islamic context , as Muslim lands. The sectarian conflict between Palestinian Jews and Arabs emerged in the early 20th century, peaking into a full - scale civil war in 1947 and transforming into the First Arab - Israeli War in May 1948. This followed the Declaration of the Establishment of the State of Israel byDavid Ben - Gurion, the Executive Head of the World Zionist Organization, who declared the establishment of a Jewish state in Eretz - Israel to be known as theState of Israel.

The conflict has shifted over the years from the large scale regional Arab – Israeli conflict to a more local Israeli – Palestinian conflict, as large - scale hostilities mostly ended with the cease-fire agreements, following the 1973 Yom Kippur War. Subsequently, peace agreements were signed between Israel and Egypt in 1979, and Israel and Jordan in 1994. The interim Oslo Accords led to the creation of thePalestinian National Authority in 1994, though a final peace agreement has yet to be reached. A cease-fire currently stands between Israel and Syria, as well as more recently with Lebanon (since 2006). The conflict between Israel and Hamas - ruled Gaza, which resulted in the 2009 cease fire (although fighting has continued since then) is usually also included as part of the Israeli – Palestinian conflict and hence the Arab – Israeli conflict. Despite the peace agreements with Egypt and Jordan and the generally existing cease fire, the Arab world and Israel generally remain at odds with each other over specific territory, besides other issues.

2 - Back ground

2 – 1 - Religious aspects of the conflict

Some groups opposed to the peace process invoke religious arguments for their uncompromising positions . The contemporary history of the Arab – Israeli conflict is very much affected by the religious beliefs of the various sides and their views of the idea of thechosen people in their policies with regard to the "Promised Land" and the "Chosen City" ofJerusalem.

The Land of Canaan or *Eretz Yisrael* (Land of Israel) was , according to the Hebrew Bible , promised by God to the Children of Israel. This is also mentioned in the Qur'an. In his 1896 manifesto *The Jewish State*, Theodor Herzl repeatedly refers to the Biblical Promised Landconcept . Likud is currently the most prominent Israeli political party to include the Biblical claim to the Land of Israel in its platform.

Muslims also claim rights to that land in accordance with the Quran . Contrary to the Jewish claim that this land was promised only to the descendants of Abraham's younger sonIsaac, they argue that the Land of Canaan was promised to what they consider the elder son, Ishmael, from whom Arabs claim descent . Additionally, Muslims also revere many sites holy for Biblical Israelites, such as the Cave of the Patriarchs and the Temple Mount. In the past 1,400 years, Muslims have constructed Islamic landmarks on these ancient Israelite sites, such as the Dome of the Rock and the Al-Aqsa Mosque on the Temple Mount, the holiest site in Judaism. This has brought the two groups into conflict over the rightful possession of Jerusalem. Muslim teaching is that Muhammad passed through Jerusalem on his first journey to heaven. Hamas, which governs the Gaza Strip, claims that all of the land of Palestine (the current Israeli and Palestinian territories) is an Islamic *waqf* that must be governed by Muslims.

Christian Zionists often support the State of Israel because of the ancestral right of the Jews to the Holy Land, as suggested, for instance, by Paul in Romans 11. Christian Zionism teaches that the return of Jews in Israel is a prerequisite for the Second Coming of Christ.

2 – 2 - National movements

The roots of the modern Arab – Israeli conflict lie in the rise of Zionism and the reactionaryArab nationalism that arose in response to Zionism towards the end of the 19th century. Territory regarded by the Jewish people as their historical homeland is also regarded by thePan-Arab movement as historically and presently belonging to the Palestinian Arabs. Before World War I, the Middle East, including Palestine (later Mandatory Palestine), had been under the control of the Ottoman Empire for nearly 400 years. During the closing years of their empire, the Ottomans began to espouse their Turkish ethnic identity, asserting the primacy of Turks within the empire, leading to discrimination against the Arabs . The promise of liberation from the Ottomans led many Jews and Arabs to support the allied powers during World War I, leading to the emergence of widespread Arab nationalism. Both Arab nationalism and Zionism had their formulative beginning in Europe. The Zionist Congress was established in Basel in 1897, while the "Arab Club" was established in Paris in 1906.

In the late 19th century European and Middle Eastern Jewish communities began to increasingly immigrate to Palestine and purchase land from the local Ottoman landlords. The population of the late 19th century in Palestine reached 600,000 – mostly Muslim Arabs, but also significant minorities of Jews, Christians, Druze and some Samaritans and Bahai's. At that time, Jerusalem did not extend beyond the walled area and had a population of only a few tens of thousands. Collective farms, known as kibbutzim, were established, as was the first entirely Jewish city in modern times, Tel Aviv.

During 1915 – 16, as World War I was underway, the British High Commissioner in Egypt, Sir Henry McMahon, secretly corresponded with Husayn ibn 'Ali, the patriarch of the Hashemite family and Ottoman governor of Mecca and Medina. McMahon convinced Husayn to lead an Arab revolt against the Ottoman Empire, which was aligned with Germany against Britain and France in the war. McMahon promised that if the Arabs supported Britain in the war, the British government would support the establishment of an independent Arab state under Hashemite rule in the Arab provinces of the Ottoman Empire, including Palestine. The Arab revolt, led by T. E. Lawrence ("Lawrence of Arabia") and Husayn's son Faysal, was successful in defeating the Ottomans, and Britain took control over much of this area.

2 – 3 - Sectarian conflict in Mandatory Palestine

2 – 3 – 1 - First mandate years and the Franco - Syrian war

In 1917, Palestine was conquered by the British forces (including the Jewish Legion). The British government issued the Balfour Declaration, which stated that the government viewed favorably "the establishment in Palestine of a national home for the Jewish people" but "that nothing shall be done which may prejudice the civil and religious rights of existing non-Jewish communities in Palestine". The Declaration was issued as a result of the belief of key members of the government, including Prime Minister David Lloyd George, that Jewish support was essential to winning the war; however, the declaration caused great disquiet in the Arab world After the war, the area came under British rule as the British Mandate of Palestine. The area mandated to the British in 1923 included what is today Israel, the West Bank and Gaza Strip. Transjordan eventually was carved into a separate British protectorate – the Emirate of Transjordan, which gained an autonomous status in 1928 and achieved complete independence in 1946 with the approval by the United Nations of the end of the British Mandate.

A major crisis among the Arab nationalists took place with the failed establishment of theArab Kingdom of Syria in 1920. With the disastrous outcome of the Franco - Syrian War, the self-proclaimed Hashemite kingdom with its capital in Damascus was defeated and the Hashemite ruler took refuge in Mandatory Iraq. The crisis saw the first confrontation of nationalist Arab and Jewish forces, taking place in the Battle of Tel Hai in March 1920, but more importantly the collapse of the pan-Arabist kingdom led to the establishment of the local Palestinian version of Arab nationalism, with the return of Haj Amin al - Husseini from Damascus to Jerusalem in late 1920.

At this point in time Jewish immigration to Mandatory Palestine continued, while to some opinions a similar, but less documented, immigration also took place in the Arab sector, bringing workers from Syria and other neighbouring areas. Palestinian Arabs saw this rapid influx of Jewish immigrants as a threat to their homeland and their identity as a people. Moreover, Jewish policies of purchasing land and prohibiting the employment of Arabs in Jewish-owned industries and farms greatly angered the Palestinian Arab communities. Demonstrations were held as early as 1920, protesting what the Arabs felt were unfair preferences for the Jewish immigrants set forth by the British mandate that governed Palestine at the time. This resentment led to outbreaks of violence later that year, as the al-Husseini incited riots broke out in Jerusalem. Winston Churchill's1922 White Paper tried to reassure the Arab population, denying that the creation of a Jewish state was the intention of the Balfour Declaration.

2 – 3 – 2 - 1929 events

In 1929, after a demonstration by Vladimir Jabotinsky's political group Betar at the Western Wall, riots started in Jerusalem and expanded throughout Mandatory Palestine; Arabs murdered 67 Jews in the city of Hebron, in what became known as the Hebron massacre.

A Jewish bus equipped with wire screens to protect against rock, glass, and grenade throwing, late 1930s

During the week of the 1929 riots, at least 116 Arabs and 133 Jews were killed and 339 wounded.

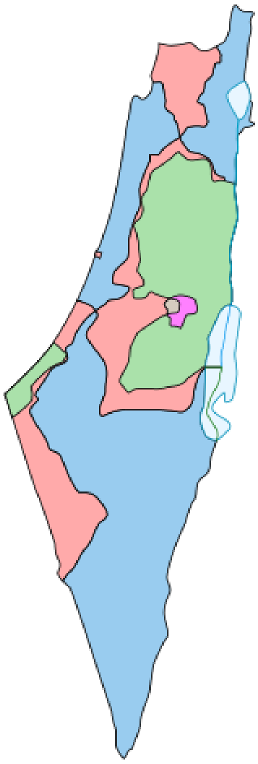
2 – 3 – 2 - 1930s and 1940s

By 1931, 17 percent of the population of Mandatory Palestine were Jews, an increase of six percent since 1922. Jewish immigration peaked soon after the Nazis came to power in Germany, causing the Jewish population in British Palestine to double.[25]

In the mid-1930s Izz ad - Din al - Qassam arrived from Syria and established the Black Hand, an anti - Zionist and anti - British militant organization. He recruited and arranged military training for peasants and by 1935 he had enlisted between 200 and 800 men. The cells were equipped with bombs and firearms, which they used to kill Jewish settlers in the area, as well as engaging in a campaign of vandalism of Jewish settler plantations . By 1936, escalating tensions led to the 1936 – 39 Arab revolt in Palestine.

In response to Arab pressure , the British Mandate authorities greatly reduced the number of Jewish immigrants to Palestine (see White Paper of 1939 and the SS *Exodus*). These restrictions remained in place until the end of the mandate, a period which coincided with the Nazi Holocaust and the flight of Jewish refugees from Europe. As a consequence, most Jewish entrants to Mandatory Palestine were considered illegal , causing further tensions in the region. Following several failed attempts to solve the problem diplomatically, the British asked the newly formed United Nations for help. On May 15, 1947, the General Assembly appointed a committee, the UNSCOP, composed of representatives from eleven states . To make the committee more neutral, none of the Great Powers were represented.[30] After five weeks of in-country study, the Committee reported to the General Assembly on September 3, 1947 . The Report contained a majority and a minority plan. The majority proposed a *Plan of Partition with Economic Union*. The minority proposed *The Independent State of Palestine*. With only slight modifications, the *Plan of Partition with Economic Union* was the one the adoption and implementation of which was recommended in resolution 181(II) of November 29, 1947 . The Resolution was adopted by 33 votes to 13 with 10 abstentions. All six Arab states who were UN-members voted against it. On the ground, Arab and Jewish Palestinians were fighting openly to control strategic positions in the region. Several major atrocities were committed by both sides.

2 – 4 - Civil War in Mandatory Palestine



Boundaries defined in the UN partition plan of 1947:
Area assigned for a Jewish state;
Area assigned for an Arab state;
Corpus separatum of Jerusalem (neither Jewish nor Arab).

Armistice Demarcation Lines of 1949:
Arab territory until 1967;
Israel

In the weeks prior to the end of the Mandate the Haganahlaunched a number of offensives in which they gained control over all the territory allocated by the UN to the Jewish State, creating a large number of refugees and capturing the towns of Tiberias, Haifa, Safad, Beisan and, in effect, Jaffa.

Early in 1948, the United Kingdom announced its firm intention to terminate its mandate in Palestine on May 14.[34]In response, U.S. President Harry S. Truman made a statement on March 25 proposing UN trusteeship rather than partition, stating that "unfortunately, it has become clear that the partition plan cannot be carried out at this time by peaceful means. ... unless emergency action is taken, there will be no public authority in Palestine on that date capable of preserving law and order. Violence and bloodshed will descend upon the Holy Land. Large-scale fighting among the people of that country will be the inevitable result " .

3 – History

3 - 1 - 1948 Arab – Israeli War

On May 14, 1948, the day on which the British Mandate over Palestine expired, the Jewish People's Council gathered at the Tel Aviv Museum, and approved a proclamation which declared the establishment of a Jewish state in Eretz Israel, to be known as the State of Israel.[36] There were no mention of the borders of the new state other than that it was in Eretz Israel. In an official cablegram from the Secretary - General of the League of Arab States to the UN Secretary - General on May 15, 1948, the Arab stated publicly that Arab Governments found "themselves compelled to intervene for the sole purpose of restoring peace and security and establishing law and order in Palestine." (Clause 10 (e)) . Further in Clause 10 (e) – "The Governments of the Arab States hereby confirm at this stage the view that had been repeatedly declared by them on previous occasions, such as the London Conference and before the United Nations mainly, the only fair and just solution to the problem of Palestine is the creation of United State of Palestine based upon the democratic principles ..."

That day, the armies of Egypt , Lebanon , Syria , Jordan, and Iraq invaded/intervened in what had just ceased to be the British Mandate, marking the beginning of the 1948 Arab – Israeli War. The nascent Israeli Defense Force repulsed the Arab nations from part of the occupied territories, thus extending its borders beyond the original UNSCOP partition . By December 1948, Israel controlled most of the portion of Mandate Palestine west of theJordan River. The remainder of the Mandate consisted of Jordan, the area that came to be called the West Bank (controlled by Jordan) , and the Gaza Strip (controlled by Egypt). Prior to and during this conflict, 713,000 Palestinian Arabs fled their original lands to become Palestinian refugees, in part, due to a promise from Arab leaders that they would be able to return when the war had been won, and also in part due to attacks on Palestinian villages and towns by Israeli forces and Jewish militant groups . Many Palestinians fled from the areas that are now present - day Israel as a response to massacres of Arab towns by militant Jewish organizations like the Irgun and the Stern Gang (See Deir Yassin massacre) . The War came to an end with the signing of the 1949 Armistice Agreements between Israel and each of its Arab neighbours.

Before the adoption by the United Nations of Resolution 181 in November 1947 and thedeclaration of the State of Israel in May 1948, several Arab countries adopted discriminatory measures against their local Jewish populations. The status of Jewish citizens in Arab states worsened dramatically during the 1948 Israeli - Arab war. Major anti - Jewish riots erupted throughout the Arab World in December 1947, and Jewish communities were hit particularly hard in Syria and Aden, with hundreds of dead and injured. By mid – 1948 , almost all Jewish communities in Arab states had suffered attacks and their status deteriorated. Jews under Islamic regimes were uprooted from their longtime residency or became political hostages of the Arab–Israeli conflict. As a result, a large number of Jews fled or were forced to emigratefrom Arab countries and other Muslim countries as well. Anti-Jewish violence and persecution initiated the first waves of exodus, with many following. In Libya, Jews were deprived of citizenship, and in Iraq, their property was seized . Egypt expelled most of its Jewish community in 1956, while Algeria denied its Jews of citizenship, upon its independence in 1962. The majority were fleeing due to worsening political conditions, although some emigrated for ideological reasons .

3 - 2 - 1949 – 67

As a result of Israel's victory in the 1948 Arab – Israeli War, any Arabs caught on the wrong side of the ceasefire line were unable to return to their homes in what became Israel. Likewise, any Jews on the West Bank or in Gaza were exiled from their property and homes to Israel. Today's Palestinian refugees are the descendants of those who left, the responsibility for their exodus being a matter of dispute between the Israeli and the Palestinian side . Over 700,000 Jews emigrated to Israel between 1948 and 1952, with approximately 285,000 of them from Arab countries .

In 1956 , Egypt closed the Straits of Tiran to Israeli shipping, and blockaded the Gulf of Aqaba, in contravention of the Constantinople Convention of 1888. Many argued that this was also a violation of the 1949 Armistice Agreements . On July 26, 1956, Egypt nationalized the Suez Canal Company, and closed the canal to Israeli shipping.[47] Israel responded on October 29, 1956, by invading the Sinai Peninsula with British and French support. During the Suez Crisis, Israel captured the Gaza Strip and Sinai Peninsula. The United States and the United Nations soon pressured it into a ceasefire. Israel agreed to withdraw from Egyptian territory. Egypt agreed to freedom of navigation in the region and the demilitarization of the Sinai. The United Nations Emergency Force (UNEF) was created and deployed to oversee the demilitarization . The UNEF was only deployed on the Egyptian side of the border, as Israel refused to allow them on its territory.

Israel completed work on a national water carrier, a huge engineering project designed to transfer Israel's allocation of the Jordan river's waters towards the south of the country in realization of Ben - Gurion's dream of mass Jewish settlement of the Negev desert. The Arabs responded by trying to divert the headwaters of the Jordan, leading to growing conflict between Israel and Syria.

The PLO (Palestinian Liberation Organization) was first established in 1964, under a charter including a commitment to "[t]he liberation of Palestine [which] will destroy the Zionist and imperialist presence..." (PLO Charter, Article 22, 1968).

On May 19, 1967, Egypt expelled UNEF observers , and deployed 100,000 soldiers in the Sinai Peninsula . It again closed the Straits of Tiran to Israeli shipping , returning the region to the way it was in 1956 when Israel was blockaded.

On May 30, 1967, Jordan signed a mutual defense pact with Egypt. Egypt mobilized Sinai units, crossing UN lines (after having expelled the UN border monitors) and mobilized and massed on

Israel's southern border. On June 5, Israel launched an attack on Egypt. TheIsraeli Air Force (IAF) destroyed most of the Egyptian Air Force in a surprise attack, then turned east to destroy the Jordanian, Syrian and Iraqi air forces . This strike was the crucial element in Israel's victory in the Six - Day War . At the war's end, Israel had gained control of the Sinai Peninsula, the Gaza Strip, the West Bank (including East Jerusalem), Shebaa farms, and the Golan Heights. The results of the war affect the geopolitics of the region to this day.

3 – 3 - 1967 – 73

Egyptian forces crossing the Suez Canal on October 7, 1973

At the end of August 1967, Arab leaders met in Khartoum in response to the war, to discuss the Arab position toward Israel. They reached consensus that there should be no recognition, no peace, and no negotiations with the State of Israel, the so - called "three no's".

In 1969, Egypt initiated the War of Attrition, with the goal of exhausting Israel into surrendering the Sinai Peninsula. The war ended following Gamal Abdel Nasser's death in 1970.

On October 6, 1973, Syria and Egypt staged a surprise attack on Israel on Yom Kippur, the holiest day of the Jewish calendar. The Israeli military were caught off guard and unprepared, and took about three days to fully mobilize . This led other Arab states to send troops to reinforce the Egyptians and Syrians. In addition, these Arab countries agreed to enforce an oil embargo on industrial nations including the U.S, Japan and Western European Countries. These OPEC countries increased the price of oil fourfold, and used it as a political weapon to gain support against Israel.[61] The Yom Kippur War accommodatedindirect confrontation between the US and the Soviet Union. When Israel had turned the tide of war, the USSR threatened military intervention. The United States, wary of nuclear war, secured a ceasefire on October 25.

3 – 4 - 1974 – 2000

3 – 4 – 1 - Egypt

Begin, Carter and Sadat at Camp David

Following the Camp David Accords of the late 1970s, Israel and Egypt signed a peace treaty in March 1979. Under its terms, the Sinai Peninsulareturned to Egyptian hands, and the Gaza Strip remained under Israeli control, to be included in a future Palestinian state. The agreement also provided for the free passage of Israeli ships through the Suez Canal and recognition of theStraits of Tiran and the Gulf of Aqaba as international water ways.

3 – 4 – 2 - Jordan

In October 1994, Israel and Jordan signed a peace agreement, which stipulated mutual cooperation, an end of hostilities, the fixing of the Israel-Jordan border, and a resolution of other issues. The conflict between them had cost roughly 18.3 billion dollars. Its signing is also closely linked with the efforts to create peace between Israel and the Palestine Liberation Organization (PLO) representing the Palestinian National Authority (PNA). It was signed at the southern border crossing of Arabah on October 26, 1994 and made

Jordan only the second Arab country (after Egypt) to sign a peace accord with Israel.

3 – 4 – 3 - Iraq

Israel and Iraq have been implacable foes since 1948. Iraq sent its troops to participate in the 1948 Arab – Israeli War, and later backed Egypt and Syria in the 1967 Six - Day War and in the 1973 Yom Kippur War.

In June 1981, Israel attacked and destroyed newly built Iraqi nuclear facilities in Operation Opera.

During the Gulf War in 1991, Iraq fired 39 Scud missiles into Israel, in the hopes of uniting the Arab world against the coalition which sought to liberate Kuwait. At the behest of the United States, Israel did not respond to this attack in order to prevent a greater outbreak of war.

3 – 4 – 4 - Lebanon

In 1970, following an extended civil war, King Hussein expelled the Palestine Liberation Organization from Jordan. September 1970 is known as the Black September in Arab history and sometimes is referred to as the "era of regrettable events". It was a month when Hashemite King Hussein of Jordan moved to quash the autonomy of Palestinian organisations and restore his monarchy's rule over the country.[62] The violence resulted in the deaths of tens of thousands of people, the vast majority Palestinians . Armed conflict lasted until July 1971 with the expulsion of the PLO and thousands of Palestinian fighters to Lebanon. The PLO resettled in Lebanon, from which it staged raids into Israel. In 1978, Israel launched Operation Litani, in which it together with the South Lebanon Army forced the PLO to retreat north of the Litani river. In 1981 another conflict between Israel and the PLO broke out, which ended with a ceasefire agreement that did not solve the core of the conflict. In June 1982, Israel invaded Lebanon. Within two months the PLO agreed to withdraw thence.

In March 1983, Israel and Lebanon signed a ceasefire agreement. However, Syria pressured President Amine Gemayel into nullifying the truce in March 1984. By 1985, Israeli forces withdrew to a 15 km wide southern strip of Lebanon, following which the conflict continued on a lower scale, with relatively low casualties on both sides. In 1993 and 1996, Israel launched major operations against the Shiite militia of Hezbollah, which had become an emergent threat. In May 2000, the newly elected government of Ehud Barak authorized a withdrawal from Southern Lebanon, fulfilling an election promise to do so well ahead of a declared deadline. The hasty withdrawal lead to the immediate collapse of the South Lebanon Army, and many members either got arrested or fled to Israel.

In 2006, as a response to a Hezbollah cross-border raid, Israel launched air strikes on Hezbollah strongholds in Southern Lebanon, starting the 2006 Lebanon War. The inconclusive war lasted for 34 days, and resulted in the creation of a buffer zone in Southern Lebanon and the deployment of Lebanese troops south of the Litani river for the first time since the 1960s. The Israeli government under Ehud Olmert was harshly criticized for its handling of the war in the Winograd Commission.

3 – 4 – 5 - Palestinians

The 1970s were marked by a large number of major, international terrorist attacks, including the Lod Airport massacre and the Munich Olympics Massacre in 1972, and the Entebbe Hostage Taking in 1976, with over 100 Jewish hostages of different nationalities kidnapped and held in Uganda.

In December 1987, the First Intifada began. The First Intifada was a mass Palestinian uprising against Israeli rule in the Palestinian territories.[64] The rebellion began in the Jabalia refugee camp and quickly spread throughout Gaza and the West Bank. Palestinian actions ranged from civil disobedience to violence. In addition to general strikes, boycotts on Israeli products, graffiti and barricades, Palestinian demonstrations that included stone-throwing by youths against the Israel Defense Forces brought the Intifada international attention. The Israeli army's heavy handed response to the demonstrations, with live ammunition, beatings and mass arrests, brought international condemnation. The PLO, which until then had never been recognised as the leaders of the Palestinian people by Israel, was invited to peace negotiations the following year, after it recognized Israel and renounced terrorism.

Yitzhak Rabin, Bill Clinton, andYasser Arafat at the Oslo Accords signing ceremony on September 13, 1993

In mid-1993, Israeli and Palestinian representatives engaged in peace talks in Oslo, Norway. As a result, in September 1993, Israel and the PLO signed the Oslo Accords, known as the *Declaration of Principles* or Oslo I; in side letters, Israel recognized the PLO as the legitimate representative of the Palestinian people while the PLO recognized the right of the state of Israel to exist and renounced terrorism, violence and its desire for the destruction of Israel.

The Oslo II agreement was signed in 1995 and detailed the division of the West Bank into Areas A, B, and C. Area A was land under full Palestinian civilian control. In Area A, Palestinians were also responsible for internal security. The Oslo agreements remain important documents in Israeli - Palestinian relations.

3 – 5 - 2000 – 09

The Second Intifada forced Israel to rethink its relationship and policies towards the Palestinians. Following a series of suicide bombings and attacks, the Israeli army launched Operation Defensive Shield. It was the largest military operation conducted by Israel since the Six-Day War.

As violence between the Israeli army and Palestinian militants intensified, Israel expanded its security apparatus around the West Bank by re - taking many parts of land in Area A. Israel established a complicated system of road blocks and checkpoints around major Palestinian areas to deter violence and protect Israeli settlements. However, since 2008, the IDF has slowly transferred authority to Palestinian security forces.

Israel's then prime minister Ariel Sharon began a policy of disengagement from Gaza from the Gaza Strip in 2003. This policy was fully implemented in August 2005 . Sharon's announcement to disengage from Gaza came as a tremendous shock to his critics both on the left and on the right. A year previously, he had commented that the fate of the most far - flung settlements in Gaza, Netzararem and Kfar Darom, was regarded in the same light as that of Tel Aviv. The formal announcements to evacuate seventeen Gaza settlements and another four in the West Bank in February 2004 represented the first reversal for the settler movement since 1968. It divided his party. It was strongly supported by Trade and Industry Minister Ehud Olmert and Tzipi Livni, the Minister for Immigration and Absorption, but Foreign Minister Silvan Shalom and Finance Minister Benjamin Netanyahu strongly condemned it. It was also uncertain whether this was simply the beginning of further evacuation.

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On March 16, 2003, Rachel Corrie, an American peace activist was crushed to death by an Israeli Defense Forces (IDF) bulldozer in Rafah, Gaza, during a non - violent protest of the Israeli demolition of Palestinian homes.[72] Corrie stood in confrontation with the bulldozers for three hours wearing a bright orange jacket and carrying a megaphone.[72] Although the Israeli government has denied responsibility in the incident and ruled her death as an accident, several eye-witness reports say that the Israeli soldier operating the bulldozer deliberately ran her over.

Aftermath of the Sbarro pizza restaurant suicide bombing. 15 Israeli civilians were killed and more than 130 wounded in the attack

In June 2006, Hamas militants infiltrated an army post near the Israeli side of the Gaza Strip and abducted Israeli soldier Gilad Shalit. Two IDF soldiers were killed in the attack, while Shalit was wounded after his tank was hit with an RPG. Three days later Israel launchedOperation Summer Rains to secure the release of Shalit.[74] He was held hostage byHamas, who barred the International Red Cross from seeing him, until October 18, 2011, when he was exchanged for 1,027 Palestinian prisoners.

In July 2006, Hezbollah fighters crossed the border from Lebanon into Israel, attacked and killed eight Israeli soldiers, and abducted two others as hostages, setting off the 2006 Lebanon War which caused much destruction in Lebanon . A UN-sponsored ceasefire went into effect on August 14, 2006, officially ending the conflict . The conflict killed over a thousand Lebanese and over 150 Israelis , severely damaged Lebanese civil infra structure, and displaced approximately one million Lebanese and 300,000 – 500,000 Israelis, although most were able to return to their homes . After the ceasefire, some parts of Southern Lebanon remained uninhabitable due to Israeli unexploded cluster bomblets.

In the aftermath of the Battle of Gaza, where Hamas seized control of the Gaza Strip in a violent civil war with rival Fatah, Israel placed restrictions on its border with Gaza borders and ended economic cooperation with the Palestinian leadership based there. Israel and Egypt have imposed a blockade of the Gaza Strip since 2007. Israel maintains the blockade is necessary to limit Palestinian rocket attacks from Gaza and to prevent Hamas from smuggling advanced rockets and weapons capable of hitting its cities.

On September 6 , 2007 , in Operation Orchard, Israel bombed an eastern Syrian complex which was allegedly a nuclear reactor being built with assistance from North Korea . Israel had also bombed Syria in 2003.

In April 2008, Syrian President Bashar al - Assad told a Qatari news paper that Syria and Israel had been discussing a peace treaty for a year, with Turkey as a go - between. This was confirmed in May 2008 by a spokesman for Prime Minister Ehud Olmert. As well as a peace treaty, the future of the Golan Heights is being discussed. President Assad said "there would be no direct negotiations with Israel until a new US president takes office." .

Speaking in Jerusalem on August 26, 2008, then United States Secretary of State Condoleezza Rice criticized Israel's increased settlement construction in the West Bank as detrimental to the peace process. Rice's comments came amid reports that Israeli construction in the disputed territory had increased by a factor of 1.8 over 2007 levels.

A fragile six - month truce between Hamas and Israel expired on December 19, 2008;[94]attempts at extending the truce failed amid accusations of breaches from both sides.[95][96][97][98] Following the expiration, Israel launched a raid on a tunnel suspected of being used to kidnap Israeli soldiers which killed several Hamas fighters Following this, Hamas resumed rocket and mortar attacks on Israeli cities, most notably firing over 60 rockets on December 24. On December 27, 2008, Israel launched Operation Cast Leadagainst Hamas. Numerous human rights organizations accused Israel and Hamas of committing war crimes.

In 2009 Israel placed a 10 - month settle ment freeze on the West Bank. Hillary Clinton praised the freeze as an "unprecedented" gesture that could "help revive Middle East talks." .

A raid was carried out by Israeli naval forces on six ships of the *Gaza Freedom Flotilla* in May 2010 . after the ships refused to dock at Port Ashdod. On the MV *Mavi Marmara*, activists clashed with the Israeli boarding party. During the fighting, nine activists were killed by Israeli special forces. Wide spread international condemnation of and reaction to the raid followed, Israel – Turkey relations were strained, and Israel subsequently eased its blockade on the Gaza Strip . Several dozen other passengers and seven Israeli soldiers were injured , with some of the commandos suffering from gunshot wounds .

3 – 6 - 2010 – present

Following the latest round of peace talks between Israel and the Palestinian Authority, 13 Palestinian militant movements led by Hamas initiated a terror campaign designed to derail and disrupt the negotiations . Attacks on Israelis have increased since August 2010, after 4 Israeli civilians were killed by Hamas militants. Palestinian militants have increased the frequency of rocket attacks aimed at Israelis. On August 2, Hamas militants launched seven Katyusha rockets at Eilat and Aqaba, killing one Jordanian civilian and wounding 4 others.

Intermittent fighting continued since then, including 680 rocket attacks on Israel in 2011 . On November 14, 2012, Israel killed Ahmed Jabari, a leader of Hamas's military wing, launching Operation Pillar of Cloud . Hamas and Israel agreed to an Egyptian - mediated ceasefire on November 21.

The Palestinian Centre for Human Rights said that 158 Palestinians were killed during the operation, of which: 102 were civilians, 55 were militants and one was a policeman; 30 were children and 13 were women . B'T selem stated that according to its initial findings, which covered only the period between 14 and 19 November, 102 Palestinians were killed in the Gaza Strip, 40 of them civilians. According to Israeli figures, 120 combatants and 57 civilians were killed . International outcry ensued, with many criticizing Israel for what much of the international community perceived as a disproportionately violent response. Protests took place on hundreds of college campuses across the U.S., and in front of the Israeli consulate in New York. Additional protests took place throughout the Middle East, throughout Europe, and in parts of South America .

However, the governments of the United States, United Kingdom, Canada, Germany, France, Australia, Belgium, Bulgaria, Czech Republic and Netherlands expressed support for Israel's right to defend itself, and/or condemned the Hamas rocket attacks on Israel.

4 - Notable wars and violent events

Time	Name
1948–1949	First Arab – Israeli War
1951–1955	Reprisal operations
1956	Suez War
1967	The Six - Day War
1967–1970	War of Attrition
1971–1982	Palestinian insurgency in South Lebanon
1973	Yom Kippur War
1978	First South Lebanon conflict
1982	First Lebanon War
1985 – 2000	Second South Lebanon conflict
1987 – 1993	First Intifada
2000 – 2004	Second Intifada
2006	Operation Summer Rains
	Second Lebanon War
2008 – 2009	Gaza War
2012	Operation Pillar of Defense
2014	Operation Protective Edge

5 - Cost of conflict

A report by Strategic Foresight Group has estimated the opportunity cost of conflict for the Middle East from 1991 – 2010 at $ 12 trillion. The report's opportunity cost calculates the peace GDP of countries in the Middle East by comparing the current GDP to the potential GDP in times of peace. Israel's share is almost $1 trillion, with Iraq and Saudi Arabia having approximately $2.2 and $4.5 trillion, respectively. In other words, had there been peace and cooperation between Israel and Arab League nations since 1991, the average Israeli citizen would be earning over $ 44,000 instead of $23,000 in 2010.

In terms of the human cost, it is estimated that the conflict has taken 92,000 lives (74,000 military and 18,000 civilian from 1945 to 1995).

Iran – Iraq War

Iranian soldier with gas mask in the battle field

Contents

Date	22 September 1980 – 20 August 1988 (7 years, 10 months, 4 weeks and 1 day)
Location	Iran – Iraq border
Result	Stalemate Iraqi failure to annex territories on the east bank of the Shatt al - Arab and bolster Arab separatism in the region of Khuzestan Iranian failure to topple Saddam Hussein UNSC Resolution 598
Territorial	*Status quo ante bellum*; observed

changes	byUNIIMOG based on Security Council Resolution 619

Belligerents	
Iran KDP PUK Support: Syria DPRK	**Iraq** MEK **Support:**
Commanders and leaders	
Ruhollah Khomeini **Supreme Leader of Iran** Abulhassan Banisadr 1st President of Iran Mohammad-Ali Rajai 2nd President of Iran Akbar Hashemi Rafsanjani Chairman of the Parliament Ali Khamenei 3rd President of Iran Mir-Hossein Mousavi Prime Minister of Iran Mostafa Chamran † Minister of Defence Mohsen Rezaee IRGC Commander Ali Sayad Shirazi Chief of Staff Massoud Barzani Leader of the Kurdistan Democratic Party Jalal Talabani Leader of the Patriotic Union of Kurdistan	**Saddam Hussein** **President of Iraq** Ali Hassan al - Majid General and Iraqi Intelligence Service head Taha Yassin Ramadan General and Deputy Party Secretary Izzat Ibrahim ad-Douri Deputy chairman, Revolutionary Command Council Abid Hamid Mahmud Lieutenant GeneralSalah Aboud Mahmoud General Tariq Aziz Foreign Minister and Revolutionary Command council member Adnan Khairallah Minister of Defence Saddam Kamel Republican Guard Commander

Nawshirwan Mustafa Deputy Secretary General of the Patriotic Union of Kurdistan Mohammed Baqir al - Hakim Leader of the Islamic Supreme Council of Iraq Abdul Aziz al-Hakim	Abdul Rahman Ghassemlou Leader of the Democratic Party of Iranian Kurdistan Uday Hussein Son of Saddam Hussein Qusay Hussein Son of Saddam Hussein Maher Abd al - Rashid General Massoud Rajavi President of the National Council of Resistance of Iran Maryam Rajavi co - leader of PMOI
Strength	
At the onset of the war: 110,000 – 150,000 soldiers, 2,100 tanks, 1,000 armoured vehicles, 1072 artillery pieces, 320 aircraft, 750 helicopters *After Iraq withdrew from Iran in 1982*: 350,000 soldiers, 700 tanks, 2,700 armoured vehicles, 400 artillery pieces, 350 aircraft, 700 helicopters *At the end of the war*: 900,000 soldiers, 2,500,000 militia, 400 tanks, 800 armoured vehicles, 600 artillery pieces, 60–80 aircraft, 70–90 helicopters	*At the onset of the war*: 350,000 soldiers, 2,650 tanks, 4,000 armoured vehicles, 800 artillery pieces, 600 aircraft, 350 helicopters *After Iraq withdrew from Iran in 1982*: 175,000 soldiers, 1,200 tanks, 2,300 armoured vehicles, 400 artillery pieces, 450 aircraft, 180 helicopters *At the end of the war*: 1,500,000 soldiers. 5,500–6,700 tanks, 8,500–10,000 armoured vehicles, 6,000–12,000 artillery pieces, 1,500 aircraft, 1,000 helicopters

Casualties and losses	
123,220–160,000 KIA and 60,711MIA (Iranian claim) 200,000 – 600,000 killed (other estimates) 800,000 killed (Iraqi claim) 320,000–500,000 WIA 40,000–42,875 POW 11,000–16,000 civilian dead Economic loss of US $ 627 billion	105,000 – 375,000 killed 400,000 WIA 70,000 POW Economic loss of $561 billion
100,000+ civilians killed on both sides (not including 182,000 civilians killed in the Al - Anfal Campaign)	

1 - Introduction

The **Iran – Iraq War**, also known as the **First Persian Gulf War** was an armed conflict between theIslamic Republic of Iran and theBa'athist Republic of Iraq lasting from September 1980 to August 1988, making it the 20th century's longest conventional war.[35][36] It was initially referred to in English as the "Gulf War" prior to thePersian Gulf War of the early 1990s.

The Iran–Iraq War began when Iraq invaded Iran via air and land on 22 September 1980. It followed a long history of border disputes, and was motivated by fears that the Iranian Revolution in 1979 would inspire insurgency among Iraq's long - suppressed Shiamajority as well as Iraq's desire to replace Iran as the dominantPersian Gulf state. Although Iraq hoped to take advantage of Iran's revolutionary chaos and attacked without formal warning, they made only limited progress into Iran and were quickly repelled; Iran regained virtually all lost territory by June 1982. For the next six years, Iran was on the offensive . A number of proxy forces participated in the war, most notably the Iranian Mujahedin – e - Khalq siding with Ba'athist Iraq and Iraqi Kurdish militias of Kurdish Democratic Party and Patriotic Union of Kurdistan siding with Iran—all suffering a major blow by the end of the conflict.

Despite calls for a ceasefire by theUnited Nations Security Council, hostilities continued until 20 August 1988. The war finally ended with Resolution 598, a U.N. - brokered ceasefire which was accepted by both sides. At the war's conclusion, it took several weeks for Iranian armed forces to evacuate Iraqi territory to honour pre-war international borders set by the 1975 Algiers Agreement.[39] The last prisoners of war were exchanged in 2003.

The war cost both sides in lives and economic damage: half a million Iraqi and Iranian soldiers, with an equivalent number of civilians, are believed to have died, with many more injured; however, the war brought neither reparations nor changes in borders. The conflict has been compared to World War I in terms of the tactics used, including large-scale trench warfare with barbed wire stretched across trenches, mannedmachine-gun posts, bayonet charges, human wave attacksacross a no-man's land, and extensive use of chemical weapons such as mustard gas by the Iraqi government against Iranian troops, civilians, and IraqiKurds. At the time of the conflict, the U.N. Security Council issued statements that "chemical weapons had been used in the war." U.N. statements never clarified that only Iraq was using chemical weapons, and according to retrospective authors "the international community remained silent as Iraq used weapons of mass destruction against Iranian[s] as well as Iraqi Kurds.".

2 – Terminology

The Iran–Iraq War was originally referred to as the *Gulf War* until the Persian Gulf War of 1990 and 1991, after which it was referred to as the *First Persian Gulf War*. The Iraq–Kuwait conflict, while originally known as the *Second Persian Gulf War*, eventually became known simply as the *Gulf War*. The Iraq War from 2003 to 2011 has since been called the *Second Persian Gulf War*.

In Iran, the war is known as the *Imposed War* (جنگ تحمیلی, *Jang-e Tahmīlī*) and the *Holy Defense* (دفاع مقدس, *Defā' - e Moqaddas*). In Iraq, Saddam Hussein had initially dubbed the conflict the *Whirlwind War*.[45]:219 It was also referred to as *Saddām's Qādisiyyah* (قادسية صدام,*Qādisiyyat Ṣaddām*), in reference to the Battle of al - Qādisiyyah.

3 – Origins

3 – 1 – Iran – Iraq relations

The Arvand Roud waterway on the Iran–Iraq border

Since the Ottoman–Persian Wars of the 16th and 17th centuries, Iran (known as Persia prior to 1935) and the Ottomans fought over Iraq (then known asMesopotamia) and full control of the Arvand Roud / Shatt al - Arab water way until the signing of theTreaty of Zuhab in 1639 which established the final borders between Iran and Iraq . The Arvand Roud was considered an important channel for both states' oil exports, and in 1937, Iran and the newly independent Iraq signed a treaty to settle the dispute. In the same year, Iran and Iraq both joined the Saadabad Pact, and relations between the two states remained good for decades afterwards.

The 1937 treaty recognised the Iran – Iraq border to be along the low-water mark on the Shatt's eastern side , except at Abadan and Khorramshahr, where the frontier ran along the deep water line (*thalweg*). This gave Iraq control of most of waterway and required Iran to pay tolls whenever its ships used it.

In 1955, both nations joined the Baghdad Pact.

However, the overthrow of the Hashemites in Iraq in 1958 brought a nationalist government to power which promptly abandoned the pact. On 18 December 1959, Iraq's new leader, General Abdul Karim Qassim, declared: "We do not wish to refer to the history of Arab tribes residing in al - Ahwazand Mohammareh [Khorramshahr]. The Ottomans handed over Mohammareh, which was part of Iraqi territory, to Iran." The Iraqi government's dissatisfaction with Iran's possession of the oil - rich Khuzestan province (which the Iraqis called *Arabistan*) that had a large Arabic-speaking population was not limited to rhetorical statements. Iraq began supporting secessionist movements in Khuzestan , and raised the issue of its territorial claims at an Arab League meeting, though unsuccessfully.

Iraq showed reluctance in fulfilling existing agreements with Iran — especially after Egyptian President Gamal Abdel Nasser's death in 1970 and the Iraqi Ba'ath Party's rise which took power in a 1968 coup, leading Iraq to take on the self-appointed role of "leader of the Arab world". At the same time, by the late 1960s, the build-up of Iranian power under ShahMohammad Reza Pahlavi, who had gone on a military spending spree, led Iran to take a more assertive stance in the region.

In April 1969, Iran abrogated the 1937 treaty over the Arvand Roud, and as such, ceased paying tolls to Iraq when its ships used the waterway.[47] The Shah justified his move by arguing that almost all river borders around the world ran along the *thalweg*, and by claiming that because most of the ships that used the waterway were Iranian, the 1937 treaty was unfair to Iran . Iraq threatened war over the Iranian move, but when, on 24 April 1969, an Iranian tanker escorted by Iranian warships sailed down the river, Iraq — being the militarily weaker state — did nothing .

Iran's abrogation of the treaty marked the beginning of a period of acute Iraqi - Iranian tension that was to last until the Algiers Accords of 1975. In 1969, Saddam Hussein, Iraq's deputy prime minister, stated: "Iraq's dispute with Iran is in connection with Khuzestan, which is part of Iraq's soil and was annexed to Iran during foreign rule."[49] Soon, Iraqi radio stations began exclusively broadcasting into "Arabistan", encouraging Arabs living in Iran and evenBalūchīs to revolt against the Shah's government . Basra TV stations began showing Iran's Khuzestan province as part of Iraq's new province *Nasiriyyah*, renaming all its cities with Arabic names.

In 1971, Iraq (now under Saddam's effective rule) broke diplomatic relations with Iran after claiming sovereignty rights over the islands of Abu Musa, Greater Tunb, and Lesser Tunb in the Persian Gulf following the withdrawal of the British.[50] As retaliation for Iraq's claims to Khuzestan, Iran became the main patron of Iraq's Kurdish rebels in the early 1970s, giving the Iraqi Kurds bases in Iran and arming the Kurdish groups . In addition to Iraq fomenting separatism in Iran's Khuzestan and Balochistan provinces, both states encouraged separatist activities by Kurdish nationalists in the other state. From March 1974 to March 1975, Iran and Iraq fought border wars over Iran's support of Iraqi Kurds.[47][51] In 1975, the Iraqis launched an offensive into Iran using tanks, though the Iranians defeated them. Several other attacks took place; however, Iran had the world's fifth most powerful military at the time and easily defeated the Iraqis with their air force. As a result, Iraq decided against continuing the war, choosing instead to make concessions to Tehran to end the Kurdish rebellion.

Iranian AH-1J Sea Cobra attack helicopters, circa 1970s

In the 1975 Algiers Agreement, Iraq made territorial concessions — including the Shatt al - Arab water way — in exchange for normalised relations . In return for Iraq recognising that the frontier on the waterway ran along the entire *thalweg*, Iran ended its support of Iraq's Kurdish guerrillas . Iraqis viewed the Algiers Agreement as humiliating . However, the agreement meant the end of Iranian and American support for the Peshmerga, who were defeated by Iraq's government in a short campaign that claimed 20,000 lives. The British journalist Patrick Brogan wrote that "...the Iraqis celebrated their victory in the usual manner, by executing as many of the rebels as they could lay their hands on."

The relationship between the governments of Iran and Iraq briefly improved in 1978, when Iranian agents in Iraq discovered plans for a pro-Soviet coup d'état against Iraq's government. When informed of this plot, Saddam ordered the execution of dozens of his army's officers and in a sign of reconciliation, expelled Ruhollah Khomeini, an exiled leader of clerical opposition to the Shah, from Iraq. Despite that, Saddam merely considered the Algiers Agreement to be a truce, rather than a definite settlement and waited for the opportunity to contest it.

3 – 2 - After the Iranian Revolution

Anti - Shah protests in Iran , 1978

Tensions between Iraq and Iran were fueled by Iran's Islamic revolution and its appearance of being a Pan - Islamic force, in contrast to Iraq's Arab nationalism. Despite Iraq's goals of regaining the Shatt al - Arab , the Iraqi government seemed to initially welcome Iran's Revolution, which overthrew Iran's Shah, who was seen as a common enemy. It is difficult to pinpoint when tensions began to build, but there were frequent cross - border skirmishes, largely at Iran's instigation.

After this incident, the Ayatollah Ruhollah Khomeini called on Iraqis to over throw the Ba'ath government, and it was received with considerable anger in Baghdad . On 17 July 1979, despite Khomeini's call, Saddam gave a speech praising the Iranian Revolution and called for an Iraqi-Iranian friendship based on non-interference in each other's internal affairs. When Khomeini rejected Saddam's overture by calling for Islamic revolution in Iraq, Saddam was alarmed . Iran's new Islamic administration was regarded in Baghdad as an irrational, existential threat to the Ba'ath government, especially because the Ba'ath party, having a secular nature, discriminated and posed a threat to the Shia movement in Iraq, whose clerics were Iran's allies within Iraq and whom Khomeini saw as oppressed .

However, Iraq's regime was very politically secure, and in little danger of being overthrown by alleged plots of revolution - wracked Iran . According to some sources, Khomeini's hostility towards Saddam was actually milder than his Arab neigh bors hostility towards

Saddam.[54] Saddam's primary interest in war stemmed from his desire to right the supposed "wrong" of the Algiers Agreement, in addition to finally achieving his desire of annexing Khuzestan and becoming the regional superpower . Saddam's goal was to replace Egyptas the "leader of the Arab world" and to achieve hegemony over the Persian Gulf. He saw Iran's increased weakness due to revolution, sanctions, and international isolation . Saddam had heavily invested in Iraq's military since his defeat against Iran in 1975, buying large amounts of weaponry from the Soviet Union and France. By 1980, Iraq possessed 200,000 soldiers, 2,000 tanks and 450 aircraft . Watching the powerful Iranian army that frustrated him in 1974 – 1975 disintegrate, he saw an opportunity to attack, using the threat of Islamic Revolution as a pretext.

A successful invasion of Iran would enlarge Iraq's petroleum reserves and make Iraq the region's dominant power. With Iran engulfed in chaos, an opportunity for Iraq to annex the oil-rich Khuzestan Province materialized . In addition, Khuzestan's large ethnic Arab population would allow Saddam to pose as a liberator for Arabs from Persian rule . Fellow Gulf states such as Saudi Arabia and Kuwait (despite being hostile to Iraq) encouraged Iraq to attack, as they feared that an Islamic revolution would take place within their own borders. Certain Iranian exiles also helped convince Saddam that if he invaded, the fledgling Islamic republic would quickly collapse.

In 1979 – 80, Iraq was the beneficiary of an oil boom that saw it take in US $ 33 billion, which allowed Iraq's government to go on a spending spree on both civilian and military projects . On several occasions, Saddam alluded to the Islamic conquest of Iran in promoting his position against Iran. For example, on 2 April 1980, half a year before the war's outbreak, in a visit to Baghdad's al-Mustansiriya University, he drew parallels to Persia's defeat at the 7th century Battle of al - Qādisiyyah:

In your name, brothers, and on behalf of the Iraqis and Arabs every where we tell those Persian cowards and dwarfs who try to avenge al - Qadisiyah that the spirit of al - Qadisiyah as well as the blood and honor of the people of al - Qadisiyah who carried the message on their spearheads are greater than their attempts .

In 1979–1980, anti-Ba'ath riots arose in the Iraq's Shia areas by groups who were working toward an Islamic revolution in their country.[47] Saddam and his deputies believed that the riots had been inspired by the Iranian Revolution and instigated by Iran's government On 10 March 1980, when Iraq declared Iran's ambassador persona non - grata, and demanded his withdrawal from Iraq by 15 March , Iran replied by downgrading its diplomatic ties to the charge d'affaires level, and demanded that Iraq withdraw their ambassador from Iran. In April 1980, Grand Ayatollah Mohammad Baqir al-Sadr and his sister Amina Haydar (better known as Bint al-Huda) were hanged as part of a crackdown to restore Saddam's control. The execution of Iraq's most senior Ayatollah caused outrage through out the Islamic world, especially among Shias

Iraq soon after expropriated the properties of 70,000 civilians believed to be of Iranian origin and expelled them from its territory.[54] Many, if not most, of those expelled were in fact Arabic-speaking Iraqi Shias who had little to no family ties with Iran. This caused tensions between the two nations to increase further.

Map of Baathist Iraq's hegemonic, ideological and territorial ambitions. Saddam Hussein wanted Iraq to be the leader of the Arab World and the Persian Gulf

In April 1980, Shia militants assassinated 20 Ba'ath officials, and Deputy Prime Minister Tariq Aziz was almost assassinated on 1 April;[47] Aziz survived, but 11 students were killed in the attack.[39] Three days later, the funeral procession being held to bury the students was bombed . Iraqi Information Minister Latif Nusseif al-Jasim also barely survived assassination by Shia militants . The Shias' repeated calls for the overthrow of the Ba'ath party and the support they allegedly received from Iran's new government led Saddam to increasingly perceive Iran as a threat that, if ignored, might one day overthrow him ; he thus used the attacks as pretext for attacking Iran later that September , though skirmishes along the Iran – Iraq border had already become a daily event by May that year.

Iraq also helped to instigate riots among Iranian Arabs in Khuzestan province , supporting them in their labor disputes,[53] and turning uprisings into armed battles between Iran's Revolutionary Guards and militants, killing over 100 on both sides . At times, Iraq also supported armed rebellion by the Kurdish Democratic Party of Iran in Kurdistan . The most notable of such events was the Iranian Embassy siege in London , in which six armed Khuzestani Arab insurgents took the Iranian Embassy's staff as hostages, resulting in an armed siege that was finally ended by Britain's Special Air Service.

According to former Iraqi general Ra'ad al-Hamdani, the Iraqis believed that in addition to the Arab revolts, the Revolutionary Guards would be drawn out of Tehran, leading to a counter-revolution in Iran that would cause Khomeini's government to collapse and thus ensure Iraqi victory . However, rather than turning against the revolutionary government as experts had predicted, Iran's people (including Iranian Arabs) rallied in support of their country and put up a stiff resistance.

5 – 3 - Iraqi preparations

Iraq began planning offensives, confident that they would succeed. Iran lacked both cohesive leadership and spare parts for their American-made equipment. Iraq, on the other hand, possessed a fully equipped and trained modern military, consisting of 190,000 men, 2,200 tanks, and 450 aircraft. The Iraqis could mobilise up to 12 mechanised divisions, and morale was running high. Through the 1970s, Saddam had armed his forces with the most advanced material available from the Soviet Union.

In addition, the area around the Shatt al - Arab posed no obstacle for the Iraqis, as they were armed with Soviet equipment to cross rivers. Iraq correctly deduced that Iran's defences at the crossing points around the Kharkeh and Karoun Rivers were undermanned and that the rivers could be easily crossed. Iraqi intelligence was also informed that the Iranian forces in Khuzestan (which consisted of two divisions prior to the revolution) now only consisted of several ill-equipped battalions. Only a handful of company - sized tank units remained operational.

The only qualms the Iraqis had were over the Islamic Republic of Iran Air Force (formerly theImperial Iranian Air Force). Despite the purge of several key pilots and commanders as well as the lack of spare parts, the air force showed its power during local uprisings and rebellions. They were also active after the failed U.S. attempt to rescue its hostages,Operation Eagle Claw. As such, Iraq's leaders decided to carry out a surprise airstrikeagainst the Iranian air force's infrastructure prior to the main invasion .

5 – 4 - Iranian preparations

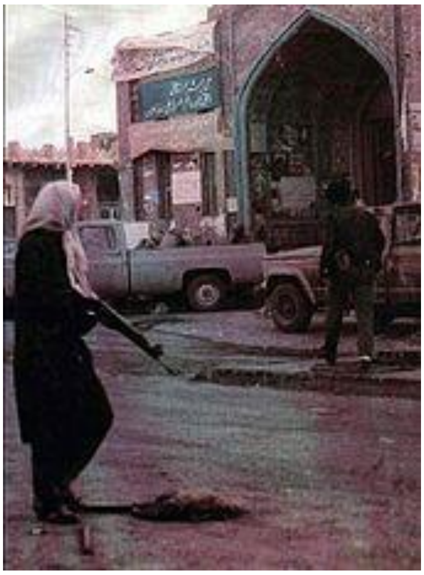
In Iran, severe officer purges (including numerous executions ordered by Sadegh Khalkhali, the new Revolutionary Court judge), and shortages of spare parts for Iran's U.S. - made equipment had crippled Iran's once - mighty military. Between February and September 1979, Iran's government executed 85 senior generals and forced all major-generals and most brigadier - generals into early retirement . By September 1980, the government had purged 12,000 army officers . These purges resulted in a drastic decline in the Iranian military's operational capacities . Their regular army (which, in 1978, was considered the world's fifth most powerful) had been badly weakened by purges and lack of spare parts. The desertion rate had reached 60 %, and the officer corps was devastated. The most highly skilled soldiers and aviators were exiled, imprisoned, or executed. Throughout the war, Iran never managed to fully recover from this flight of human capital . Continuous sanctions prevented Iran from acquiring many heavy weapons, such as tanks and aircraft. When the invasion occurred, many pilots and officers were released from prison, or had their executions commuted to combat the Iraqis. In addition, many junior officers were promoted to generals, resulting in the army being more integrated as a part of the regime by the war's end, as it is today. Iran still had at least 1,000 operational tanks and several hundred functional aircraft, and could cannibalize equipment to procure spare parts.

Meanwhile, a new paramilitary organisation gained prominence in Iran , the Islamic Revolutionary Guard Corps (often shortened to *Revolutionary Guards*, and known in Iran as the *Sepah - e - Pasdaran*) , which intended to protect the new regime and counterbalance the decaying army. Despite having been trained as a paramilitary organisation, after the Iraqi invasion, they were forced to act as a regular army. Initially, they refused to fight alongside the army, which resulted in many defeats, but, by 1982, the two groups began carrying out combined operations. Another paramilitary militia was founded in response to the invasion, the "Army of 20 Million", commonly known as the Basij . The Basij were poorly armed and had members as young as 12 and as old as 70. They often acted in conjunction with the Revolutionary Guard, launching so - called human wave attacks and other campaigns against the Iraqis. They were subordinate to the Revolutionary Guards, and they made up most of the manpower that was used in the Revolutionary Guard's attacks.

3 – 5 - Border conflicts leading to war

By September, skirmishes between Iran and Iraq were increasing in number. Iraq began to grow bolder, both shelling and launching border incursions in disputed territories. Iran responded by shelling several Iraqi border towns and posts, though this did little to alter the situation on the ground. By 10 September, Saddam declared that the Iraqi Army had "liberated" all disputed territories within Iran.[39] With the conclusion of the "liberating operations", on 17 September, in a statement addressed to Iraq's parliament, Saddam stated :

The frequent and blatant Iranian violations of Iraqi sovereignty...have rendered the 1975 Algiers Agreement null and void... This river [Shatt al-Arab]...must have its Iraqi-Arab identity restored as it was throughout history in name and in reality with all the disposal rights emanating from full sovereignty over the river...We in no way wish to launch war against Iran.



An armed Iranian militia woman in front of a mosque during the Iraqi invasion of Khorramshahr, September – October 1980

Despite Saddam's claim that Iraq did not want war with Iran, the next day his forces proceeded to attack Iranian border posts in preparation for the planned invasion . Iraq's 7th Mechanised and 4th Infantry Divisions attacked the Iranian border posts leading to the cities of Fakkeh and Bostan, opening the route for future armoured thrusts into Iran. Weakened by internal chaos, Iran was unable to repel the attacks; which in turn led to Iraq becoming more confident in its military edge over Iran and prompting them to believe in a quick victory.

4 - Geographic analysis

The mountainous border between Iran and Iraq made a deep ground invasion almost impossible , and air strikes were used instead. The invasion's first waves were a series of air strikes targeted at Iranian airfields. Iraq also attempted to bomb Tehran , Iran's capital and command centre, into submission .

5 - Course of the war

5 – 1 - 1980 : Iraqi invasion

Location of Khūzestān Province in Iran

Destroyed Iranian C- 47 Skytrain

Iraq launched a full - scale invasion of Iran on 22 September 1980. TheIraqi Air Forcelaunched surprise air strikes on ten Iranian airfields with the objective of destroying the Iranian Air Force . The attack damaged some of Iran's airbase infrastructure, but failed to destroy a significant number of aircraft: the Iraqi Air Force was only able to strike in depth with a few MiG – 23 BN, Tu - 22, and Su-20 aircraft. Three MiG - 23s managed to attack Tehran, striking its airport but destroyed only a few aircraft.

The next day, Iraq launched a ground invasion of Iran along a front measuring 644 km in three simultaneous attacks . The invasion's purpose, according to Saddam, was to blunt the edge of Khomeini's movement and to thwart his attempts to export his Islamic revolution to Iraq and the Persian Gulf states . Saddam hoped that by annexing Khuzestan, he would send such a blow to Iran's prestige that it would lead to the new government's downfall, or, at very least, end Iran's calls for his over throw.

Of Iraq's six divisions that were invading by ground, four were sent to Khuzestan, which was located near the border's southern end, to cut off the Arvand Roud from the rest of Iran and to establish a territorial security zone . The other two divisions invaded across the northern and central part of the border to prevent an Iranian counter-attack.[47] Two of the four Iraqi divisions, one mechanised and one armoured, operated near the southern end and began a siege of the strategically important port cities of Abadan and Khorramshahr.

The other two divisions, both armoured, secured the territory bounded by the cities of Khorramshahr , Ahvaz, Susangerd, and Musian . On the central front, the Iraqis occupied Mehran, advanced towards the foothills of the Zagros Mountains, and were able to block the traditional Tehran – Baghdad invasion route by securing territory forward of Qasr - e Shirin, Iran. On the northern front, the Iraqis attempted to establish a strong defensive position opposite Suleimaniya to protect the Iraqi Kirkuk oil complex . Iraqi hopes of an uprising by the ethnic Arabs of Khuzestan failed to materialise, as most of the ethnic Arabs remained loyal to Iran.[47] The Iraqi troops advancing into Iran in 1980 were described by Patrick Brogan as "badly led and lacking in offensive spirit". The first known chemical weapons attack by Iraq on Iran probably took place during the fighting around Susangerd.

Though the Iraqi air invasion surprised the Iranians, the Iranian air force retaliated with an attack against Iraqi military bases and infrastructure in Operation *Kaman* 99 (Bow 99) . Groups of F - 4 Phantom and F - 5 Tiger fighter jets attacked targets throughout Iraq, such as oil facilities , dams, petrochemical plants, and oil refineries, and included Mosul Airbase, Baghdad, and the Kirkuk oil refinery. Iraq was taken by surprise at the strength of the retaliation, as Iran took few losses while the Iraqis took heavy defeats and economic disruptions.

The Iranian force of AH - 1 Cobra helicopter gunships began attacks on the advancing Iraqi divisions, along with F-4 Phantoms armed with Maverick missiles ; they destroyed numerous armoured vehicles and impeded the Iraqi advance, though not completely halting it . Iran had discovered that a group of two or three low - flying F- 4 Phantoms could hit targets almost anywhere in Iraq . Meanwhile, Iraqi air attacks on Iran were repulsed by Iran's F-14 Tomcat interceptor fighter jets, using Phoenix missiles, which downed a dozen of Iraq's Soviet - built fighters in the first two days of battle.

The Iranian regular military, police forces, volunteer Basij, and Revolutionary Guards all conducted their operations separately; thus, the Iraqi invading forces did not face coordinated resistance However, on 24 September, the Iranian Navy attacked Basra, Iraq, destroying two oil terminals near the Iraqi port Faw, which reduced Iraq's ability to export oil . The Iranian ground forces (primarily consisting of the Revolutionary Guard) retreated to the cities, where they set up defences against the invaders.

On 30 September, Iran's air force launched Operation Scorch Sword, striking and badly damaging the Osirak nuclear reactor near Baghdad.

Iranian soldier in Khorramshahr

By 1 October, Baghdad had been subjected to eight air attacks . In response, Iraq launched aerial strikes against Iranian targets .

3 – 1 - 1 - First Battle of Khorramshahr

On 22 September, a prolonged battle began in the city of Khorramshahr , eventually leaving 7, 000 dead on each side . Reflecting the bloody nature of the struggle, Iranians came to call Khorramshahr "City of Blood" (شهر خونین , *Khunin shahr*) .

The battle began with Iraqi air raids against key points and mechanised divisions advancing on the city in a crescent-like formation. They were slowed by Iranian air attacks and Revolutionary Guard troops with recoilless rifles, rocket - propelled grenades, and Molotov cocktails . The Iranians flooded the marsh areas around the city, forcing the Iraqis to traverse through narrow strips of land Iraqi tanks launched attacks with no infantry support, and many tanks were lost to Iranian anti - tank teams.[80] However, by 30 September, the Iraqis had managed to clear the Iranians from the outskirts of the city. The next day, the Iraqis launched infantry and armoured attacks into the city. After heavy house-to-house fighting, the Iraqis were repelled. On 14 October, the Iraqis launched a second offensive. The Iranians launched a controlled withdrawal from the city, street by street.[80] By 24 October, most of the city was captured, and the Iranians evacuated across the Karun River. Some partisans remained, and fighting continued until 10 November.

Iranian journalists exit by jumping from an Islamic Republic of Iran ArmyAviation Bell 214 helicopter in the Western front (Kermanshah and neighbouring provinces) of the Iran - Iraq War.

3 – 1 - 2 - Iraqi advance stalls

The people of Iran, rather than turning against their still-weak Islamic Republic, rallied around their country to resist invasion. An estimated 200,000 fresh troops had arrived at the front by November, many of them ideologically committed volunteers

Though Khorramshahr was finally captured, the battle had delayed the Iraqis enough to allow the large - scale deployment of the

Iranian military. In November, Saddam ordered his forces to advance towards Dezful and Ahvaz, and lay sieges to both cities. However, the Iraqi offensive had been badly damaged by Iranian militias and air power. Iran's air force had destroyed Iraq's army supply depots and fuel supplies, and was strangling the country through an aerial siege On the other hand, Iran's supplies had not been exhausted, despite sanctions, and they often cannibalised spare parts from other equipment and began searching for more parts on the black market. On 28 November, Iran launched Operation *Morvarid* (Pearl), a combined air and sea attack which destroyed 80 % of Iraq's navy and all of their radar sites in the southern portion of the country. When Iraq laid siege to Abadan and dug their troops in around the city, they were unable to blockade the port, which allowed Iran to resupply Abadan by sea.

Iraq's strategic reserves had been depleted, and by now they lacked the power to go on any major offensives until nearly the end of the war . On 7 December, Hussein announced that Iraq was going on the defensive . By the end of 1980 the Iraqis had destroyed about 500 of Western - built Iranian tanks and captured 100 others.

For the next eight months, both sides were to be on a defensive footing (with the exception of the Battle of Dezful), as the Iranians needed more time to reorganise their forces and the damage inflicted by the purge of 1979 – 80 . During this period, fighting consisted mainly of artillery duels and raids . Iraq had mobilised 21 divisions for the invasion, while Iran countered with only 13 regular army divisions and one brigade. Of the regular divisions, only seven were deployed to the border. The war bogged down into World War I-style trench warfare with tanks and modern late-20th century weapons. Due to the power of anti - tank weapons such as the RPG-7, armored maneuver by the Iraqis was very costly, and they consequently entrenched their tanks into static positions.

Iraq also began firing Scud missiles into the cities of Dezful and Ahvaz and used terror bombing to bring the war to the Iranian civilian population . Iran launched dozens of human wave assaults.

5 – 2 - 1981: Stalemate

5 – 2 – 1 - Battle of Dezful

On 5 January 1981, Iran had reorganised its forces enough to launch a large-scale offensive, Operation *Nasr* (Victory). The Iranians launched their major armoured offensive from Dezful in the direction of Susangerd, consisting of the 16th *Qazvin* and the 77th *Khorasan* armoured divisions , and broke through Iraqi lines . However, the Iranian tanks had raced through Iraqi lines with their flanks unprotected and with no infantry support ; as a result, they were cut off by Iraqi tanks . In the ensuing Battle of Dezful, the Iranian division was nearly wiped out in one of the biggest tank battles of the war . When the Iranian tanks tried to manoeuvre, they became stuck in the mud of the marshes, and many tanks were abandoned The Iraqis lost 45 T- 62 tanks, while the Iranians lost 100 - 200 Chieftain and M - 60 tanks. Reporters counted roughly 150 destroyed or deserted Iranian tanks, and also 40 Iraqi tanks.[47] 141 Iranians were killed during this battle.

The battle had been ordered by Iranian president Abulhassan Banisadr, who was hoping that a victory might shore up his deteriorating political position; instead, the failure hastened his fall Many of Iran's problems took place because of political infighting between President Banisadr, who supported the regular army, and the hardliners who supported the IRGC. Once he was impeached and the competition ended, the performance of the Iranian military improved. Iran was further distracted by internal fighting between the regime and theIslamic Marxist *Mujaheddin e - Khalq* (MEK) on the streets of Iran's major cities in June 1981 and again in September . After the end of these battles, the MEK gradually leaned towards Saddam Hussein, completely taking his side by the mid - 1980s . Approximate clarification : People's Mujahedin of Iran started to take the side of Saddam in 1984 or 1986 (Mid of 80s decade). Clearly, in 1986 Rajavi moved from Paris to Iraq and set up a base on the Iranian border.[87] The Battle of Dezful became a critical battle in Iranian military thinking. Less emphasis was placed on the Army with its conventional tactics, and more emphasis was placed on the Revolutionary Guard with its unconventional tactics.

Attack formation of six Iranian F - 4 Phantoms during the airstrike on Iraqi Kirkuk Refinery

5 – 2 – 2 - Attack on H3

The Iraqi Air Force, badly damaged by the Iranians, was moved to the H-3 Airbase in Western Iraq, near the Jordanian border and away from Iran. However, on 3 April 1981, the Iranian air force used eight F-4 Phantom fighter bombers, four F-14 Tomcats, threeBoeing 707 refuelling tankers, and one Boeing 747command plane to launch a surprise attack on H3, destroying 27–50 Iraqi fighter jets.

Despite the successful H-3 airbase attack (in addition to other air attacks), in April, the Iranian Air Force was forced to cancel its successful 180 - day air offensive against Iraq. In addition, they gave up trying to hold total control of Iranian airspace. Due to the heavy toll of sanctions and pre-war purges, the Iranian air force could not suffer further heavy attrition, and made the decision in order to limit their losses. They were also damaged by a fresh purge, after the impeachment crisis of President Banisadr . The Iranian air force would fight heavily on the defensive, trying to hold back the Iraqis rather than engaging them. While throughout 1981–1982 the Iraqi air force would remain weak, within the next few years they would rearm and expand again, and begin to regain the strategic initiative.

5 – 2 – 3 - Iran introduces the human wave attack

Iranian woman ties headband around combatant's head before he leaves for the front

Since the Iranians suffered from a shortage of heavy weapons but had a large number of devoted volunteer troops, they began using human wave attacks against the Iraqis. Typically, an Iranian assault would consist of the following: First, the poorly trained Basij would launch the primary human wave assaults to swamp the weakest portions of the Iraqi lines en masse (on some occasions even bodily clearing minefields) . They would be followed up by the more experienced Revolutionary Guard infantry, who would breach the weakened Iraqi lines . Afterwards, the regular army using mechanized forces would maneuver through the breach and encircle and defeat the enemy.

According to historian Stephen C. Pelletiére, the idea of Iranian "human wave attacks" were a misconception. Instead, the Iranian tactics consisted of using groups of 22 man infantrysquads which moved forward to attack specific objectives. As the squads surged forward to execute their missions, that gave the impression of a "human wave attack". Nevertheless, the idea of "human wave attacks" remained virtually synonymous with any large - scale infantry frontal assault Iran carried out.[93] Large amounts of troops would be used, aimed at overwhelming the Iraqi lines (usually the weakest portion manned by the Iraqi Popular Army) regardless of losses.

According to the former Iraqi general Ra'ad al - Hamdani, the Iranian human waves charges consisted of armed "civilians" who carried most of their necessary equipment themselves into battle and often lacked command and control and logistics . However, Iranian tactics also were sophisticated as well. Operations were often carried out during the night, and deception operations, infiltrations, and maneuvers became more common.

The Iranians attempted to add the element of surprise to most of their attacks, differing them from those in World War I . During 1982, Iran used the same marshes that proved fatal to their tank forces during the Battle of Dezful to infiltrate to the rear of the Iraqi lines The Iranians would reinforce the infiltrating forces with new units to keep up their momentum. Once a weak point was found, the Iranians would concentrate all of their forces into that area in an attempt to break through with human waves attacks.

The human wave attacks, while extremely bloody (tens of thousands of troops died in the process) , when used in combination with infiltration and surprise caused major Iraqi defeats. As the Iraqis would dig in their tanks and infantry into static, entrenched positions, the Iranians would manage to break through the lines and encircle entire divisions . Merely the fact that the Iranian forces used maneuver warfare using their light infantry against static Iraqi defenses was often the decisive factor in the battle. However, lack of coordination between the Army and IRGC and shortages of heavy weaponry did play a detrimental role, with most of the infantry not supported by artillery and armor.

5 – 2 – 4 - Operation Eighth Imam

For about a year after the Iraqi offensive stalled in March 1981, there was little change in the front other than Iran retaking the high ground above Susangerd in May. However, by late 1981, Iran returned to the offensive and the Iraqi military was forced to retreat. Iran launched a new operation, Operation *Samen – ol - A'emeh* (The Eighth Imam) , ending the Iraqi Siege of Abadan on 27 – 29 September 1981. The Iranians used a combined force of regular army artillery with small groups of armor, supported by Pasdaran and Basij infantry.[90] Iranians lost 150 M - 48A tanks on September 29. On October 15, after the end of the siege, a large Iranian convoy was ambushed by Iraqi tanks. During tank battle betweenT-55s tanks and Chieftains, Iranians lost 20 Chieftains and other armored vehicles and withdrew.

5 – 2 – 5 - Operation Tariq al - Qods

By the fall of 1981, serious problems with morale had developed in the Iraqi Army, with many soldiers seeing no point to the invasion.

On 29 November 1981, Iran began Operation *Tariq al-Qods* with three army brigades and seven Revolutionary Guard brigades. The Iraqis failed to properly patrol their occupied areas, and the Iranians constructed a 14 km ,road through the unguarded sand dunes, infiltrating in and launching their attack from the Iraqi rear . The battle saw the town of Bostan being retaken from Iraqi divisions by 7 December. Operation Tariq al - Qods also saw the first use of the Iranian "human wave" tactics, where the Revolutionary Guardlight infantry charged at Iraqi positions repeatedly, oftentimes without the support of armour or air power. The fall of Bostan exacerbated the Iraqis' logistical problems, forcing them to use a roundabout route from Ahvaz far to the south to resupply its troops. 6,000 Iranians and over 2,000 Iraqis were killed in the operation.

5 – 3 - 1982 : Iraqi retreat , Iranian offensive

Iraqi prisoners of war at Khorramshahr

The Iraqis, realising that the Iranians were planning to attack, decided to preempt them with Operation*al - Fawz al - 'Azim* (Supreme Success) on 19 March. Using a large number of tanks, helicopters, and fighter jets, they attacked the Iranian buildup around the

Roghabiyeh pass. Though Saddam and his generals assumed they had succeeded, in reality the Iranian forces remained fully intact. The Iranians had concentrated much of their forces by bringing them directly from the cities and towns throughout Iran via trains, buses, and private cars. The concentration of forces did not resemble a traditional military buildup, and although the Iraqis detected a population buildup near the front, they failed to realise that this was an attacking force. As a result, Saddam's army was unprepared for the Iranian offensives to come.

5 – 3 – 1 - Operation Undeniable Victory

Iran's next major offensive, led by General Ali Sayad Shirazi, was Operation *Fath - ol – Mobeen* (Undeniable Victory) . On 22 March 1982, Iran launched an attack which took the Iraqi forces by surprise: using Chinook helicopters, they landed behind Iraqi lines, silenced their artillery, and captured an Iraqi head quarter . The Iranian Basij then launched human wave attacks, consisting of 1,000 fighters per wave. Though they took heavy losses, they eventually broke through Iraqi lines.

Iraqi T - 62 tank wreckage in Khuzestan province , Iran

The Revolutionary Guard and regular army followed up by surrounding the Iraqi 9th and 10th Armoured and 1st Mechanised divisions that had camped close to the Iranian town of Shush. The Iraqis launched a counter - attack using their 12th Armoured division to break the encirclement and rescue the surrounded divisions. Iraqi tanks came under attack by 95 Iranian F - 4 Phantom and F-5 Tiger fighter jets, effectively destroying the entire division.

Operation Undeniable Victory ended decisively in Iran's favour, and Iraqi forces were driven away from, Shush, Dezful and Ahvaz. The Iranian armed forces destroyed 320 - 400 Iraqi tanks and armored vehicles in combat, but the price they paid for it was high. In just the first day of the battle the Iranians lost 196 tanks. By this time, most of the Khuzestan province had returned to Iran's hands.

5 – 3 – 2 - Operation Beit ol - Moqaddas

In preparation for Operation *Beit ol - Moqaddas*, the Iranians had launched numerous air raids against Iraq air bases, destroying 47 jets (including Iraq's brand new Mirage F-1 fighter jets from France); this gave the Iranians air superiority over the battlefield while allowing them to monitor Iraqi troop movements.

On 29 April, Iran launched the offensive. 70,000 Revolutionary Guard and Basij members struck on several axes – Bostan, Susangerd, the west bank of the Karun River, and Ahvaz. The Basij launched human wave attacks, which were followed up by the regular army and Revolutionary Guard support along with tanks and helicopters. Under heavy Iranian pressure, the Iraqi forces retreated. By 12 May, Iran had driven out all Iraqi forces from the Susangerd area. The Iranians captured several thousand Iraqi troops and a large number of tanks. Nevertheless, the Iranians took many losses as well, especially among the Basij

.

The Iraqis retreated to the Karun River, with only Khorramshahr and a few outlying areas remaining in their possession . Saddam ordered 70,000 troops to be placed around the city of Khorramshahr. The Iraqis created a hastily constructed defence line around the city and outlying areas . To discourage airborne commando landings, the Iraqis also placed metal spikes and destroyed cars in areas likely to be used as troop landing zones. Saddam Hussein even visited Khorramshahr in a dramatic gesture, swearing that the city would never be relinquished. However, Khorramshahr's only resupply point was across the Arvand Roud , and the Iranian air force began bombing the supply bridges to the city, while their artillery zeroed in on the besieged garrison.

5 – 3 – 2 - 1 - Liberation of Khorramshahr (Second Battle of Khorramshahr)

An admonitory declaration issued from the Iraqi government in order to warn Iranian troops in the Iran - Iraq war. The statement says: «Hey Iranians! No one has been downtrodden in the country where Ali ibn Abi Ṭālib, Husayn ibn Ali and Abbas ibn Ali are buried. Iraq has undoubtedly been honorable country. All refugee should be precious. Every body who wants to live in exile can choose Iraq freely. We Iraq's sons have been ambushing to foreign aggressors. The enemies who plan to assault to Iraq are going to be disfavored with God in this world and eternity universe. Be careful to think to attack to Iraq and Ali ibn Abi Ṭālib! If you surrender you will be in peace.»

In the early morning hours of 23 May 1982 the Iranians began the drive towards Khorramshahr across the Karun River . This part of Operation Beit ol - Moqaddas was spearheaded by the 77th Khorasan division with tanks along with the Revolutionary Guard and Basij. The Iranians hit the Iraqis with destructive air strikes and massive artillery barrages, crossed the Karun River, captured bridgeheads, and launched human waves attacks towards the city. Saddam's defensive barricade collapsed ; in less than 48 hours of fighting, the city fell and 19,000 Iraqis surrendered to the Iranians. A total of 10,000 Iraqis were killed or wounded in Khorramshahr, while the Iranians suffered

30,000 casualties. During the whole of Operation Beit ol - Moqaddas, 33,000 Iraqi soldiers were taken prisoner by the Iranians.

5 – 3 - 3 - State of Iraqi armed forces

Iraqi Mirage F1 - EQ pilots prior to a mission

The fighting had battered the Iraqi military: its strength fell from 210,000 to 150,000 troops; over 20,000 Iraqi soldiers were killed and over 30,000 captured; two out of four active armoured divisions and at least three mechanised divisions fell to less than a brigade's strength; and the Iranians had captured over 450 tanks and armoured personnel carriers.

The Iraqi Air Force was also left in poor shape: after losing up to 55 aircraft since early December 1981, they had only 100 intact fighter - bombers andinterceptors. A defector who flew his MiG-21 to Syriain June 1982 revealed that the Iraqi Air Force had only three squadrons of fighter-bombers left that were capable of mounting offensive operations into Iran. The Iraqi Army Air Corps was in slightly better shape, and could still operate more than 70 helicopters . Despite that, the Iraqis still held 3,000 tanks, while Iran held 1,000.

At this point, Saddam believed that his army was too demoralised and damaged to hold onto Khuzestan and major swaths of territory in Iran, and withdrew his remaining armed forces from those areas. He redeployed them along the border between Iraq and Iran as a means of defence . How ever, his troops continued to occupy some key border areas of Iran, and continued to hold onto the disputed territories that prompted his invasion, including the Shatt al - Arab waterway which was the primary cause of the war. In response to their failures against the Iranians in Khorramshahr, Saddam ordered the executions of General Juwad Shitnah, General Salah al - Qadhi, and Colonel Masa abd al - Jalil . At least a dozen high-ranking officers were also executed during this time . This became increasingly common punishment for those who failed him in battle.

5 – 3 - 4 - International response in 1982

In April 1982, the rival Baathist regime in Syria, one of the few nations that supported Iran, closed the Kirkuk – Banias pipeline that had allowed Iraqi oil to reach tankers on the Mediterranean, reducing the Iraqi budget by US$5 billion per month . Journalist Patrick Brogan wrote, "It appeared for a while that Iraq would be strangled economically before it was defeated militarily ". Syria's closure of the Kirkuk - Banis pipe line left Iraq with the pipeline to Turkey as the only mean of exporting oil. However, that pipeline had a capacity of only 500,000 barrels per day (79,000 m^3 / d), which was insufficient to pay for the war. However, Saudi Arabia, Kuwait, and the other Gulf states saved Iraq from bankruptcy by providing it with an average of $60 billion in subsidies per year . Though Iraq had previously been hostile towards other Gulf states, "the threat of Persian fundamentalism was far more feared " . They were especially inclined to fear Iranian victory after Ayatollah Khomeini declared monarchies to be illegitimate and an un-Islamic form of government. Khomeini's statement was widely received as a call to overthrow the Gulf monarchies . Journalists John Bulloch and Harvey Morris wrote:

The virulent Iranian campaign, which at its peak seemed to be making the overthrow of the Saudi regime a war aim on a par with the defeat of Iraq, did have an effect on the Kingdom [of Saudi Arabia], but not the one the Iranians wanted: instead of becoming more conciliatory, the Saudis became tougher, more self - confident, and less prone to seek compromise.

Saudi Arabia was said to provide Iraq with $ 1 billion per month starting mid - 1982.

Iraq began receiving support from the United States and west European countries as well. Saddam Hussein was given diplomatic, monetary, and military support by the U.S., including massive loans, political clout, and intelligence on Iranian deployments gathered using American spy satellites, which allowed them to coordinate attacks against the Iranians . The Iraqis relied heavily on American satellite footage and radar planes to detect Iranian troop movements, and they enabled Iraq to move troops to the site before the battle.

With Iranian success on the battlefield, the U.S. made its backing of Iraq more pronounced, supplying intelligence, economic aid, and dual - use equipment and vehicles, as well as normalizing their intergovernmental relations (which had been broken during the 1967 Six - Day War) . President Ronald Reagan decided that the United States "could not afford to allow Iraq to lose the war to Iran", and that the United States "would do whatever was necessary to prevent Iraq from losing the war with Iran". President Reagan formalised this policy by issuing a National Security Decision Directive to this effect in June 1982.

In 1982, Reagan removed Iraq from the list of countries "supporting terrorism" and sold weapons such as howitzers to Iraq via Jordan and Israel . France sold Iraq millions of dollars worth of weapons, including Gazelle helicopters, Mirage F-1 fighters, and Exocet missiles. Both the United States and West Germany sold Iraq dual-use pesticides and poisons that would be used to create chemical and other weapons, such as Roland missiles.

At the same time, the Soviet Union, angered with Iran for purging and destroying the Tudeh Party (Iran's national communist party) , sent large shipments of weapons to Iraq. The Iraqi Air Force was rearmed with Soviet and French fighter jets and helicopters. Iraq also bought weapons such as AK - 47s and rocket - propelled grenades from the Chinese. The depleted tank forces were replenished with Soviet tanks, and the Iraqis were reinvigorated in the face of the coming Iranian onslaught. Iran was portrayed as the aggressor, and would be seen as such until the 1990 – 1991 Persian Gulf War, when Iraq would be condemned.

Iran did not have the same financial capability to purchase arms to the same extent as Iraq. Iran could count on China, North Korea, Libya, Syria and Japan for supplying anything from weapons and munitions to logistical and engineering equipment . There were also clandestine purchases from certain elements within Israel and the United States, who also bought small arms from China, via North Korea.

5 – 3 - 5 - Ceasefire proposal

95,000 Iranian child soldiers were made casualties during the Iran–Iraq War, mostly between the ages of 16 - 17, but a few even younger than that.

On 20 June 1982 Saddam announced that he wanted to sue for peace and proposed an immediate ceasefire. Khomeini rejected the Iraqi peace offer because an immediate ceasefire would mean that Iraqi troops would remain on Iran's borders in the disputed territory. He proclaimed that Iran would invade Iraq and would not stop until the Ba'ath regime was replaced by an Islamic republic (or at least until Iraq withdrew from the disputed territories) . Iran supported agovernment in exile for Iraq, the Supreme Council of the Islamic Revolution in Iraq, led by exiled Iraqi cleric Mohammad Baqer al-Hakim, was dedicated to over throwing the Ba'ath party. They recruited dissidents, exiles, and Shias to join the Badr Brigade, the military wing of the organisation.

The decision to invade Iraq was taken after much debate within the Iranian government . One faction, comprising Prime Minister Mir - Hossein Mousavi , Foreign Minister Ali Akbar Velayati, President Ali Khamenei, and Army Chief of Staff General Ali Sayad Shirazi, wanted to accept the ceasefire, as most of Iranian soil had been recaptured . In particular, General Shirazi was opposed to the invasion of Iraq on logistical grounds, and stated he would consider resigning if "unqualified people continued to meddle with the conduct of the war."[47]:38 Of the opposing view was a hardline faction led by the clerics on the Supreme Defence Council, whose leader was the politically powerful speaker of the *Majlis*, Akbar Hashemi Rafsanjani.

The most important factor for continuing the war (as Rafsanjani argued) was that despite Iran having foiled Iraq's major territorial ambitions, they still held nearly 3,000 square miles of Iranian territory, areas such as Shalamcheh, Mehran, the Naft Shahr oil fields, and many of the pre - war disputed areas (ex. Shatt al - Arab). In the event of an immediate ceasefire, the Iraqis would remain in those territories and the fear was they wouldn't relinquish those areas, but instead reinforce them for a future invasion . Iran understood that it was internationally isolated and unlikely to receive foreign support to pressure Iraq to withdraw, nor receive compensation, nor get an international condemnation of Iraq, making it unlikely that they could gain an advantageous peace unless they scored a major military victory. While western sources often believe that because Saddam's ceasefire plea of 1982 served as a basis for the 1988 ceasefire, they blame Khomeini's decision for extending the war for the next six years ; Iranian sources point out that Saddam's ceasefire plea would have Iraqi troops occupying Iran's border areas and Iran would receive no compensation, nor would Iraq be found guilty for starting the war, while the 1988 UN ceasefire ordered a return to the pre-war borders, and allowed a commission to determine war guilt and compensation, meaning that continuing the war was advantageous for Iran after all (although very bloody and costly).

While many officials wanted to fight the war until total victory, according to a 2003 interview with Rafsanjani (the architect of Iran's strategy against Iraq), Iran's main strategy was to occupy key portions of Iraqi territory to use as bargaining chips to force a diplomatic and political solution to the war (possibly in an international court), primarily getting Iraq to withdraw from the remaining areas of Iranian territory and to accept Iranian rights, have Iraq recognized as the aggressor, and pay compensation . The areas Rafsanjani had in mind were the Al-Faw Peninsula and the major port of Umm Qasr (cutting Iraq off from the sea) , isolating and capturing Basra (the second largest city of Iraq), and capturing part of the Tigris River and Highway 8 (Baghdad - Basra Highway) , which would effectively split Iraq in two and sever the Iraqi government from their main oil fields in the south. They also wanted to capture Darbandikhan Dam in northern Iraq , which supplied most of Iraq's water . They also hoped that their attacks would ignite a revolt against Saddam's rule by the Shia and Kurdish population of Iraq, possibly resulting in his downfall (or at least forcing him to the negotiation table). They were successful in doing so with the Kurdish population, but not the Shia . Iran had captured large quantities of Iraqi equipment (enough to create several tank battalions, Iran once again had 1,000 tanks) and also managed to clandestinely procure spare parts as well.

At a cabinet meeting in Baghdad, Minister of Health Riyadh Ibrahim Hussein suggested that Saddam could step down temporarily as a way of easing Iran towards a ceasefire, and then afterwards would come back to power . Saddam, annoyed, asked if anyone else in the Cabinet agreed with the Health Minister's idea. When no one raised their hand in support, he escorted Riyadh Hussein to the next room, closed the door and shot him with his pistol. Saddam returned to the room and continued with his meeting.

5 – 3 - 6 - Iran invades Iraq

5 – 3 - 6 – 1 - Iraqi tactics against Iranian invasion

For most part, Iraq remained on the defensive for the next six years of war, unable and unwilling to launch any major offensives, while Iran launched no less than 70 offensives against the Iraqis. Iraq's strategy changed from holding territory in Iran to denying Iran any major gains in Iraq (as well as holding onto disputed territories and Iran's border areas). Saddam commenced a policy of total war, gearing most of his country towards defending against Iran. By 1988, Iraq was spending 40 – 75 % of their GDP on military equipment. Saddam had also more than doubled the size of the Iraqi army, from 200,000 soldiers (12 divisions and 3 independent brigades) to 500,000 (23 divisions and nine brigades). They also began launching air raids against Iranian border cities, greatly increasing the practice by 1984. By the end of 1982, Iraq had been resupplied with new Soviet materiel, and the ground war entered a new phase. Iraq used newly acquired T - 55, T- 62 and T-72 tanks, BM - 21 truck - mounted rocket launchers, and Mi - 24 helicopter gunships to prepare a Soviet-type three-line defence, replete with obstacles such as barbed wire, minefields, fortified positions and bunkers. The Combat Engineer Corps built bridges across water obstacles, laid minefields, erected earthen revetments, dug trenches, built machinegun nests, and prepared new defence lines and fortifications .

Iraq began to focus on using defense in depth to defeat the Iranians. Iraq created multiple static defense lines to bleed the Iranians through sheer size. When faced against large Iranian attack, where human waves would overrun Iraq's entrenched infantry defences, the Iraqis would often retreat, but their static defences would bleed the Iranians and channel them into certain directions, drawing them into a trap. After wards, Iraqi air and artillery attacks would pin the Iranians down, while tanks and mechanised infantry attacks using mobile warfare would push them back.[101] Sometimes, the Iraqis would launch "probing attacks" into the Iranian lines to provoke them into launching their attacks sooner. Chemical weapons were used as well , and were a major source of Iranian infantry casualties. While Iranian human wave attacks were successful against the dug in Iraqi forces in Khuzestan, they had trouble breaking through Iraq's defense in depth lines. Iraq had a logistical advantage in their defence: the front was located near the main Iraqi bases and arms depots, allowing their army to be efficiently supplied . By contrast, the front in Iran was a considerable distance away from the main Iranian bases and arms depots, and as such, Iranian troops and supplies had to travel through roads across mountain ranges before arriving at the front.

Column of Iranian T-55 tanks

In addition, Iran's military power was weakened once again by large purges in 1982, resulting from another supposedly attempted coup.

5 – 3 - 6 – 2 - Operation Ramadan (First Battle of Basra)

The Iranian generals wanted to launch an all - out attack on Baghdad and seize it before the weapon shor tages continued to manifest further. Instead, that was rejected as being unfeasable, and the decision was made to capture one area of Iraq after the other in the hopes that a series of blows delivered foremost by the Revolutionary Guards Corps would force a political solution to the war (including Iraq withdrawing completely from disputed territories of Iran).

The Iranians planned their attack in southern Iraq, near Basra, the second most important city in Iraq. Called Operation Ramadan, it involved over 180,000 troops from both sides, and was one of the largest land battles since World War II. Iranian strategy dictated that they launch their primary attack on the weakest point of the Iraqi lines; however, the Iraqis were informed of Iran's battle plans and moved all of their forces to the area the Iranians planned to attack. The Iraqis were equipped with tear gas to use against the enemy, which would be first major use of chemical warfare during the conflict, throwing an entire attacking division into chaos.

Iranian 55th Airborne Special Forces Brigade prepare to board a Lockheed C-130H for a training exercise

Over 100,000 Revolutionary Guards and Basij volunteer forces charged towards the Iraqi lines . The Iraqi troops had entrenched themselves in formidable defences, and had set up a network of bunkers and artillery positions. The Basij used human waves, and were even used to bodily clear the Iraqi minefields and allow the Revolutionary Guards to advance. Combatants came so close to one another that Iranians were able to board Iraqi tanks and throw grenades inside the hulls. By the eighth day, the Iranians had gained 16 km (9.9 mi) inside Iraq and had taken several bridges. Iran's Revolutionary Guards also used the T-55 tanks they had captured in earlier battles.

However, the attacks came to a halt and the Iranians turned to defensive measures. Seeing this, Iraq used their Mi - 25 helicopters, along with French - built Gazelle helicopters armed withEuromissile HOT, against columns of Iranian mechanised infantry and tanks. These "hunter - killer" teams of helicopters, which had been formed with the help of East German advisors, proved to be very costly for Iranians. Aerial dogfights occurred between Iraqi Migs and Iranian F-4 Phantoms.

On 16 July, Iran tried again further north and managed to push the Iraqis back. However, only 13 km from Basra, the poorly equipped Iranian forces were surrounded on three sides by Iraqis with heavy weaponry. Some were captured, while many were killed. Only a last-minute attack by Iranian AH-1 Cobra helicopters stopped the Iraqis from routingthe Iranians. Three more similar attacks occurred around the Khorramshar - Baghdad road area towards the end of the month, but none were significantly successful . Iraq had concentrated three armoured divisions, the 3rd, 9th, and 10th, as a counter - attack force to attack any penetrations. They were successful in defeating the Iranian breakthroughs, but suffered heavy losses. The 9th Armoured Division in particular had to be disbanded, and was never reformed. 80,000 soldiers from both sides were killed. 400 Iranian tanks and armored vehicles were destroyed or abandoned, while Iraq lost 100 tanks.

5 – 3 - 6 – 3 - Fighting during the rest of 1982

After Iran's defeat in Operation Ramadan, they carried out only a few smaller attacks. Iran launched two limited offensives aimed at liberating the Sumar Hills and isolating the Iraqi pocket at Naft Shahr near the Iraqi border, both of which were Iranian territory still under Iraq occupation. They then aimed to capture the Iraqi border city of Mandali . They planned to take the Iraqis by surprise using Basij militiamen , army helicopters, and some armoured forces, then stretch their defences and possibly break through them to open a road to Baghdad for future exploitation . During Operation *Muslim ibn Aqil* (1–7 October) , Iran recovered 150 km^2 of its own territory and reached the outskirts of Mandali before being stopped by Iraqi helicopter and armoured attacks . During Operation *Muharram* (1 – 21 November) , the Iranians captured part of the Bayat oilfield with their fighter jets and helicopters, destroying 105 Iraqi tanks, 70 APCs, and 7 planes with few losses. They nearly breached the Iraqi lines but failed to capture Mandali after the Iraqis sent reinforcements, including brand new T-72 tanks, which possessed armour that could not be pierced from the front by Iranian TOW missiles . The Iranian advance was also impeded by heavy rains. 3,500 Iraqis and an unknown number of Iranians died, with only minor gains for Iran.

5 – 4 - 1983 – 84 : Strategic stalemate and war of attrition

Ali Khamenei, with Iranian soldiers on the front - line. Khamenei initially opposed Khomeini's decision to extend the war into Iraq.

After the failure of the 1982 summer offensives, Iran believed that a major effort along the entire breadth of the front would yield the victory. During the course of 1983, the Iranians launched five major assaults along the front, though none achieved substantial success, as the Iranians staged more massive "human wave" attacks . By this time, it was estimated that more than 70 Iranian fighter aircraft were still operational at any given time; Iran had their own helicopter repair facilities, left over from before the revolution, and thus often used helicopters for close air support . While Iranian fighter pilots had superior training compared to their Iraqi counterparts , and would continue to dominate in combat , due to shortages of aircraft, the size of defended territory and American intelligence supplied to Iraq, the Iraqis could exploit gaps in Iranian airspace. The Iraqis were able to gain air superiority towards the end of the war. Iraqi air campaigns met little opposition, striking over half of Iran.

5 – 4 – 1 - Operation Before the Dawn

Operation *Fajr al - Nasr* (Before the Dawn/Dawn of Victory), launched 6 February 1983 , saw the Iranians shift focus from the southern to the central and northern sectors. Iran, using 200,000 "last reserve" Revolutionary Guard troops, attacked along a 40 km stretch near al - Amarah, Iraq about 200 km southeast of Baghdad, in an attempt to reach the highways connecting northern and southern Iraq. The attack was stalled by 60 km of hilly escarpments, forests, and river torrents blanketing the way to al - Amarah, but the Iraqis could not force the Iranians back. Iran directed artillery on Basra and Al Amarah, and Mandali.

The Iranians suffered a large number of casualties clearing mine fields and breaching Iraqianti - tank mines, which Iraqi engineers were unable to replace. After this battle, Iran reduced its use of human wave attacks, though they still remained a key tactic as the war went on.

The Mandali – Baghdad northcentral sector also witnessed fighting in April 1983, as Iranian attacks were stopped by Iraqi mechanised and infantry divisions. Casualties were high, and by the end of 1983, an estimated 120,000 Iranians and 60,000 Iraqis had been killed. Iran, however, held the advantage in the war of attrition.

5 – 4 – 2 - Dawn Operations

From early 1983 – 1984 , Iran launched a series of four *Valfajr* (Dawn) Operations (that eventually numbered to 10) . During Operation Dawn - 1 , in early February 1983, 50,000 Iranian forces attacked westward from Dezful and were confronted by 55,000 Iraqi forces. The Iranian objective was to cut off the road from Basra to Baghdad in the central sector. The Iraqis carried out 150 air sorties against the Iranians, and even bombed Dezful, Ahvaz, and Khorramshahr in retribution. The Iraqi counterattack was broken up by Iran's 92nd Armoured Division.

During Operation Dawn - 2 , the Iranian's directed insurgency operations by proxy in April 1983 by supporting the Kurds in the north. With Kurdish support, the Iranians attacked on 23 July 1983, capturing the Iraqi town of Haj Omran and maintaining it against an Iraqi poison gas counter offensive . This operation incited Iraq to later conduct indiscriminate chemical attacks against the Kurds . The Iranians attempted to further exploit activities in the north on 30 July 1983, during Operation Dawn-3. Iran saw an opportunity to sweep away Iraqi forces controlling the roads between the Iranian mountain border towns of Mehran, Dehloranand Elam. Iraq launched airstrikes, and equipped attack helicopters with chemical warheads; while ineffective, it demonstrated both the Iraqi general staff's and Saddam's increasing interest in using chemical weapons. In the end, 17,000 had been killed on both sides, with no gain for either country.

The focus of Operation Dawn - 4 in September 1983 was the northern sector in Iranian Kurdistan. Three Iranian regular divisions, the Revolutionary Guard, and Kurdistan Democratic Party (KDP) elements amassed in Marivan andSardasht in a move to threaten the major Iraqi city Suleimaniyah. Iran's strategy was to press Kurdish tribes to occupy the Banjuin Valley, which was within 45 km of Suleimaniyah and 140 km from the oilfields ofKirkuk. To stem the tide, Iraq deployed Mi - 8 attack helicopters equipped with chemical weapons and executed 120 sorties against the Iranian force, which stopped them 15 km into Iraqi territory. 5,000 Iranians and 2,500 Iraqis died.[110] Iran gained 110 km^2 ,of its territory back in the north, gained 15 km^2 of Iraqi land, and captured 1,800 Iraqi prisoners while Iraq abandoned large quantities of valuable weapons and war materiel in the field. Iraq responded to these losses by firing a series of SCUD - B missiles into the cities of Dezful, Masjid Soleiman, andBehbehan. Iran's use of artillery against Basra while the battles in the north raged created multiple fronts, which effectively confused and wore down Iraq .

5 - 4 – 3 - Iran's change in tactics

Iranian troops boarding a Sea King helicopter, many helicopters were used during Operation Kheibar

Previously, the Iranians had outnumbered the Iraqis on the battlefield, but Iraq expanded their military draft (pursuing a policy of total war), and by 1984, the armies were equal in size. By 1986, Iraq had twice as many soldiers as Iran. By 1988, Iraq would have 1 million soldiers, giving it the fourth largest army in the world. Some of their equipment, such as tanks, outnumbered the Iranians' by at least five to one. Iranian commanders, however, remained more tactically skilled.

Iranian child soldier

After the Dawn Operations, Iran attempted to change tactics. In the face of increasing Iraqi defense in depth, as well as increased armaments and manpower, Iran could no longer rely on simple human wave attacks . Iranian offensives became more complex and involved extensive maneuver warfare using primarily light infantry. Iran launched frequent , and sometimes smaller offensives to slowly gain ground and deplete the Iraqis through attrition.[79] They wanted to drive Iraq into economic failure by wasting money on weapons and war mobilization, and to deplete their smaller population by bleeding them dry, in addition to creating an anti - government insurgency (they were successful in Kurdistan, but not southern Iraq) . Iran also kept its goal of capturing important territory to force Iraq to negotiate . Iran also supported their attacks with heavy weaponry when possible and with better planning (although the brunt of the battles still fell to the infantry). The Army and Revolutionary

Guards worked together better as their tactics improved. Human wave attacks became less frequent (although still used) . To defeat Iraqi defense in depth, static positions, and heavy firepower, Iran began to focus on fighting in areas that the Iraqis could not use their heavy weaponry, such as marshes, valleys, and mountains, and frequently using infiltration tactics.

Iran began training troops in infiltration, patrolling, night-fighting, marsh warfare, and mountain warfare . They also began training thousands of Revolutionary Guardcommandos in amphibious warfare, as southern Iraq is marshy and filled with wetlands. Iran used speedboats to cross the marshes and rivers in southern Iraq and landed troops on the opposing banks, where they would dig and set up pontoon bridges across the rivers and wetlands to allow heavy troops and supplies to cross. Iran also learned to integrate foreign guerrilla units as part of their military operations . On the northern front, Iran began working heavily with the Peshmerga, Kurdish guerrillas.[80] Iranian military advisors organised the Kurds into raiding parties of 12 guerrillas, which would attack Iraqi command posts, troop formations, infrastructure (including roads and supply lines), and government buildings. The oil refineries of Kirkuk became a favourite target, and were often hit by home made Peshmerga rockets.

5 – 4 – 4 - Battle of the Marshes

By 1984, the Iranian ground forces were reorganised well enough for the Revolutionary Guard to start Operation *Kheibar* (named after Kheibar, Saudi Arabia) , which lasted from 24 February to 19 March. On 15 February 1984, the Iranians began launching attacks against the central section of the front, where the Second Iraqi Army Corps was deployed: 250,000 Iraqis faced 250,000 Iranians.[47] The goal of this new major offensive was the capture of Basra-Baghdad Highway, cutting off of Basra from Baghdad and setting the stage for an eventual attack upon the city (one of Iran's major goals to force Iraq to negotiate). The Iraqi high command had assumed the marshlands above Basra were natural barriers to attack, and had not reinforced them. The marshes negated Iraqi advantage in armor, and absorbed artillery and bombs.

Prior to the attack, Iranian commandos on helicopters had landed behind Iraqi lines and destroyed Iraqi artillery. Iran launched two preliminary attacks prior to the main offensive, Operation Dawn 5 and Dawn 6.[110] They saw the Iranians attempting to capture Kut al-Imara, Iraq and sever the highway connecting Baghdad to Basra, which would impede Iraqi coordination of supplies and defences. Iranian troops crossed the river on motorboatsin a surprise attack, though only came within 24 km of the highway.

Operation Kheibar began on 24 February with Iranian infantrymen crossing the Hawizeh Marshes using motorboats and transport helicopters in an amphibious assault.[39] The Iranians attacked the vital oil-producing Majnoon Island by landing troops via helicopters onto the islands and severing the communication lines between Amareh and Basra . They then continued the attack towards Qurna . By 27 February, they had captured the island, but suffered catastrophic helicopter losses to IRAF. On that day, a massive array of Iranian helicopters transporting Pasdaran troops were intercepted by Iraqi combat aircraft (Mi Gs , Mirages and Sukhois). In what was essentially an aerial slaughter, Iraqis jets shot down 49 of 50 Iranian helicopters. At times, fighting took place in waters over 2 m deep. Iraq ran live electrical cables through the water, electrocuting numerous Iranian troops and then displaying their corpses on state television.

By 29 February, the Iranians had reached the outskirts of Qurna and were closing in on the Baghdad–Basra highway. They had broken out of the marshes and returned to open terrain, where they were confronted by conventional Iraqi weapons, including artillery, tanks, air power, and mustard gas. 1,200 Iranian soldiers were killed in the counter-attack. The Iranians retreated back to the marshes, though they still held onto them along with Majnoon Island.

The Battle of the Marshes saw an Iraqi defence that had been under continuous strain since 15 February; they were relieved by their use of chemical weapons and defence - in - depth, where they layered defensive lines: even if the Iranians broke through the first line, they were usually unable to break through the second due to exhaustion and heavy losses. They also largely relied on Mi-24 Hind to "hunt" the Iranian troops in the marshes , and at least 20,000 Iranians were killed in the marsh battles. Iran used the marshes as a springboard for future attacks/infiltrations.

Four years into the war, the human cost to Iran had been 170,000 combat fatalities and 340,000 wounded. Iraqi combat fatalities were estimated at 80,000 with 150,000 wounded.

5 – 4 – 5 - The "Tanker War" and the "War of the Cities"

IS Hengam LST built by Yarrow Shipbuilders , Scotstoun and commissioned by the Iranian Navy in 1974

Unable to launch successful ground attacks against Iran, Iraq used their now expanded air force to carry out strategic bombing against Iranian shipping, economic targets, and cities in order to damage Iran's economy and morale . Iraq also wanted to provoke Iran into doing something that would cause the superpowers to be directly involved in the conflict on the Iraqi side.

5 – 4 – 5 - 1 - Attacks on shipping

The so-called "Tanker War" started when Iraq attacked the oil terminal and oil tankers at Kharg Island in early 1984.[47] Saddam's aim in attacking Iranian shipping was to provoke the Iranians to retaliate with extreme measures, such as closing theStrait of Hormuz to all maritime traffic, thereby bringing American intervention: the United States had threatened several times to intervene if the Strait of Hormuz were closed . As such, the Iranians limited their retaliatory attacks to Iraqi shipping, leaving the strait open to general passage.

Iraq declared that all ships going to or from Iranian ports in the northern zone of the Persian Gulf were subject to attack . They used air power, primarily helicopters, F-1 Mirage, and MiG-23 fighters armed with Exocet anti-ship missiles, to enforce their threats. Iraq began to repeatedly bomb Iran's main oil export facility on Khark Island, causing increasingly heavy damage. After these attacks, Iran attacked a Kuwaiti tanker carrying Iraqi oil near Bahrain on 13 May 1984, as well as a Saudi tanker in Saudi waters on 16 May. Because Iraq had become landlocked during the invasion, they had to rely on their Arab allies, primarily Kuwait, to transport their oil. Iran attacked tankers carrying Iraqi oil from Kuwait, later attacking tankers from any Persian Gulf state supporting Iraq. Attacks on ships of noncombatant nations in the Persian Gulf sharply increased thereafter, with both nations attacking oil tankers and merchant ships of neutral nations in an effort to deprive their opponent of trade. The Iranian attacks against Saudi shipping led to Saudi F-15s shooting down a pair of F-4 Phantom II on 5 June 1984.

The air and small - boat attacks, however, did little damage to Persian Gulf state economies, and Iran moved its shipping port to Larak Island in the Strait of Hormuz.

The Iranian Navy imposed a naval blockade of Iraq, using its British-built frigates to stop and inspect any ships thought to be trading with Iraq. They operated with virtual impunity, as Iraqi pilots had little training in hitting naval targets. Some Iranian warships attacked tankers with ship – to - ship missiles, while others used their radars to guide land - based anti - ship missiles to their targets. Iran began to rely on its new Revolutionary Guard's navy, which usedBoghammar speedboats: fitted with rocket launchers, RPGs, and heavy machine guns, these speedboats would launch surprise attacks against tankers and cause substantial damage. Iran also used aircraft and helicopters to launch Maverick missiles and unguided rockets at tankers.

A U.S. Navy ship, the *Stark*, was struck on 17 May 1987 by two Exocet anti - ship missiles fired from an Iraqi F-1 Mirage plane. The missiles had been fired at about the time the plane was given a routine radio warning by the *Stark*. The frigate did not detect the missiles with radar, and warning was given by the lookout only moments before they struck. Both missiles hit the ship, and one exploded in crew quarters, killing 37 sailors and wounding 21.

Lloyd's of London, a British insurance market, estimated that the Tanker War damaged 546 commercial vessels and killed about 430 civilian sailors. The largest portion of the attacks was directed by Iraq against vessels in Iranian waters, with the Iraqis launching three times as many attacks as the Iranians . But Iranian speed boat attacks on Kuwaiti shipping led Kuwait to formally petition foreign powers on 1 November 1986 to protect its shipping. The Soviet Union agreed to charter tankers starting in 1987, and the United States Navy offered to provide protection for foreign tankers reflagged and flying the U.S. flag starting 7 March 1987 in Operation Earnest Will . Neutral tankers shipping to Iran were unsurprisingly not protected by Earnest Will, resulting in reduced foreign tanker traffic to Iran, since they risked Iraqi air attack. Iran accused the US of helping Iraq.

During the course of the war, Iran attacked two Soviet Navy ships which were protecting Kuwaiti tankers . Notably, the *Seawise Giant*, the largest ship ever built, was struck and damaged by Iraqi Exocet missiles as it was carrying Iranian crude oil out of the Gulf.

5 – 4 – 5 - 2 - Attacks on cities

Meanwhile, Iraq's air force also began carrying out strategic bombing raids against Iranian cities. While Iraq had launched numerous attacks with aircraft and missiles against border cities from the beginning of the war and sporadic raids on Iran's main cities, this was the first systematic strategic bombing that Iraq carried out during the war. This would become known as the "War of the Cities". With the help of the USSR and the west, Iraq's air force had been rebuilt and expanded.[91] Meanwhile Iran, due to sanctions and lack of spare parts, had heavily curtailed their air force operations. Iraq used Tu-22 Blinder and Tu -16 Badgerstrategic bombers to carry out long - range high - speed raids on Iranian cities, including Tehran. Fighter - bombers such as the Mig - 25 Foxbat and Su - 22 Fitter were used against smaller or shorter range targets, as well as escorting the strategic bombers . Civilian and industrial targets were hit by the raids and each successful raid inflicted economic damage from regular strategic bombing.

In response, the Iranians deployed their F - 4 Phantoms to combat the Iraqis, and eventually they deployed F-14s as well. Most of the Iraqi air raids were intercepted by the Iranian fighter jets and air defense , but some also success fully hit their targets, becoming a major headache for Iran. By 1986, Iran also expanded their air defensenetwork heavily to take the load of the fighting off the air force. By later in the war, Iraqi raids primarily consisted of indiscriminate missile attacks while air attacks were used only on fewer, more important targets. Starting in 1987, Saddam also ordered several chemical attacks on civilian targets in Iran, such as the town of Sardasht.

Iran also launched several retaliatory air raids on Iraq, while primarily shelling border cities such as Basra. Iran also bought some Scudmissiles from Libya, and launched them against Baghdad. These too inflicted damage upon Iraq.

On 7 February 1984, (during the first war of the cities) Saddam ordered his air force to attack eleven Iranian cities;[47] bombardments ceased on 22 February 1984. Though Saddam had aimed for the attacks to demoralise Iran and force them to negotiate, they had little effect, and Iran quickly repaired the damage . Iraq's air force took heavy losses , however, and Iran struck back, hitting Baghdad and other Iraqi cities. Nevertheless, the attacks resulted in tens of thousands of civilian casualties on both sides, and became known as the first "war of the cities". It was estimated that 1,200 Iranian civilians were killed during the raids in February alone There would be five such major exchanges throughout the course of the war, and multiple minor ones. While interior cities such as Tehran, Qom, Isfahan and Shiraz did receive numerous raids, it was the cities of western Iran that suffered the most death and destruction.

5 – 4 – 6 - Strategic situation in 1984

By 1984, Iran's losses were estimated to be 300,000 soldiers, while Iraq's losses were estimated to be 150,000 . Foreign analysts agreed that both Iran and Iraq failed to use their modern equipment properly, and both sides failed to carry out modern military assaults that could win the war. Both sides also abandoned equipment in the battlefield because their technicians were unable to carry out repairs. Iran and Iraq showed little internal coordination on the battlefield, and in many cases units were left to fight on their own. As a result, by the end of 1984, the war was a stalemate.

[126] One limited offensive Iran launched (Dawn 7) took place from 18–25 October 1984, when they recaptured the Iranian city of Mehran, which had been occupied by the Iraqis from the beginning of the war.

5 - 5 - 1985 – 86: Offensives and retreats

By 1985, Iraqi armed forces were receiving financial support from Saudi Arabia, Kuwait, and other Persian Gulf states, and were making substantial arms purchases from the Soviet Union, China, and France. For the first time since early 1980, Saddam launched new offensives.

On 6 January 1986, the Iraqis launched an offensive attempting to retake Majnoon Island. However, they were quickly bogged down into a stalemate against 200,000 Iranian infantrymen, rein forced by amphibious divisions. However, they managed to gain a foothold in the southern part of the island.

Iraq also carried out another "war of the cities" between 12–14 March, hitting up to 158 targets in over 30 towns and cities, including Tehran. Iran responded by launching 14 Scud missiles for the first time, purchased from Libya. More Iraqi air attacks were carried out in August, resulting in hundreds of additional civilian casualties. Iraqi attacks against both Iranian and neutral oil tankers in Iranian waters continued, with Iraq carrying out 150 airstrikes using French bought Super Etendard and Mirage F-1 jets as well as Super Frelon helicopters, using Exocet missiles .

5 - 5 – 1 - Operation Badr

The Iraqis attacked again on 28 January 1985; they were defeated, and the Iranians retaliated on 11 March 1985 with a major offensive directed against the Baghdad - Basra highway (one of the few major offensives conducted in 1985) , codenamed Operation *Badr* (after the Battle of Badr, Muhammad's first military victory in Mecca) . Ayatollah Khomeini urged Iranians on, declaring:

It is our belief that Saddam wishes to return Islam to blasphemy and polytheism...if America becomes victorious...and grants victory to Saddam, Islam will receive such a blow that it will not be able to raise its head for a long time...The issue is one of Islam versus blasphemy, and not of Iran versus Iraq.

This operation was similar to Operation Kheibar, though it invoked more planning. Iran used 100,000 troops, with 60,000 more in reserve. They assessed the marshy terrain, plotted points where they could land tanks, and constructed pontoon bridges across the marshes. The Basij forces were also equipped with anti-tank weapons.

The ferocity of the Iranian offensive broke through the Iraqi lines. The Revolutionary Guard, with the support of tanks and artillery, broke through north of Qurna on 14 March. That same night 3,000 Iranian troops reached and crossed the Tigris River using pontoon bridges and captured part of the Baghdad – Basra Highway 8, which they had failed to achieve in Operations Dawn 5 and 6.

Saddam responded by launching chemical attacks against the Iranian positions along the highway and by initiating the aforementioned second "war of the cities", with an air and missile campaign against twenty to thirty Iranian population centres, including Tehran . Under General Sultan Hashim Ahmad al - Tai and General Jamal Zanoun (both considered to be among Iraq's the most skilled commanders), the Iraqis launched air attacks against the Iranian positions and pinned them down. They then launched a pincer attack using mobile infantry and heavy artillery. Chemical weapons were used, and the Iraqis also flooded Iranian trenches with specially constructed pipes delivering water from the Tigris River.

Wounded Iranian soldiers evacuated by motor boat

The Iranians retreated back to the Hoveyzeh marshes while being attacked by helicopters , and the highway was recaptured by the Iraqis. Operation Badr resulted in 10,000 – 12,000 Iraqi casualties and 15,000 Iranian ones.

5 - 5 – 2 - Strategic situation at the beginning of 1986

The failure of the human wave attacks in earlier years had prompted Iran to develop a better working relationship between the Army and the Revolutionary Guard and to mould the Revolutionary Guard units into a more conventional fighting force. To combat Iraq's use of chemical weapons, Iran began producing an antidote.[110] They also created and fielded their own homemade drones, theMohajer 1's, fitted with six RPG -7's to launch attacks. They were primarily used in observation, being used for up to 700 sorties.

For the rest of 1986, and until the spring of 1988, the Iranian Air Force's efficiency in air defence increased, with weapons being repaired or replaced and new tactical methods being used. For example, the Iranians would loosely integrate their SAM sites and interceptors to create "killing fields" in which dozens of Iraqi planes were lost (which was reported in the West as the Iranian Air Force using F-14s as "mini - AWACs"). The Iraqi Air Force reacted by increasing the sophistication of its equipment, incorporating modern electronic countermeasure pods , decoys such as chaff and flare, and anti-radiation missiles . Due to the heavy losses in the last war of the cities, Iraq reduced their use of aerial attacks on Iranian cities. Instead, they would launch Scud missiles, which the Iranians could not stop. Since the range of the Scud missile was too short to reach Tehran, they converted them toal-Hussein missiles with the help of East German engineers, cutting up their Scuds into three chunks and attaching them together. Iran responded to these attacks by using their own Scud missiles.[129] Iranian attacks were fewer, and meant primarily to deter the Iraqis from launching their air/missile strikes.

Aside from extensive foreign help to Iraq, Iranian attacks were severely hampered by their shortages of weaponry, including heavy weaponry. Large portions of them had been lost during the last several years. Iran still managed to maintain 1,000 tanks (often by capturing Iraqi ones) and additional artillery, but many needed repairs to be operational. But by this time Iran managed to procure spare parts from various sources, helping them to restore some weapons. They secretly imported some weapons, such as RBS -70 anti – aircraft MANPADS. In an exception to the US's support for Iraq, in exchange for Iran using its influence to help free western hostages in Lebanon, the US secretly sold Iran some limited supplies (in the Ayatollah Rafsanjani's postwar interview, he stated that during the period when Iran was succeeding, for a short time the US supported Iran, then shortly after began helping Iraq again) . Iran managed to get some advanced weapons, such as anti - tankTOW missiles, which worked better than rocket - propelled grenades. Iran later reverse-engineered and produced those weapons on their own as well. All of these almost certainly helped increase the effectiveness of Iran, although it did not reduce the human cost of their attacks.

5 - 5 – 3 - First Battle of al - Faw

On the night of 10–11 February 1986, the Iranians launched Operation Dawn 8 , in which 30,000 troops comprising five Army divisions and men from the Revolutionary Guard and the Basij advanced in a two-pronged offensive to capture the al - Faw peninsula in southern Iraq, the only area touching the Persian Gulf.[47] The capture of Al Faw and Umm Qasr was a major goal for Iran to force Iraq to negotiate a favorable settlement.[54] Iran began with a feint attack against Basra, which was stopped by the Iraqis. Meanwhile, an amphibious strike force landed at the foot of the peninsula. The resistance, consisting of several thousand poorly trained soldiers of the Iraqi Popular Army, fled or were defeated, and the Iranian forces set up pontoon bridges crossing the Shatt al-Arab,[note 1] allowing 30,000 soldiers to cross in a short period of time.[112] They drove north along the peninsula almost unopposed, capturing it after only 24 hours of fighting . Afterwards they dug in and set up defenses.

The sudden capture of al-Faw took the Iraqis by shock, since they had thought it impossible for the Iranians to cross the Shatt al-Arab. On 12 February 1986, the Iraqis began a counter - offensive to retake al - Faw, which failed after a week of heavy fighting. On 24 February 1986, Saddam sent one of his best commanders, General Maher Abd al - Rashid, and theRepublican Guard to begin a new offensive to recapture al - Faw. A new round of heavy fighting took place, However, their attempts again ended in failure, costing them many tanks and air craft : their 15th mechanised division was almost completely wiped out. The capture of al-Faw and the failure of the Iraqi counter - offensives were blows to the Ba'ath regime's prestige, and led the Gulf countries to fear that Iran might win the war.[47] Kuwait in particular felt menaced with Iranian troops only 16 km away, and increased its support of Iraq accordingly.

In March 1986, the Iranians tried to follow up their success by attempting to take Umm Qasr, which would have completely severed Iraq from the Gulf and placed Iranian troops on the border with Kuwait, which was a major Iranian goal in forcing Iraq into negotiations. However, the offensive failed due to Iranian shortages of armor. By this time, 10,000 Iraqis and 30,000 Iranians were casualties. The First Battle of al-Faw ended in March, but heavy combat operations lasted on the peninsula into 1988, with neither side being able to displace the other. The battle bogged down into a World War I-style stalemate in the marshes of the peninsula. 53,000 Iraq troops and an unknown number of Iranian troops were killed.

5 - 5 – 4 - Battle of Mehran

Immediately after the Iranian capture of al - Faw, Saddam declared a new offensive against Iran, designed to drive deep into the state.[39] The Iranian border city of Mehran, on the foot of the Zagros Mountains, was selected as the first target. On 15 – 19 May, Iraqi Army's Second Corps, supported by helicopter gunships, attacked and captured the city. Saddam then offered the Iranians to exchange Mehran for al-Faw. The Iranians rejected the offer. Iraq then continued the attack, attempting to push deeper into Iran. However, Iraq's attack was quickly warded off by Iranian AH-1 Cobra helicopters with TOW missiles, which destroyed numerous Iraqi tanks and vehicles.

The Iranians built up their forces on the heights surrounding Mehran. On 30 June, using mountain warfare tactics they launched their attack, recapturing the city by 3 July. Saddam ordered the Republican Guard to retake the city on 4 July, but their attack was ineffective. Iraqi losses were heavy enough to allow the Iranians to also capture territory inside Iraq , and depleted the Iraqi military enough to prevent them from launching a major offensive for the next two years. Iraq's defeats at al-Faw and at Mehran were severe blows to the prestige of the Iraqi regime, and western powers, including the U.S., became more determined to prevent an Iraqi loss.

5 - 5 – 5 - Strategic situation at the end of 1986

Through the eyes of international observers, Iran was prevailing in the war by the end of 1986. In the northern front, the Iranians began launching attacks toward the city ofSuleimaniya with the help of Kurdish fighters, taking the Iraqis by surprise. They came within 16 km of the city before being stopped by chemical and army attacks. Iran's army had also reached the Meimak Hills, only 113 km from Baghdad . Iraq managed to contain Iran's offensives in the south, but was under serious pressure, as the Iranians were slowly overwhelming them.

Iraq responded by launching another "war of the cities". In one attack, Tehran's main oil refinery was hit, and in another instance, Iraq damaged Iran's Assadabad satellite dish, disrupting Iranian overseas telephone and telex service for almost two weeks . Civilian areas were also hit, resulting in many casualties . Iraq continued to attack oil tankers via air. Iran responded by launching Scud missiles and air attacks at Iraqi targets.

Iraq continued to attack Kharg Island and the oil tankers and facilities as well. Iran created a tankershuttle service of 20 tankers to move oil from Kharg to Larak Island, escorted by Iranian fighter jets. Once moved to Larak, the oil would be moved to oceangoing tankers (usually neutral). They also rebuilt the oil terminals damaged by Iraqi air raids and moved shipping to Larak Island, while attacking foreign tankers that carried Iraqi oil (as Iran had blocked Iraq's access to the open sea with the capture of al – Faw) . By now they almost always used the armed speedboats of the IRGC navy, and attacked many tankers.[39] The tanker war escalated drastically, with attacks nearly doubling in 1986 (the majority carried out by Iraq). Iraq got permission from the Saudi government to use its airspace to attack Larak Island, although due to the distance attacks were less frequent there. The escalating tanker war in the Gulf became an ever increasing concern to foreign powers, especially the United States.

In April 1986, Ayatollah Khomeini issued a fatwa declaring that the war must be won by March 1987. The Iranians increased recruitment efforts, obtaining 650,000 volunteers. The animosity between the Army and the Revolutionary Guard arose again, with the Army wanting to use more refined, limited military attacks while the Revolutionary Guard wanted to carry out major offensives.[110] Iran, confident in its successes, began planning their largest offensives of the war, which they called their "final offensives." .

5 - 5 – 5 - 1 - Iraq's Dynamic Defense Strategy

Faced with their recent defeats in al - Faw and Mehran, Iraq appeared to be losing the war. Iraq's generals, angered by Saddam's interference, threatened a full - scale mutiny against the Ba'ath Party unless they were allowed to conduct operations freely. In one of the few times during his career, Saddam gave in to the demands of his generals . Up to this point, Iraqi strategy was to ride out Iranian attacks. However, the defeat at al-Faw led Saddam to declare the war to be *Al-Defa al Mutahharakkha* (The Dynamic Defense) , and announcing that all civilians had to take part in the war effort. The universities were closed and all of the male students were drafted into the military. Civilians were instructed to clear marshlands to prevent Iranian amphibious infiltrations and to help build fixed defenses.

The government tried to integrate the Shias into the war effort by recruiting many as part of the Ba'ath Party . In an attempt to counterbalance the religious fervor of the Iranians and gain support from the devout masses, the regime also began to promote religion and, on the surface, Islamization, despite the fact that Iraq was run by a socialist regime. Scenes of Saddam praying and making pilgrimages to shrines became common on state-run television. While Iraqi morale had been low through out the war, the attack on al - Faw raised patriotic fervor, as the Iraqis feared invasion. Saddam also recruited volunteers from other Arab countries into the Republican Guard, and received much technical support from foreign nations as well . While Iraqi military power had been depleted in recent battles, through heavy foreign purchases and support, they were able to expand their military even to much larger proportions by 1988.

At the same time, Saddam ordered the genocidal al-Anfal Campaign in an attempt to crush the Kurdish resistance, who were now allied with the Iranians. The result was the deaths of several hundred thousand Iraqi Kurds, and the destruction of villages, towns, and cities.

Iraq began to try to perfect their maneuver tactics . The Iraqis began to prioritize the professionalization of their military. Prior to 1986, the conscription-based Iraqi regular army and the volunteer-based Iraqi Popular Army conducted to bulk of the operations in the war, to little effect. The Republican Guard, formerly an elite praetorian guard, was expanded as a volunteer army and filled with Iraq's best generals . Loyalty to the state was no longer a primary requisite for joining. However, due to Saddam's paranoia, the former duties of the Republican Guard were transferred to a new unit, the Special Republican Guard. Full - scale war games against hypothetical Iranian positions were carried out in the western Iraqi desert against mock targets, and they were repeated over the course of a full year until the forces involved fully memorized their attacks. Iraq built its military massively, eventually possessing the 4th largest in the world, in order to overwhelm the Iranians through sheer size.

5 – 6 - 1987 – 88 : Towards a cease fire

The People's Mujahedin of Iran, supported by Saddam, started a ten-day operation after both the Iranian and Iraqi governments accepted UN Resolution 598. Casualty estimates range from 2,000 to 10,000.

Meanwhile, as the Iraqis were planning their strike, the Iranians continued to attack. 1987 saw a renewed series of major Iranian human wave offensives in both northern and southern Iraq. The Iraqis had constructed heavy static fortifications around the city. They built 5 defensive rings, supported by natural waterways such as the Shatt - al-Arab, and manmade ones, such as *Fish Lake* and the Jasim River, along with manmade earth barriers. Fish Lake was a massive lake filled with mines, underwater barbed wire, electrodes, and various sensors. In addition, behind each waterway and defensive line was radar-guided artillery, ground attack aircraft, and combat helicopters; all capable of firing poison gas in addition to conventional munitions.

Iran's strategy was to penetrate through these massive defensive lines, and encircle Basra, cutting off the city as well as the Al - Faw peninsula from the rest of Iraq. The Iranians hoped that the capture of Basra would be such a major blow to Iraq that they would be forced to negotiate a settlement favorable to Iran. Iran's plan was for three assaults: a diversionary attack near Basra, the main offensive, and another diversionary attack using Iranian armor in the north to have Iraqi heavy armor diverted away from Basra. For these battles, Iran had re-expanded their military by recruiting many new Basij and Pasdaran volunteers. Iran brought 150,000–200,000 total troops into the battles.

5 - 6 – 1 - Karbala Operations

5 - 6 – 1 – 1 - Operation Karbala - 4

On 25 December 1986, Iran launched Operation Karbala - 4 (*Karbala* referring to Hussein ibn Ali's Battle of Karbala). According to General Ra'ad al - Hamdani, this was a diversionary attack.[67] The Iranians launched an amphibious assault against the Iraqi island of Umm al-Rassas which lie in the Shatt – Al - Arab river parallell to Khoramshahr; they then set up a pontoon bridge and continued the attack, eventually capturing it after taking many casualties and failing to advance further; they had taken 60,000 casualties, while the Iraqis took 9,500. The Iraqi commanders exaggerated Iran's losses to Saddam, and it was assumed that the main Iranian attack on Basra had been fully defeated and that the Iranians were depleted for six months. Therefore, when the main Iranian attack, Operation Karbala 5 began, many Iraqi troops had gone on leave.

5 - 6 – 1 – 2 - Operation Karbala-5 (Second Battle of Basra)

Operation Karbala-5 began midnight 8 January 1987, when a strike force of 35,000 Pasdaran crossed Fish Lake, while 4 Iranian divisions attacked at the southern end shore of the lake, overrunning the Iraqi forces and capturing Duaiji, an irrigation canal. They used their bridgehead at Duaiji as a springboard to recapture the Iranian town ofShalamcheh. Between 9 – 10 January, the Iranians broke through the first and second defense lines of Basra at the north of Fish Lake with tanks . The Iranians rapidly reinforced their forces with 60,000 troops and began to clear the remaining Iraqis in the area .

As early as 9 January, the Iraqis began their counterattack, supported by newer Su - 25 and Mig - 29 aircraft, by the 10th the Iraqis were throwing every available heavy weapon in a bid to eject the Iranians. Despite being outnumbered 10–1 in the air, Iran's air defense system downed many Iraqi air craft (50–60 jets total ; 10 % of Iraq's air force) , allowing Iran to provideclose air support with their smaller air force, which also proved superior in dog - fighting, causing the Iraqis to temporarily stop providing their troops air support . Iraqi tanks floundered in the marshland and were defeated by Cobra helicopters and TOW missile - equipped anti - tank commandos. Later in the battle, after their ground forces taking heavy losses due to the lack of air support, the Iraqi aircraft came back to the battlefield once again, facing their Iranian counterparts.

However, despite superior Iranian infantry tactics, it was the sheer size of the Iraqi defensive lines that prevented the Iranians from achieving a victory. On 19–24 January, Iran launched another major infantry offensive, breaking the third line and driving the Iraqis across the Jasim river . The battle became a contest of which side could bring morereinforcements . By 29 January, the Iranians launched a new attack from the west of the Jasim river, breaking through the fourth line . They were within 12 km of the city. At this point, the battle became a stalemate. Iranian TV broadcast footage of the outskirts of Basra, but the Iranians pushed no further . Iranian losses were so severe that Iraq took the offensive and pushed them back to their original positions . Despite that, the fighting continued, and 30,000 Iranians still held positions around Fish Lake. The battle bogged down into a trench war, where neither side could displace the other. Iran launched several more unsuccessful attacks. Karbala-5 officially ended by the end of February, but heavy combat operations continued, and Iran continued to besiege the city.

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Among those killed was Iranian commander Hossein Kharrazi. Possibly 65,000 Iranians and 40,000 Iraqis were casualties because of Operation Karbala-5. Basra was largely destroyed, and Iraq's army had taken many material losses . The fighting during this operation was the heaviest and bloodiest during the war, with the area around Shalamcheh becoming known as the "Somme of the Iran-Iraq War" . At one point, the situation had declined to the point that Saddam ordered several of his officers to be executed . With Iranian aircraft fighting at Basra, the Iraqis bombed Iranian supply routes with chemical weapons, as well as Iranian cities with conventional bombs, including Tehran, Isfahan, and Qom. It is believed that around 3,000 Iranian civilians were killed in these attacks. Iran retaliated by firing eleven long-range missiles further into Iraqi territory, inflicting heavy casualties among civilians and killing at least 300.

5 - 6 – 1 – 3 - Operation Karbala - 6

At the same time as Operation Karbala 5, Iran also launched Operation Karbala-6 against the Iraqis in Qasr - e Shirin in central Iran to prevent the Iraqis from rapidly transferring units down to defend against the Karbala-5 attack. The attack was carried out by Basij infantry and the Revolutionary Guard's 31st *Ashura* and the Army's 77th *Khorasan* armored divisions. The Basij attacked the Iraqi lines, forcing the Iraqi infantry to retreat. An Iraqi armored counter-attack surrounded the Basij in a pincer movement, but the Iranian tank divisions attacked, breaking the encirclement. The Iranian attack was finally stopped by mass Iraqi chemical weapons attacks.

5 - 6 – 2 – Iran's increasing war - weariness

Operation Karbala-5 was a severe blow to Iran's military and morale. To foreign observers, it appeared that Iran was continuing to strengthen. By 1988, Iran had become self - sufficient in many areas, such as anti-tank TOW missiles, Scud ballistic missiles (Shahab-1), Silkworm anti-ship missiles,Oghab tactical rockets, and producing spare parts for their weaponry. Iran had also beefed up their air defenses with smuggled surface to air missiles . Iran even was producing UAV's and the Pilatus PC - 7 propellor aircraft for observation.[39] Iran also doubled their stocks of artillery, and was self-sufficient in manufacture of ammunition and small arms.

But, while it was not obvious to foreign observers, the Iranian public had become increasingly war - weary and disillusioned with the fighting, and relatively few volunteers joined the fight in 1987 – 88. Because the Iranian war effort relied on popular mobilization, their military strength actually declined, and Iran was unable to launch any major offensives after Karbala - 5. As a result, for the first time since 1982, the momentum of the fighting shifted towards the regular army. Since the regular army was conscription based, it made the war even less popular. Many Iranians began to try to escape the conflict. As early as May 1985, anti - war demonstrations took place in 74 cities throughout Iran; however, they were crushed by the regime, resulting in some protesters being shot and killed. By 1987,draft - dodging had become a serious problem, and the Revolutionary Guards and police set up roadblocks throughout cities to capture those who tried to evade conscription. However, other people (including the more nationalistic and religious) as well as the clergy, the Revolutionary Guards, and the regular army wanted to continue the war to achieve their goals. The issue of Iranian border territory in Iraqi hands still was a major motivating factor.

The leader ship acknowledged that the war was a stalemate, and began to plan accordingly. There were no more "final offensives" planned.[39] The head of the Supreme Defense Council Hashemi Rafsanjani announced during a news conference to finally end the use of human wave attacks. Mohsen Rezaee, head of the IRGC, announced that Iran would focus exclusively on limited attacks/infiltrations, while arming and supporting opposition groups inside of Iraq (such as the Kurds and Badr Brigade).

On the Iranian home front, the combination of sanctions, declining oil prices, and Iraqi attacks on Iranian oil facilities and shipping took a heavy toll on the economy. While the attacks themselves were not as destructive as some analysts believed, the US-led Operation Earnest Will (which protected Iraqi and allied oil tankers, but not Iranian ones) led many neutral countries to stop trading with Iran because of rising insurance and fear of air attack.[39][44][53] Iranian oil and non-oil exports fell by 55 %, inflation reached 50% by 1987, and the unemployment rate skyrocketed. At the same time, Iraq was experiencing crushing debt and shortages of workers, encouraging its leadership to try to end the war quicker.

5 - 6 – 2 – 1 - Strategic Situation in late 1987

By the end of 1987, Iraq possessed 5,550 tanks (outnumbering the Iranians five to one) and 900 fighter aircraft (outnumbering the Iranians ten to one) . However, after Operation Karbala - 5, Iraq only had 100 qualified fighter pilots remaining; therefore, Iraq began to invest in recruiting foreign pilots from countries such as Belgium, Australia, South Africa, both Eastand West Germany, and the Soviet Union. They replenished their manpower by integrating volunteers from other Arab countries into their army (for example, Iran eventually captured 3,000 Egyptian soldiers). Iraq also became self-sufficient in chemical weapons and some conventional ones and received much equipment from abroad . Foreign support helped Iraq bypass its economic troubles and massive debt to continue the war and increase the size of its military.

While the southern and central fronts were at a stalemate, Iran began to focus on carrying out offensives in northern Iraq with the help of the Peshmerga (Kurdish insurgents). The capture of Iraq's northern oil fields, and dams remained an important goal for Iran to force Iraq to negotiate, and with the help of the Peshmerga, there was a good chance it could succeed.[54] The Iranians used a combination of semi-guerrilla and infiltration tactics in the Kurdish mountains with the Peshmerga. During Operation Karbala - 9 in early April, Iran captured territory near Suleimaniya, provoking a severe poison gas counterattack. During Operation Karbala - 10, Iran attacked near the same area, capturing more territory. During Operation Nasr-4, the Iranians surrounded the city of Suleimaniya, and with the help of the Peshmerga infiltrated over 140 kilometers into Iraq and raided and threatened to capture the oil - rich city of Kirkuk and other northern oilfields . Nasr - 4 was considered to be Iran's most successful individual operation of the war. However, Iranian forces were unable to consolidate their gains and continue their advance, and while these offensives coupled with the Kurdish uprising sapped Iraqi strength, losses in the north would not mean a catastrophic failure for Iraq.

On 20 July, the UN Security Council passed the US - sponsored Resolution 598, which called for an end to the fighting and a return to pre-war boundaries. This resolution was noted by Iran for being the first resolution to call for a return to the pre-war borders, and setting up a commission to determine the aggressor and compensation. This was in contrast to previous settlements that only allowed a ceasefire (leaving Iraq in possession of disputed Iranian territories). The head of the IRGC, Mohsen Rezaee believed that it was a direct result of the capture of Al - Faw and Iran began to consider the ceasefire. While Iraq accepted the resolution, according to Iran's then foreign minister Ali Akbar Velayati, Iraq refused to set a timetable for withdrawing their troops from Iran, and thus Iran did not adopt the ceasefire yet, although they seriously considered it. The resolution was very ambiguous as well. Velayati stated that as a result, the western nations claimed that it was Iran that refused to accept peace.

5 - 6 – 2 – 2 - Air and Tanker War in 1987

With the stalemate on land, the air/tanker war began to play an increasingly major role in the conflict.

The Iranian air force had become very small, containing only 20 F-4 Phantoms, 20 F - 5 Tigers, and 15 F - 14 Tomcats in operation. Despite that, Iran managed to restore some damaged planes into service. The Iranian Air force, despite its once sophisticated equipment, lacked enough equipment and personnel to sustain the war of attrition that had arisen, and was unable to lead an outright onslaught against Iraq . The Iraqi Air Force, however, had originally lacked modern equipment and experienced pilots, but after pleas from Iraqi military leaders, Saddam decreased political influence on everyday operations and left the fighting to his combatants. In addition, the Soviets began delivering more advanced aircraft and weapons to Iraq, while the French improved training for flying crews and technical personnel and continually introduced new methods for countering Iranian weapons and tactics. However, at the same time, Iran's ground air defense downed many Iraqi aircraft.

The main Iraqi air effort had shifted to the destruction of Iranian war-fighting capability (primarily Persian Gulf oil fields, tankers, and Kharg Island) , and starting late 1986 the Iraqi Air Force moved on a comprehensive campaign against the Iranian economic infrastructure . By late 1987, the Iraqi Air Force could count on direct American support for conducting long - range operations against Iranian infrastructural targets and oil installations deep in the Persian Gulf. U.S. Navy ships actively tracked and reported movements of Iranian shipping and defences. They supplied targeting information on several occasions in February and March 1988; when they failed to warn Iraqi aircraft of Iranian interceptors' presence, the Iraqis suffered considerable losses. The massive Iraqi air strike against Kharg Island, flown on 18 March 1988, was one such occasion: the Iraqis destroyed two supertankers but lost five aircraft to Iranian F-14 Tomcats, including two Tupolev Tu - 22Bs and one Mikoyan MiG - 25RB . The U.S. Navy was now becoming more involved in the fight in the Persian Gulf, launching Operations Earnest Will and Prime Chance against the Iranians.

The attacks on oil tankers continued. Both Iran and Iraq carried frequent attacks during the first four months of the year. Iran was effectively waging a naval guerrilla war with its IRGC navy speedboats, while Iraq attacked with its aircraft. In 1987, Kuwait asked to reflag its tankers to the US flag. They did so in March, and the US navy began Operation Earnest Will to escort the tankers. The result of Earnest Will would be that while oil tankers shipping Iraqi/Kuwaiti oil were protected, Iranian tankers, and neutral tankers shipping to Iran would be unprotected, resulting in both losses for Iran and the undermining of its trade with foreign countries, damaging Iran's economy further. Iran also deployed Silkworm missiles to attack some ships, but only a few were actually fired. Both the US and Iran jockeyed for influence in the Gulf. To discourage the US from escorting tankers, Iran secretly mined some areas in the Gulf. The US began to escort the reflagged tankers, but one of them was destroyed by a mine while under escort. While being a public-relations victory for Iran, the US increased its reflagging efforts. While Iran mined the Persian Gulf, their speedboat attacks were reduced, primarily attacking unflagged tankers shipping in the area.

On 24 September, US Navy SEALS captured the Iranian mine-laying ship Iran Ajr, a diplomatic disaster for the already isolated Iranians. On 8 October, the US Navy destroyed four Iranian speedboats, and in response to Iranian Silkworm missile attacks on Kuwaiti oil tankers, launched Operation Nimble Archer, destroying two Iranian oil rigs in the Persian Gulf. During November and December, the Iraqi air force launched a bid to destroy all Iranian airbases in Khuzestan and the remaining Iranian air force. However, Iran managed to shoot down 30 Iraqi fighters with fighter jets, anti-aircraft guns, and missiles, allowing the Iranian air force to survive to the end of the war.

Bodies of Iranian students killed in an Iraqi bomber attack on a school inBorujerd, 10 January 1987.

On 28 June, Iraqi fighter bombers attacked the Iranian town of Sardasht near the border, using chemical mustard gasbombs. While many towns and cities had been bombed before, and troops attacked with gas, this was the first time that the Iraqis had attacked a civilian area with poison gas . One quarter of the town's then population of 20,000 was burned and stricken, and 113 were killed immediately, with many more dying and suffering health effects over the next decades.[125] Saddam ordered the attack in order to test the effects of the newly developed "dusty mustard" gas, which was designed to be even more crippling than traditional mustard gas. While little known outside of Iran (unlike the later Halabja chemical attack) , the Sardasht bombing (and future similar attacks) had a tremendous effect on the Iranian people's psyche.

5 - 6 – 3 – 1988 : Iraqi offensives and the UN ceasefire

By 1988, with massive equipment imports and reduced Iranian volunteers, Iraq was ready to launch major offensives against Iran.[71] On February 1988, Saddam began the fifth and most deadly "war of the cities". Over the next two months, Iraq launched over 200 al-Hussein missiles at 37 Iranian cities . Saddam also threatened to use chemical weapons in his missiles, which caused 30% of Tehran's population to leave the city . Iran retaliated, launching at least 104 missiles against Iraq in 1988 and shelling Basra. This event was nicknamed the "Scud Duel" in the foreign media. In all, Iraq launched 520 Scuds and al - Husseins against Iran and Iran fired 177 at them . However, the Iranian attacks were too few in number to deter Iraq from launching their attacks . Iraq also increased their airstrikes against Kharg Island and Iranian oil tankers. With their allies tankers protected by US war ships, they could operate with virtual impunity. To make matters worse, the West supplied Iraq's air force with laser-guided smart bombs, allowing them to attack economic targets while evading anti-aircraft defenses. These attacks began to have a major toll on the Iranian economy, morale, and caused many casualties as well.

5 - 6 – 3 – 1 - Iran's Kurdistan Operations

In March 1988, the Iranians carried out Operation Dawn 10, Operation *Beit - ol - Moqaddas* 2, and Operation *Zafar* 7 (Victory 7) in Iraqi Kurdistan with the aim of capturing theDarbandikhan Dam and the power plant at Lake Dukan, which supplied Iraq with much of its electricity and water, as well as the city of Suleimaniya. Iran hoped that the capture of these areas would bring more favorable terms to the ceasefire agreement . This infiltration offensive was carried out in conjunction with the Peshmerga. Iranian airborne commandos landed behind the Iraqi lines and Iranian helicopters hit Iraqi tanks with TOW missiles. The Iraqis were taken by surprise, and Iranian F - 5E Tiger fighter jets even damaged the Kirkuk oil refinery. Iraq carried out executions of multiple officers for these failures in March – April 1988, including Colonel Jafar Sadeq.[67] The Iranians used infiltration tactics in the Kurdish mountains, captured the town of Halabja and began to fan out across the province.

Though the Iranians advanced to within sight of Dukan, and captured around 1,040 km^2 and 4,000 Iraqi troops, the offensive failed due to the Iraqi use of chemical warfare. The Iraqis launched the deadliest chemical weapons attacks of the war. The Republican Guard launched 700 chemical shells, while the other artillery divisions launched 200 – 300 chemical shells each, unleashing a chemical cloud over the Iranians, killing or wounding 60 % of them, the blow was felt particurarly by the Iranian 84th infantry division and 55 th paratrooper division. The Iraqi special forces then stopped the remains of the Iranian force . In retaliation for Kurdish collaboration with the Iranians, Iraq launched a massive poison gas attack against Kurdish civilians in Halabja, recently taken by the Iranians, killing thousands of civilians.[139] Iran airlifted foreign journalists to the ruined city, and the images of the dead were shown throughout the world. However, Western mistrust of Iran and collaboration with Iraq led them to also blame Iran for the attack. At one point, the United States claimed that Iran had launched the attack and then tried to blame Iraq for it.

5 - 6 – 3 – 2 - Second Battle of al - Faw

On 17 April 1988, Iraq launched Operation Ramadan *Mubarak* (Blessed Ramadan) , a surprise attack against the 15,000 Basij troops on the peninsula . The attack on al-Faw was preceded by Iraqi diversionary attacks in northern Iraq, with a massive artillery and air barrage of Iranian front lines. Key areas, such as supply lines, command posts, and ammunition depots, were hit by a storm of mustard gas and nerve gas, as well as by conventional explosives. Helicopters landed Iraqi commandos behind Iranian lines while the main Iraqi force attacked in a frontal assault. Within 48 hours, all of the Iranian forces had been killed or cleared from the al-Faw Peninsula . The day was celebrated in Iraq as Faw Liberation Day throughout Saddam's rule. The Iraqis had planned the offensive well. Prior to the attack the Iraqi soldiers gave themselves poison gas antidotes to shield themselves from the effect of the saturation of gas. The heavy and well executed use of chemical weapons was the decisive factor in the Iraqi victory . Iraqi losses were relatively light, especially compared to Iran's casualties.[67] The Iranians eventually managed to halt the Iraqi drive as they pushed towards Khuzestan.

To the shock of the Iranians, rather than breaking off the offensive, the Iraqis kept up their drive, and a new force attacked the Iranian positions around Basra . Following this, the Iraqis launched a sustained drive to clear the Iranians out of all of southern Iraq.

One of the most successful Iraqi tactics was the "one - two punch" attack using chemical weapons. Using artillery, they would saturate the Iranian front line with rapidly dispersingcyanide and nerve gas, while longer - lasting mustard gas was launched via fighter - bombers and rockets against the Iranian rear, creating a "chemical wall" that blocked reinforcement.

5 - 6 – 3 – 3 - Operation Praying Mantis

The same day as Iraq's attack on al - Faw peninsula, the United States Navy launched Operation Praying Mantis in retaliation against Iran for damaging a warship with a mine . Iran lost oil platforms, destroyers , and frigates in this battle, which ended only when President Reagan decided that the Iranian navy had been put down enough. In spite of this, the Revolutionary Guard's navy continued their speedboat attacks against oil tankers . However, the combined defeats at al - Faw and in the Persian Gulf nudged Iranian leadership towards quitting the war, especially when facing the prospect of fighting the Americans.

5 - 6 – 3 – 4 - Iranian counteroffensive

Faced with such losses, Khomeini appointed the cleric Hashemi Rafsanjani as the Supreme Commander of the Armed Forces, though he had in actuality occupied that position for months.[135] Rafsanjani ordered a surprise counter - attack into Iraq, which was launched 13 June 1988. The Iranians infiltrated through the Iraqi trenches and moved 10 km into Iraq, and managed to strike Saddam's presidential palace in Baghdad using fighter aircraft . After 10 hours of fighting, the decimated Iranians were driven back to their original positions again as the Iraqis launched 650 helicopter and 300 aircraft sorties.

5 - 6 – 3 – 5 - Operation Forty Stars

On 18 June, Iraq launched Operation Forty Stars (چل چراغ *chehel cheragh*) in conjunction to the Mujahideen – e - Khalq (MEK) around Mehran. With 530 aircraft sorties and heavy use of nerve gas, they crushed the Iranian forces in the area, killing 3,500 , and nearly destroying a Revolutionary Guard division . Mehran was captured once again and occupied by the MEK. Iraq also launched air raids on Iranian population centers and economic targets, setting 10 oil installations on fire.

5 - 6 – 3 – 6 - Tawakalna ala Allah Operations

On 25 May 1988, Iraq launched the first of four *Tawakalna ala Allah* (Trust in God) Operations , consisting of one of the largest artillery barrages in history , coupled with chemical weapons. The marshes had been dried by drought, allowing the Iraqis to use tanks to bypass Iranian field fortifications, expelling the Iranians from the border town ofShalamcheh after less than 10 hours of combat.

On 25 June, Iraq launched the second Tawakal ala Allah operation against the Iranians on Majnoon Island. Iraqi commandos used amphibious craft to block the Iranian rear , then used hundreds of tanks with heavy conventional and chemical artillery barrages to recapture the island after 8 hours of combat . Saddam appeared live on Iraqi television to "lead" the charge against the Iranians . The majority of the Iranian defenders were killed during the quick assault. The final two Tawakal ala Allah operations took place near al-Amarah and Khaneqan . By 12 July, the Iraqis had captured the city of Dehloran, 40 km inside Iran, along with 2,500 troops and much armour and material, which took four days to transport to Iraq. These losses included more than 570 of the 1,000 remaining Iranian tanks, over 430 armored vehicles, 45 self - propelled artillery, 620 towed artillery and antiaircraft guns . The Iraqis withdrew from Dehloran soon after, claiming that they had "no desire to conquer Iranian territory ". Historian Kaveh Farrokh considered this to be Iran's greatest military disaster during the war. Pelletier notes that “Tawakal ala Allah … resulted in the absolute destruction of Iran’s military machine.”

During the 1988 battles, the Iranians put up little resistance to the Iraqi offensives, having been worn out by nearly eight years of war . They lost large amounts of equipment; however, they managed to rescue most of their troops from being captured by the Iraqis, leaving Iraq with relatively few prisoners . On 2 July, Iran belatedly set up a joint central command which unified the Revolutionary Guard, Army, and Kurdish rebels, and dispelled the rivalry between the Army and the Revolutionary Guard. However, this came too late, and Iran was believed to have fewer than 200 remaining tanks on the southern front, faced against thousands of Iraqi ones . The only area where the Iranians were not suffering major defeats was in Kurdistan.

5 - 6 – 3 – 7 - Iran accepts the ceasefire

Saddam sent a warning to Khomeini in mid - 1988, threatening to launch a full - scale invasion and attack Iranian cities with weapons of mass destruction. Shortly afterwards, Iraqi aircraft bombed the Iranian town of Oshnavieh with poison gas, immediately killing and wounding over 2,000 civilians. The fear of an all out chemical attack against Iran's largely unprotected civilian population weighed heavily on the Iranian leader ship, and they realized that theinternational community had no intention of restraining Iraq . The lives of the civilian population of Iran were becoming very disrupted, with a third of the urban population evacuating major cities in fear of the seemingly imminent chemical war. Meanwhile, Iraqi conventional bombs and missiles continuously hit towns and cities as well as destroyed vital civilian and military infrastructure, and the death toll increased. Iran did reply with missile and air attacks as well, but not enough to deter the Iraqis from attacking.

Under the threat of a new and even more powerful invasion, Commander - in - Chief Akbar Rafsanjani ordered the Iranians to retreat from Haj Omran, Kurdistan on 14 July. The Iranians did not publicly describe this as a retreat, instead called it a "temporary withdrawal" . By July, Iran's army inside Iraq (except Kurdistan) had largely disintegrated . Iraq put up a massive display of captured Iranian weapons in Baghdad, claiming they "captured" 1,298 tanks, 5,550 recoil - less rifles, and thousands of other weapons . However, Iraq had taken heavy losses as well, and the battles were very costly.

On July 1988, Iraqi aeroplanes dropped cyanide bombs on the Iranian Kurdish village of Zardan (as they had done four months earlier on their own Kurdish village of Halabja) . Dozens of villages, and some larger towns, such as Marivan, were attacked with poison gas, resulting in even heavier civilian casualties . About the same time, the USS *Vincennes* shot down Iran Air Flight 655, killing 290 passengers. The lack of international sympathy disturbed the Iranian leadership, and they came to the conclusion that the United States was on the verge of waging a full-scale war against them, and that Iraq was on the verge of unleashing its entire chemical arsenal upon their major cities.

At this point, elements of the Iranian leadership, led by Ali Akbar Hashemi Rafsanjani (who had pushed for the war initially), persuaded Khomeini to accept the UN ceasefire . They stated that in order to win the war, Iran's military budget would have to be increased by 700 % and the war would last until 1993 . Many officials also pointed out to Khomeini that while Resolution 598 would not give all of the gains that Iran wanted, it was better than anything else that had been proposed before, and likely would be proposed afterward, considering that it provided a return to the pre - war status quo, rather than having Iraq occupy Iranian border areas like previous agreements. While many parts were ambiguous, it could be negotiated with Iraq.

On 20 July 1988, Iran accepted Resolution 598, showing its willingness to accept a ceasefire . A statement from Khomeini was read out in a radio address, and he expressed deep displeasure and reluctance about accepting the ceasefire:

Happy are those who have departed through martyrdom. Happy are those who have lost their lives in this convoy of light. Unhappy am I that I still survive and have drunk the poisoned chalice...

The news of the end of the war was greeted with celebration in Baghdad, with people dancing in the streets; in Tehran, however, the end of the war was greeted with a somber mood.
Kurdish civilians fleeing the Al - Anfal Campaign are airlifted to Iran

5 - 6 – 4 – Operation Mersad and end of the war

Operation *Mersad* (مرصاد "ambush") was the last major military operation of the war. Both Iran and Iraq had accepted Resolution 598. But despite the ceasefire, after seeing Iraqi victories in the previous months, MEK decided to launch an attack of its own and wished to advance all the way to Teheran. Saddam and the Iraqi high command decided on a two pronged offensive across the border: central Iran, and Iranian Kurdistan . Shortly after Iran accepted the ceasefire the MEK army began its offensive, attacking into Ilam province under cover of Iraqi air power.

In the north, Iraq also launched an attack into Iraqi Kurdistan, which was blunted by the Iranians.

On 26 July 1988, the Mujahadeen – e - Khalq (MEK) , with the support of the Iraqi army, started their campaign, Operation *Forough Javidan* (Eternal Light) in central Iran. The MEK supported by Iraq attacked western Iran, advancing towards Kermanshah. The Iranians had withdrawn their remaining soldiers to Khuzestan in fear of a new Iraqi invasion attempt, and as a result the Mujahedeen advanced rapidly, seizing Qasr - e Shirin, Sarpol - e Zahab , Kerend - e Gharb, and Islamabad - e - Gharb, and towards Kermanshah. The MEK expected the Iranian population to rise up and support their advance; however, the uprising never materialised, but they reached 145 km (90 mi) deep into Iran. In response, the Iranian military launched its counter-attack, Operation Mersad, under Lieutenant General Ali Sayyad Shirazi. Iranian paratroopers landed behind the MEK lines while the Iranian Air Force and helicopters launched an air attack, destroying much of the enemy columns . The Iranians defeated the MEK in the city of Kerend-e Gharb on 29 July 1988 . On 31 July, Iran drove the MEK out of Qasr-e-Shirin and Sarpol Zahab, though MEK claimed to have "voluntarily withdrawn" from the towns . Iran estimated that 4,500 MEK were killed, while 400 Iranian soldiers died.

MEK Soldiers killed in Operation Mersad in 1988

The last notable combat actions of the war took place on 3 August 1988, in the Persian Gulf when the Iranian navy fired on a freighter and Iraq launched chemical attacks on Iranian civilians, killing an unknown number of them and wounding 2,300.

Iraq came under heavy international pressure to end the war. Resolution 598 became effective on 8 August 1988, ending all combat operations between the two countries. By 20 August 1988, peace with Iran was restored . UN peace keepersbelonging to the UNIIMOG mission took the field, remaining on the Iran – Iraq border until 1991. The majority of Western analysts believe that the war had no winners while some believed that Iraq emerged as the victor of the war, based on Iraq's overwhelming successes between April and July 1988 . While the war was now over, Iraq spent the rest of August and early September clearing the Kurdish resistance. Using 60,000 troops along with helicopter gunships, chemical weapons (poison gas), and mass executions, Iraq hit 15 villages, killing rebels and civilians, and forced tens of thousands of Kurds to relocate tosettlements.[135] Many Kurdish civilians immigrated to Iran. By 3 September 1988, the anti-Kurd campaign ended, and all resistance had been crushed . 400 Iraqi soldiers and 50,000 Kurdish civilians and soldiers had been killed.

6 – After math

The Iran – Iraq War was the deadliest conventional war ever fought between regular armies of developing countries . Iraqi casualties are estimated at 105,000 – 200,000 killed , while about 400,000 had been wounded and some 70,000 taken prisoner . Thousands of civilians on both sides died in air raids and ballistic missile attacks . Prisoners taken by both countries began to be released in 1990, though some were not released until more than 10 years after the end of the conflict . Cities on both sides had also been considerably damaged. While revolutionary Iran had been bloodied, Iraq was left with a large military and was a regional power, albeit with severe debt, financial problems, and labor shortages.

According to Iranian government sources, the war cost Iran an estimated 200,000 – 220,000 killed , or up to 262,000 according to the conservative Western estimates . This includes 123,220 combatants , 60,711MIA and 11,000 - 16,000 civilians . Combatants include 79,664 members of the Revolutionary Guard Corps and additional

35,170 soldiers from regular military . In addition, prisoners of war comprise 42,875 Iranian casualties, they were captured and kept in Iraqi detention centers from 2.5 to more than 15 years after the war was over . According to the Janbazan Affairs Organization, 398,587 Iranians sustained injuries that required prolonged medical and health care following primary treatment, including 52,195 (13 %) injured due to the exposure to chemical warfare agents . From 1980 to 2012, 218,867 Iranians died due to war injuries and mean age of combatants was 23 years old . This includes 33,430 civilians, mostly women and children . More than 144,000 Iranian children were orphaned as a consequence of these deaths . Other estimates put Iranian casualties up to 600,000.

Both Iraq and Iran manipulated loss figures to suit their purposes. At the same time, Western analysts accepted improbable estimates . By April 1988, such casualties were estimated at between 150,000 to 340,000 Iraqis dead, and 450,000 to 730,000 Iranians . Shortly after the end of the war, it was thought that Iran suffered even more than a million dead . Considering the style of fighting on the ground and the fact that neither side penetrated deeply into the other's territory, USMC analysts believe events do not substantiate the high casualties claimed.[150] Iraqi government has claimed 800,000 Iranians were killed in conflict, four times more than Iranian official figures . Iraqi losses were also revised downwards over time.

6 – 1 - Peace Talks and Postwar Situation

With the ceasefire in place, and UN peacekeepers monitoring the border, Iran and Iraq sent their representatives to Geneva, Switzerland, to negotiate a peace agreement on the terms of the ceasefire. However, peace talks stalled. Iraq, in violation of the UN ceasefire, refused to withdraw its troops from 3,000 square miles of Iranian territory unless the Iranians accepted Iraq's full sovereignty over the Shatt al-Arab waterway (as Iran had feared in 1982) . Foreign powers continued to support Iraq, which wanted to gain at the negotiating table what they failed to achieve on the battlefield, and Iran was portrayed as the one who was not wanting peace . Iran, in response, refused to release 70,000 Iraqi prisoners of war (twice as many compared to Iranian prisoners of war in Iraq). They also continued to carry out a naval blockade of Iraq, although its effects were mitigated by Iraqi trade with its Arab neighbors. Iran also began to improve relations with many of the states that opposed it during the war. Because of Iranian actions, by 1990, Saddam had become more conciliatory, and in a letter to the now President Rafsanjani, he became more open to the idea of a peace agreement, although he still insisted on full sovereignty over the Shatt al - Arab.

By 1990, Iran was undergoing military rearmament and reorganization, purchasing from the USSR and China $10 billion worth of heavy weaponry, including aircraft, tanks, and missiles. Rafsanjani reversed Iran's self - imposed ban on chemical weapons, and ordered the manufacture and stockpile of them (in 1993, Iran ratified the Chemical Weapons Convention, and subsequently destroyed them) . Saddam realized that if Iran attempted to expel the Iraqis from their territory, it was likely they would succeed . As war with the western powers loomed , Iraq became concerned about Iran mending their relations with the west in order to attack Iraq. Iraq had lost their support from the West, and their position in Iran was increasingly untenable . Shortly after his invasion of Kuwait, Saddam wrote a letter to Rafsanjani stating that Iraq recognised Iranian rights over the eastern half of the Shatt al-Arab, a reversion to the *status quo ante bellum* that he had repudiated a decade earlier,[153] and that he would accept Iran's demands and withdraw Iraq's military from the disputed territories at the border. A peace agreement was signed finalizing the terms of the UN resolution, diplomatic relations was restored, and by late 1990 - early 1991, the Iraqi military withdrew from the disputed territories. The UN peacekeepers withdrew from the border shortly afterward. Most of the prisoners of war were released in 1990, although some remained as late as 2003. Iranian politicians declared it to be the "greatest victory in the history of the Islamic Republic of Iran".

Most historians and analysts consider the war to be a stalemate. Certain analysts believe that Iraq won, on the basis of the success of their 1988 offensives which thwarted Iran's major territorial ambitions in Iraq and persuaded Iran to accept the ceasefire . Iranian analysts believe that they won the war because although they did not succeed in defeating Iraq militarily, they did manage to gain their political goals of driving Iraq entirely from their territory (which was an important purpose of the post 1982 invasion of Iraq, to force the Iraqis to negotiate a withdrawal from Iran's border areas) . They also cite the fact that Iran achieved its goals against Iraq's superior military, they thwarted Iraq's major territorial ambitions in Iran, and that, 2 years after the war had ended, Iraq permanently gave up its claims to the Shatt al-Arab as well.

On 9 December 1991, Javier Pérez de Cuéllar, UN Secretary General at the time, reported that Iraq's initiation of the war was unjustified, as was its occupation of Iranian territory and use of chemical weapons against civilians :

That [Iraq's] explanations do not appear sufficient or acceptable to the international community is a fact...[the attack] cannot be justified under the charter of the United Nations, any recognized rules and principles of international law, or any principles of international morality, and entails the responsibility for conflict. Even if before the outbreak of the conflict there had been some encroachment by Iran on Iraqi territory, such encroachment did not justify Iraq's aggression against Iran — which was followed by Iraq's continuous occupation of Iranian territory during the conflict — in violation of the prohibition of the use of force, which is regarded as one of the rules of jus cogens...On one occasion I had to note with deep regret the experts' conclusion that "chemical weapons ha[d] been used against Iranian civilians in an area adjacent to an urban center lacking any protection against that kind of attack".

He also stated that had the UN accepted this fact earlier, the war would have almost certainly not lasted as long as it did. Iran, encouraged by the announcement, sought reparations from Iraq, but never received any.

United Nations observers on the Iran–Iraq border,
inspecting Iraqi chemical shells

Throughout the 1990s and early 2000s, Iran and Iraq relations remained at a limbo between a cold war and a cold peace. Despite renewed and somewhat thawed relations, both sides continued to have low level conflicts with each other. Iraq continued to host and support the Mujahedeen – e – Khalq , which carried out multiple attacks throughout Iran up until the 2003 invasion of Iraq (including theassassination of Iranian general Ali Sayyad Shiraziin 1998, cross border raids, and mortar attacks). Iran carried out several airstrikes and missile attacks against Mujahedeen targets inside of Iraq (the largest taking place in 2001, when Iran fired 56 Scud missiles at Mujahedeen targets) . In addition, according to General Hamdani, Iran continued to carry out low-level infiltrations of Iraqi territory, using Iraqi dissidents and anti - government activists rather than Iranian troops, in order to incite revolts. After the fall of Saddam in 2003, Hamdani claimed that Iranian agents infiltrated and created numerous militias in Iraq and built an intelligence system operating within the country.

In 2005, the new government of Iraq apologised to Iran for starting the war.[156] The Iraqi government also commemorated the war with various monuments, including the Hands of Victory and the al - Shaheed Monument, both in Baghdad. The war also helped to create a forerunner for the Coalition of the Gulf War, when the Gulf Arab states banded together early in the war to form the Gulf Cooperation Council to help Iraq fight Iran .

With the 2003 invasion of Iraq and Iran's involvement in Iraq's new government and backing of proxy militias, many observers believe that Iran has effectively gained influence over Iraq .

6 – 2 - Financial situation

The financial loss at the time was believed to exceed US $ 500 billion for each country ($ 1.2 trillion total) . In addition, economic development stalled and oil exports were disrupted. Iran, having used bloodier but economically cheaper tactics during the war, only incurred a small debt, in contrast to the large ones incurred by Iraq. Iraq had accrued more than $ 130 billion of international debt, excluding interest, and was also weighed down by a slowed GDP growth. Iraq's debt to Paris Club amounted to $21 billion, 85% of which had originated from the combined inputs of Japan, the USSR, France, Germany, the United States, Italy and the United Kingdom. The largest portion of Iraq's debt, amounting to $130 billion, was to its former Arab backers, with $67 billion loaned by Kuwait, Saudi Arabia, Qatar, UAE, and Jordan.[159] After the war, Iraq accused Kuwait of slant drilling and stealing oil, inciting its invasion of Kuwait, which in turn worsened Iraq's financial situation: the United Nations Compensation Commission mandated Iraq to pay reparations of more than $200 billion to victims of the invasion, including Kuwait and the United States. To enforce payment Iraq was put under a complete international embargo, which put further strain on the Iraqi economy and pushed its external debt and international liabilities to private and public sectors to more than $500 billion by the end of Saddam's rule. Combined with Iraq's negative economic growth after prolonged international sanctions, this produced a debt-to-GDP ratio of more than 1,000%, making Iraq the most indebted developing country in the world. The unsustainable economic situation compelled the new Iraqi government to request that a considerable portion of debt incurred during the Iran – Iraq war be written off . Consequently the effects of the Iran – Iraq War led to the Iraqi invasion of Kuwait and the subsequent Persian Gulf War two years later.

Much of the oil industry in both countries was damaged in air raids. 10 million shells had landed in Iraq's oil fields at Basra, seriously damaging their oil production. Iran's production capacity has yet to fully recover from the damages of the war.

6 – 3 - Science and technology

The war had a marked effect on the scientific and technological advancement of the involved countries: Iraq's productivity in the field collapsed and has not yet recovered , and Kuwait's scientific output was initially slowed and later became stagnant .

The war had its impact on medical science: a surgical intervention for comatose patients with penetrating brain injuries was created by Iranian physicians treating wounded soldiers, later establishing neurosurgery guidelines to treat civilians who had suffered blunt or penetrating skull injuries . Iranian physicians' experience in the war reportedly helped U.S. congress woman Gabrielle Giffords recover after the 2011 Tucson shooting .

In addition to helping trigger the Persian Gulf War, the Iran–Iraq War also contributed to Iraq's defeat in the Persian Gulf War. Iraq's military was accustomed to fighting the slow moving Iranian infantry formations with artillery and static defenses, while using mostly unsophisticated tanks to gun down and shell the infantry and overwhelm the smaller Iranian tank force; in addition to being dependent on weapons of mass destruction to help secure victories. Therefore, they were rapidly overwhelmed by the high - tech, quick-maneuvering US forces using modern doctrines such as AirLand Battle.

7 - Home front

7 – 1 – Iraq

At first, Saddam attempted to ensure that the Iraqi population suffered from the war as little as possible. There was rationing, but civilian projects begun before the war continued . At the same time, the already extensive personality cult around Saddam reached new heights of adulation while the regime tightened its control over the military.

After the Iranian victories of the spring of 1982 and the Syrian closure of Iraq's main pipeline, Saddam did a volte-face on his policy towards the home front: a policy of austerity and total war was introduced, with the entire population being mobilised for the war effort . All Iraqis were ordered to donate blood and around 100,000 Iraqi civilians were ordered to clear the reeds in the southern marshes. Mass demonstrations of loyalty towards Saddam became more common . Saddam also began implementing a policy of discrimination against Iraqis of Iranian origin.

In the summer of 1982, Saddam began a campaign of terror. More than 300 Iraqi Army officers were executed for their failures on the battlefield . In 1983, a major crackdown was launched on the leadership of the Shia community. Ninety members of the al-Hakim family, an influential family of Shia clerics whose leading members were the émigrés Mohammad Baqir al - Hakim and Abdul Aziz al-Hakim, were arrested, and 6 were hanged . The crack down on Kurds saw 8,000 members of the Barzani clan, whose leader (Massoud Barzani) also led the Kurdistan Democratic Party, summarily executed . From 1983 onwards, a campaign of increasingly brutal repression was started against the Iraqi Kurds, characterised by Israeli historian Efraim Karsh as having "assumed genocidal proportions" by 1988. The al - Anfal Campaign was intended to "pacify" Iraqi Kurdistan permanently.

7 – 1 – 1 - Gaining civilian support

To secure the loyalty of the Shia population, Saddam allowed more Shias into the Ba'ath Party and the government, and improved Shia living standards, which had been lower than those of the Iraqi Sunnis . Saddam had the state pay for restoring Imam Ali's tomb with white marble imported from Italy. The Baathists also increased their policies of repression against the Shia. The most infamous event was the massacre of 148 civilians of the Shia town of Dujail .

Despite the costs of the war, the Iraqi regime made generous contributions to Shia *waqf* (religious endowments) as part of the price of buying Iraqi Shia support . The importance of winning Shia support was such that welfare services in Shia areas were expanded during a time in which the Iraqi regime was pursuing austerity in all other non-military fields . During the first years of the war in the early

1980s, the Iraqi government tried to accommodate the Kurds in order to focus on the war against Iran. In 1983, thePatriotic Union of Kurdistan agreed to cooperate with Baghdad, but the Kurdish Democratic Party (KDP) remained opposed . In 1983, Saddam signed an autonomy agreement withJalal Talabani of the Patriotic Union of Kurdistan (PUK), though Saddam later reneged on the agreement . By 1985, the PUK and KDP had joined forces, and Iraqi Kurdistan saw widespread guerrilla warfare up to the end of the war.

7 – 2 – Iran

The Iranian government saw the outbreak of war as chance to strengthen its position and consolidate the Islamic revolution: the war was presented to the Iranian people as a glorious *jihad* and a test of Iranian national character . The Iranian regime followed a policy of total war from the beginning, and attempted to mobilise the nation as a whole . They established a group known as the Reconstruction Campaign, whose members were exempted from conscription and were instead sent into the countryside to work on farms to replace the men serving at the front.

Iranian workers had a day's pay deducted from their pay cheques every month to help finance the war, and mass campaigns were launched to encourage the public to donate food, money, and blood for the soldiers . To further help finance the war, the Iranian government banned the import of all non - essential items, and launched a major effort to rebuild the damaged oil plants .

7 – 2 - 1 - Civil unrest

In June 1981, street battles broke out between the Revolutionary Guard and the left-wing Mujaheddin e - Khalq (MEK), continuing for several days and killing hundreds on both sides . In September, more unrest broke out on the streets of Iran as the MEK attempted to seize power. Thousands of left - wing Iranians (many of whom were not associated with the MEK) were shot and hanged by the government in the aftermath . The MEK began an assassination campaign that killed hundreds of regime officials by the fall of 1981 . On 28 June 1981, they assassinated the secretary-general of the Islamic Republican Party, Mohammad Beheshti and on 30 August, killed

Iran's president , Mohammad-Ali Rajai . The government responded with mass executions of suspected MEK members, a practice that lasted until 1985.

In addition to the open civil conflict with the MEK, the Iranian government was faced with Iraqi - supported rebellions in Iranian Kurdistan, which were gradually put down through a campaign of systematic repression . 1985 also saw student anti - war demonstrations, which were crushed by government activists.

7 – 2 – 2 - Economy

The war furthered the decline of the Iranian economy that had begun with the revolution in 1978 – 79. Between 1979 and 1981, foreign exchange reserves fell from US $ 14.6 billion to $ 1 billion. As a result of the war, living standards dropped dramatically, and Iran was described by British journalists John Bulloch and Harvey Morris as "a dour and joyless place" ruled by a harsh regime that "seemed to have nothing to offer but endless war " . Though Iran was becoming bankrupt, Khomeini interpreted Islam's prohibition of usury to mean they could not borrow against future oil revenues to meet war expenses. As a result, Iran funded the war by the income from oil exports after cash had run out. The revenue from oil dropped from $20 billion in 1982 to $ 5 billion in 1988.

In January 1985, former prime minister and anti-war Islamic Liberation Movement Mehdi Bazargan criticised the war in a telegram to the United Nations, calling it un - Islamic and illegitimate and arguing that Khomeini should have accepted Saddam's truce offer in 1982 instead of attempting to over throw the Ba'ath. He added, "Since 1986, you have not stopped proclaiming victory, and now you are calling upon population to resist until victory. Is that not an admission of failure on your part?" Khomeini was annoyed by Bazargan's telegram, and issued a lengthy public rebuttal in which he defended the war as both Islamic and just.

By 1987, Iranian morale had begun to crumble, reflected in the failure of government campaigns to recruit "martyrs" for the front . Israeli historian Efraim Karsh points to the decline in morale in 1987–

88 as being a major factor in Iran's decision to accept the ceasefire of 1988.

Not all saw the war in negative terms. The Islamic Revolution of Iran was strengthened and radicalised . The Iranian government-owned *Etelaat* newspaper wrote, "There is not a single school or town that is excluded from the happiness of 'holy defence' of the nation, from drinking the exquisite elixir of martyrdom, or from the sweet death of the martyr, who dies in order to live forever in paradise." ·

8 - Comparison of Iraqi and Iranian military strength

At the beginning of the war, Iraq held a clear advantage in armour, while both nations were roughly equal in terms of artillery. The gap only widened as the war went on. Iran started with a stronger air force, but over time, the balance of power reversed in Iraq's favour. Estimates for 1980 and 1987 were :

Imbalance of Power (1980 – 1987)	Iraq	Iran
Tanks in 1980	2700	1740
Tanks in 1987	4500+	1000
Fighter aircraft in 1980	332	445
Fighter aircraft in 1987	500 +	65 (serviceable)
Helicopters in 1980	40	500
Helicopters in 1987	150	60
Artillery in 1980	1000	1000 +
Artillery in 1987	4000 +	1000 +

9 - Foreign support to Iraq and Iran

Donald Rumsfeld as the American special envoy to the Middle East meets Saddam in December 1983. Rumsfeld would later become U.S. Defense Secretary during the 2003 Iraq War, which saw Saddam ousted from power and ultimately executed.

During the war, Iraq was regarded by the West and the Soviet Union as a counterbalance to post-revolutionary Iran . The Soviet Union, Iraq's main arms supplier during the war, did not wish for the end of its alliance with Iraq, and was alarmed by Saddam's threats to find new arms suppliers in the West and China if the Kremlin did not provide him with the weapons he wanted . The Soviet Union hoped to use the threat of reducing arms supplies to Iraq as leverage for forming a Soviet-Iranian alliance.

During the early years of the war, the United States lacked meaningful relations with either Iran or Iraq, the former due to the Iranian Revolution and the Iran hostage crisis and the latter because of Iraq's alliance with the Soviet Union and hostility towards Israel. Following Iran's success of repelling the Iraqi invasion and Khomeini's refusal to end the war in 1982 , the U.S. made an outreach to Iraq, beginning with the restoration of diplomatic relations in 1984. The United States wished to both keep Iran away from Soviet influence and protect other Gulf states from any threat of Iranian expansion. As a result, it began to provide limited support to Iraq. In 1982 , Henry Kissinger, former Secretary of State, outlined U.S. policy towards Iran :

The focus of Iranian pressure at this moment is Iraq. There are few governments in the world less deserving of our support and less capable of using it. Had Iraq won the war, the fear in the Gulf and the threat to our interest would be scarcely less than it is today. Still, given the importance of the balance of power in the area, it is in our interests to promote a ceasefire in that conflict; through not a cost that will preclude an eventual rapprochement with Iran either if a more moderate regime replaces Khomenini's or if the present rulers wake up to geopolitical reality that the historic threat to Iran's independence has always come from the country with which it shares a border of 2,400 km : the Soviet Union. A rapprochement with Iran, of course, must await at a minimum Iran's abandonment of hegemonic aspirations in the Gulf.

Richard Murphy, Assistant Secretary of State during the war, testified to Congress in 1984 that the Reagan administration believed a victory for either Iran or Iraq was "neither militarily feasible nor strategically desirable " .

Support to Iraq was given via technological aid, intelligence, the sale of chemical and biological warfare technology and military equipment, and satellite intelligence. While there was direct combat between Iran and the United States, it is not universally agreed that the fighting between the U.S. and Iran was specifically to benefit Iraq, or for separate issues between the U.S. and Iran. American official ambiguity towards which side to support was summed up by Henry Kissinger when he remarked, "It's a pity they both can't lose."[170] The Americans and the British also either blocked or watered down UN resolutions that condemned Iraq for using chemical weapons against the Iranians and their own Kurdish citizens.

More than 30 countries provided support to Iraq, Iran, or both; most of the aid went to Iraq. Iran had a complex clandestine procurement network to obtain munitions and critical materials. Iraq had an even larger clandestine purchasing network, involving 10–12 allied countries, to maintain ambiguity over their arms purchases and to circumvent "official restrictions". Arab mercenaries and volunteers from Egypt[171] and Jordan formed theYarmouk Brigade[172] and participated in the war alongside Iraqis.

9 – 1 – Iraq

According to the Stockholm International Peace Institute, the Soviet Union , France , and China together accounted for over 90% of the value of Iraq's arms imports between 1980 and 1988.

The United States pursued policies in favour of Iraq by reopening diplomatic channels, lifting restrictions on the export of dual - use technology, overseeing the transfer of third - party military hardware, and providing operational intelligence on the battlefield. France, which from the 1970s onward had been one of Iraq's closest allies, was a major supplier of military hardware to Iraq . French sold weapons equal to the sum of US $ 5 billion, which comprised well over a quarter of Iraq's total arms stockpile . China, which had no direct stake in the victory of either side and whose interests in the war were entirely commercial, freely sold arms to both sides.

Iraq also made extensive use of front companies, middlemen, secret ownership of all or part of companies all over the world, forged end - user certificates, and other methods to hide what it was acquiring . Some transactions may have involved people, shipping, and manufacturing in as many as 10 countries . Support from Great Britain exemplified the methods by which Iraq would circumvent export controls. Iraq bought at least one British company with operations in the United Kingdom and the United States, and had a complex relationship with France and the Soviet Union, its major suppliers of actual weapons.

The United Nations Security Council initially called for a cease-fire after a week of fighting while Iraq was occupying Iranian territory, and renewed the call on later occasions. However, the UN did not come to Iran's aid to repel the Iraqi invasion, and the Iranians thus interpreted the UN as subtly biased in favour of Iraq .

9 – 1 – 1- Financial support

Iraq's main financial backers were the oil - rich Persian Gulf states , most notably Saudi Arabia ($ 30.9 billion) , Kuwait ($ 8.2 billion), and the United Arab Emirates ($ 8 billion) . In all, Iraq received $ 35 billion in loans from the West and between $ 30 and $ 40 billion from the Persian Gulf states during the 1980s.

The Iraqgate scandal revealed that a branch of Italy's largest bank, Banca Nazionale del Lavoro (BNL) , in Atlanta , Georgia, US relied partially on U.S. taxpayer-guaranteed loans to funnel $5 billion to Iraq from 1985 to 1989. In August 1989, when FBI agents raided the Atlanta branch of BNL, branch manager Christopher Drogoul was charged with making unauthorised, clandestine, and illegal loans to

Iraq – some of which , according to his indictment, were used to purchase arms and weapons technology.

According to the *Financial Times*, the companies involved in the scandal by shipping militarily useful technology to Iraq were Hewlett-Packard, Tektronix and Matrix Churchill's branch in Ohio, US.

9 – 2 – Iran

While the United States directly fought Iran, citing freedom of navigation as a major *casus belli*, it also indirectly supplied some weapons to Iran as part of a complex and illegal programme that became known as the Iran - Contra affair. These secret sales were partly to help secure the release of hostages held in Lebanon, and partly to make money to help theContras rebel group in Nicaragua. This arms for hostages agreement turned into a major scandal.

North Korea was a major arms supplier to Iran, often acting as a third party in arms deals between Iran and the Communist bloc. Support included domestically manufactured arms and Eastern-Bloc weapons, for which the major powers wanted deniability. Other arms suppliers and supporters of Iran included Libya and China.

9 – 3 - Both countries

Besides the United States and the Soviet Union, Yugoslavia also sold weapons to both countries for the entire duration of the conflict. Likewise, Portugal helped both countries ; it was not unusual to see Iranian and Iraqi flagged ships moored side – by - side at the Port of Sines.

From 1980 to 1987 Spain sold € 458 million in weapons to Iran and € 172 million in weapons to Iraq. Weapons sold to Iraq included 4 x 4 vehicles , BO - 105 helicopters , explosives, and ammunition. A research party later discovered that an unexploded chemical Iraqi war head in Iran was manufactured in Spain.

Although neither side acquired any weapons from Turkey, both sides enjoyed Turkish civilian trade during the conflict, although the Turkish government remained neutral and refused to support the trade embargo imposed by the U.S. on Iran. Turkey's export market jumped from $220 million in 1981 to $ 2 billion in 1985 , making up 25 % of Turkey's overall exports. Turkish construction projects in Iraq totaled $ 2.5 billion between 1974 and 1990. Trading with both countries helped Turkey to offset its ongoing economic crisis, though the benefits decreased as the war neared its end and accordingly disappeared entirely with Iraq's invasion of Kuwait and the resulting Iraq sanctions Turkey imposed in response.

10 - U.S. involvement

10 – 1 - U.S. Embargo

A key element of US political – military and energy–economic planning occurred in early 1983. The Iran – Iraq war had been going on for five years and there were significant casualties on both sides, reading hundreds of thousands. Within the Reagan National Security Council concern was growing that the war could spread beyond the boundaries of the two belligerents. A National Security Planning Group meeting was called chaired by Vice President George Bush to review US options. It was determined that there was a high likelihood that the conflict would spread into Saudi Arabia and other Gulf states, but that the US had little capability to defend the region. Furthermore it was determined that a prolonged war in the region would induce much higher oil prices and threaten the fragile world recovery which was just beginning to gain momentum. On 22 May 1984, President Reagan was briefed on the project conclusions in the Oval Office by William Flynn Martin who had served as the head of the NSC staff that organized the study. The full declassified presentation can be seen here.[180] The conclusions were threefold: first oil stocks needed to be increased among members of the International Energy Agency and, if necessary, released early in the event of oil market disruption; second the United States needed to beef up the security of friendly Arab states in the region and thirdly an embargo should be placed on sales of military equipment to Iran and Iraq. The Plan was approved by the President and later affirmed by the G - 7 leaders headed by Margaret Thatcher in the London Summit of 1984.

10 – 2 - Iraqi attack on U.S. war ship

	
A missile departs the forward launcher ofVincennes during a 1987 exercise. This ship later shot down civilian air liner Iran Air 655.	*Stark listing following two hits byExocet missiles.*

On 17 May 1987, an Iraqi Mirage F1 attack aircraft launched two Exocet missiles at the USS *Stark*, a*Perry* class frigate. The first struck the port side of the ship and failed to explode, though it left burning propellant in its wake; the second struck moments later in approximately the same place and penetrated through to crew quarters, where it exploded, killing 37 crew members and leaving 21 injured. Whether or not Iraqi leadership authorised the attack is still unknown. Initial claims by the Iraqi government (that *Stark* was inside the Iran–Iraq War zone) were shown to be false, and the motives and orders of the pilot remain unanswered. Though American officials claimed that the pilot who attacked *Stark* had been executed, an ex-Iraqi Air Force commander since stated he had not been punished, and was still alive at the time.[45] The attack remains the only successful anti-ship missile strike on an American warship . Due to the extensive political and military cooperation between the Iraqis and Americans by 1987, the attack had little effect on relations between the two countries.

10 – 3 - U . S . military actions toward Iran

U.S. attention was focused on isolating Iran as well as maintaining freedom of navigation. It criticised Iran's mining of international waters, and sponsored UN Security Council Resolution 598, which passed unanimously on 20 July, under which the U.S. and

Iranian forces skirmished during Operation Earnest Will. During Operation Nimble Archer in October 1987, the U.S. attacked Iranian oil platforms in retaliation for an Iranian attack on the U.S.-flagged Kuwaiti tanker

On 14 April 1988, the frigate USS *Samuel B. Roberts* was badly damaged by an Iranian mine, and 10 sailors were wounded. U.S. forces responded with Operation Praying Mantison 18 April, the U.S. Navy's largest engagement of surface warships since World War II. Two Iranian oil platforms were damaged, and five Iranian warships and gunboats were sunk. An American helicopter also crashed . This fighting manifested in the International Court of Justice as Oil Platforms case (Islamic Republic of Iran v. United States of America), which was eventually dismissed in 2003.

10 – 4 - U . S . shoots down civilian airliner

In the course of escorts by the U.S. Navy, the cruiser USS *Vincennes* shot down Iran Air Flight 655 on 3 July 1988, killing all 290 passengers and crew on board. The American government claimed that the *Vincennes* was in international waters at the time (which was later proven to be untrue), that the civilian airliner had been mistaken for an Iranian F-14 Tomcat, and the *Vincennes* feared that it was under attack . The Iranians maintain that the *Vincennes* was in their own waters, and that the passenger jet was turning away and increasing altitude after take – off . U.S. Admiral William J. Crowe later admitted on *Nightline* that the *Vincennes* was in Iranian territorial waters when it launched the missiles. At the time of the attack, Admiral Crowe claimed that the Iranian plane did not identify itself and sent no response to warning signals he had sent.

According to an investigation conducted by *Nightline*, decoys were sent by the U.S. Navy into the Persian Gulf during the war to lure out the Iranian gunboats and destroy them, and that the *Vincennes* was performing such an operation when she shot down the Iranian airliner.

In 1996, the U.S. expressed regret for the event and the civilian deaths it caused.

11 - Use of chemical weapons by Iraq

Iranian solit had to use full PPE in front line of Iran – Iraq War

In a declassified 1991 report, the CIA estimated that Iran had suffered more than 50,000 casualties from Iraq's use of several chemical weapons , though current estimates are more than 100,000 as the long - term effects continue to cause casualties . The official CIA estimate did not include the civilian population contaminated in bordering towns or the children and relatives of veterans, many of whom have developed blood, lung and skin complications, according to the Organization for Veterans of Iran. According to a 2002 article in the *Star - Ledger*, 20,000 Iranian soldiers were killed on the spot by nerve gas. As of 2002, 5,000 of the 90,000 survivors continue to seek regular medical treatment, while 1,000 are hospital inpatients.

According to Iraqi documents, assistance in developing chemical weapons was obtained from firms in many countries, including the United States, West Germany, the Netherlands, the United Kingdom, and France. A report stated that Dutch , Australian, Italian, French and both West and East German companies were involved in the export of raw materials to Iraqi chemical weapons factories. Declassified CIA documents show that the United States was providing reconnaissance intelligence to Iraq around 1987 – 88 which was then used to launch chemical weapon attacks on Iranian troops and that CIA fully knew that chemical weapons would be deployed and sarin attacks followed.

On 21 March 1986, the United Nations Security Council made a declaration stating that "members are profoundly concerned by the unanimous conclusion of the specialists that chemical weapons on many occasions have been used by Iraqi forces against Iranian troops, and the members of the Council strongly condemn this continued use of chemical weapons in clear violation of the Geneva Protocol of 1925, which prohibits the use in war of chemical weapons." The United States was the only member who voted against the issuance of this statement . A mission to the region in 1988 found evidence of the use of chemical weapons, and was condemned in Security Council Resolution 612 .

Halabja poison gas attack in 1988

According Walter Lang, senior defence intelligence officer for the U.S. Defense Intelligence Agency at the time, "the use of gas on the battlefield by the Iraqis was not a matter of deep strategic concern" to Reagan and his aides , because they "were desperate to make sure that Iraq did not lose ." He claimed that the Defense Intelligence Agency "would have never accepted the use of chemical weapons against civilians, but the use against military objectives was seen as inevitable in the Iraqi struggle for survival" . The Reagan administration did not stop aiding Iraq after receiving reports of the use of poison gas on Kurdish civilians .

The U.S. has accused Iran of using chemical weapons as well,[45]:214 though the allegations have been disputed. Joost Hiltermann, the principal researcher for Human Rights Watchbetween 1992 and 1994, conducted a two - year study that included a field investigation in Iraq, and obtained Iraqi government documents in the process. According to Hiltermann, the literature on the Iran – Iraq War reflects allegations of chemical weapons used by Iran, but they are "marred by a lack of specificity as to time and place, and the failure to provide any sort of evidence".

Analysts Gary Sick and Lawrence Potter have called the allegations against Iran "mere assertions" and stated, "No persuasive evidence of the claim that Iran was the primary culprit [of using chemical weapons was ever presented " . Policy consultant and author Joseph Tragert stated, "Iran did not retaliate with chemical weapons, probably because it did not possess any at the time".

At his trial in December 2006, Saddam said he would take responsibility "with honour" for any attacks on Iran using conventional or chemical weapons during the 1980–1988 war, but he took issue with charges he ordered attacks on Iraqis.[194] A medical analysis of the effects of Iraqi mustard gas is described in a U.S. military textbook and contrasted effects of World War I gas .

12 - Dissimilarities from other conflicts

Iran's attack on the Osirak nuclear reactor in September 1980 was the first attack on anuclear reactor and one of only six military attacks on nuclear facilities in history. It was also the first instance of a pre-emptive attack on a nuclear reactor to forestall the development of a nuclear weapon, though it did not achieve its objective, as France repaired the reactor after the attack. It took a second pre - emptive strike by the Israeli Air Force to disable the reactor, killing a French engineer in the process and causing France to pull out of Osirak. The decommissioning of Osirak has been cited as causing a substantial delay to Iraqi acquisition of nuclear weapons .

The Iran–Iraq War was also the first and only conflict in the history of warfare in which both forces used ballistic missiles against each other . The war also saw the only confirmed air – to - air helicopter battles in the history of warfare, with Iraqi Mi - 25s flying against Iranian AH - 1J SeaCobras on numerous occasions. The first instance of these helicopter " dog fights " was on the starting day of the war (22 September 1980) : two Iranian Sea Cobras crept up on two Mi - 25s and hit them with TOW, wire-guided anti - tank missiles. One Mi - 25 went down immediately, the other was badly damaged and crashed before reaching base. The Iranians won a similar air battle on 24 April 1981, destroying two Mi-25s without incurring losses to themselves. According to unclassified documents, Iranian pilots achieved a 10 to 1 kill ratio over the Iraqi helicopter pilots during these engagements and even engaged Iraqi, fixed wing air craft . Both sides also carried out air and missile attack against population centers, especially Iraq.

In October 1986, Iraqi aircraft began to attack civilian passenger trains and aircraft on Iranian soil, including an Iran Air Boeing 737 unloading passengers at Shiraz International Airport . In retaliation for the Iranian Operation Karbala 5, Iraq attacked 65 cities in 226 sorties over 42 days, bombing civilian neighbourhoods. Eight Iranian cities came under attack from Iraqi missiles. The bombings killed 65 children in an elementary school inBorujerd. The Iranians also responded with Scud missile attacks on Baghdad and struck a primary school there. These events became known as the "war of the cities".

Despite both sides fighting a war with each other, Iran and Iraq maintained diplomatic relations and embassies in each other's countries until mid - 1987. Iran's government used human waves to attack enemy troops or even in some cases to clear minefields. Children also volunteered as well. Some reports have the Basijis marching into battle marking their expected entry to heaven by wearing "plastic keys to paradise" around their necks, although other analysts consider it to be a hoax, having been misinterpreted with a prayer book called "The Keys to Paradise"(Mafatih al - Janan) by Sheikh Abbas Qumi given to all volunteers.

According to journalist Robin Wright,

During the Fateh offensive [in February 1987], I toured the southwest front on the Iranian side and saw scores of boys, aged anywhere from nine to sixteen, who said with staggering and seemingly genuine enthusiasm that they had volunteered to become martyrs. Regular army troops, the paramilitary Revolutionary Guards and mullahs all lauded these youths, known as baseeji [Basij], for having played the most dangerous role in breaking through Iraqi lines. They had led the way, running over fields of mines to clear the ground for the Iranian ground assault. Wearing white headbands to signify the embracing of death, and shouting "Shaheed, shaheed" (Martyr , martyr) they literally blew their way into heaven. Their numbers were never disclosed. But a walk through the residential suburbs of Iranian cities provided a clue. Window after window, block after block, displayed black-bordered photographs of teenage or preteen youths.

Aum Shinrikyo

Aleph (formerly *Aum Shinrikyo*)	
	
Formation	1984
Type	Japanese new religious movement Terrorist organization
Membership	1,030
Key people	Shoko Asahara

Contents

1 - Introduction

Aum Shinrikyo, currently known as **Aleph**, is a Japanese cult founded by Shoko Asahara in 1984. It gained international notoriety in 1995 when it carried out theTokyo subway sarin attack and was found to have been responsible for another smaller sarin attack the previous year. As a consequence, it is now listed as a terrorist organization by several countries.

The name "Aum Shinrikyo" . usually rendered in English as "Supreme Truth", derives from the Sanskrit syllable *Aum*, used to representthe universe, followed by the Japanese*Shinrikyo* (meaning, roughly, "religion of Truth") written in kanji. In 2000, the organization changed its name to "Aleph" – a reference to the first letter of the Phoenician,Hebrew and Arabic alphabets – and replaced its logo.

In 1995, the group claimed 40,000 members worldwide and over 9,000 members in Japan. Police consider the existing groups Aleph and Hikari no Wa to be branches of "dangerous religion".

Aum Shinrikyo has been formally designated a terrorist organization by several countries and geopolitical organizations, including Canada , Kazakhstan and the United States.

2 – Doctrine

Aum Shinrikyo / Aleph is a syncretic belief system that incorporates Asahara's facets ofChristianity with idiosyncratic inter pretations of Yoga, and the writings of Nostradamus . In 1992 Asahara published a foundational book, and declared himself "Christ", Japan's only fully enlightened master and identified with the "Lamb of God". His purported mission was to take upon himself the sins of the world, and he claimed he could transfer to his followers spiritual power and ultimately take away their sins and bad deeds.

Ultimately, Asahara outlined a doomsday prophecy, which included a World War IIIinstigated by the United States.[9] Asahara described a final conflict culminating in a nuclear"Armageddon", borrowing the term from the Book of Revelation 16 : 16 . Humanity would end, except for the elite few who joined Aum.[10] Aum's mission was not only to spread the word of "salvation", but also to survive these "End Times". Asahara predicted Armageddon would occur in 1997 . He named the United States as The Beast from the Book of Revelation, predicting it would eventually attack Japan . He also saw dark conspiracies everywhere promulgated by Jews , Freemasons , the Dutch, the British Royal Family, and rival Japanese religions.

3 – History

The movement was founded by Shoko Asahara in his one –bed room apartment in Tokyo's Shibuya ward in 1984, starting off as a yoga and meditation class known as *Aum Shinsen no Kai "Aum club of gods and hermits"*?) and steadily grew in the following years. It gained the official status as a religious organization in 1989 . It attracted such a considerable number of young graduates from Japan's elite universities that it was dubbed a "religion for the elite".

3 – 1 – Activities

While Aum was considered a rather controversial phenomenon in Japan, it was not yet associated with serious crimes. It was during this period that Asahara became obsessed with Biblical prophecies. Aum's public relations activities included publishing. In Japan, where comics and animated cartoons enjoy exceptional popularity among all ages, Aum attempted to tie religious ideas to popular anime and manga themes – space missions, extremely powerful weapons, world conspiracies and conquest for ultimate truth . Aum published several magazines including *Vajrayana Sacca* and *Enjoy Happiness*, adopting a somewhat missionary attitude

Isaac Asimov's science fiction *Foundation Trilogy* was referenced "depicting as it does an elite group of spiritually evolved scientists forced to go underground during an age of barbarism so as to prepare themselves for the moment ... when they will emerge to rebuild civilization " . Aum's publications used Christian and Buddhist ideas to impress what he considered to be the more shrewd and educated Japanese who were not attracted to boring, purely traditional sermons.

In private, both Asahara and his top disciples reportedly continued their humble lifestyles, the only exception being the armored Mercedes - Benz gifted by a wealthy follower concerned over his Guru's traffic safety. In rather rare footage, Asahara is seen on the street in front of a large clown doll resembling himself, smiling happily.

Intense advertising and recruitment activities, dubbed the 'Aum Salvation plan', included claims of curing physical illnesses with health improvement techniques, realizing life goals by improving intelligence and positive thinking, and concentrating on what was important at the expense of leisure. This was to be accomplished by practicing ancient teachings, accurately translated from original Pali sutras (these three were referred to as 'threefold Salvation') . These efforts resulted in Aum becoming one of the fastest - growing religious groups in Japan's history.

The religion's practices remained shrouded in secrecy. Initiation rituals often involved the use of hallucinogens, such as LSD. Religious practices often involved extreme ascetic practices claimed to be "yoga". These included everything from renunciants being hung upside down to being given shock therapy.

3 – 2 - Incidents before 1995

The cult started attracting controversy in the late 1980s with accusations of deception of recruits, and of holding cult members against their will and forcing members to donate money; a murder of a cult member who tried to leave is now known to have taken place in February 1989 .

In October 1989, the group's negotiations with Tsutsumi Sakamoto, an anti-cult lawyer threatening a lawsuit against them which could potentially bankrupt the group, failed. In the same month, Sakamoto recorded an interview for a talk show on the Japanese TV stationTBS. The network then had the interview secretly shown to the group without notifying Sakamoto, intentionally breaking protection of sources. The group then pressured TBS to cancel the broadcast. The following month Sakamoto, his wife and his child went missing from their home in Yokohama. The police were unable to resolve the case at the time, although some of his colleagues publicly voiced their suspicions of the group. It was not until 1995 that they were known to have been murdered and their bodies dumped by cult members.

Aum was also connected with such activities as extortion. The group commonly took patients into its hospitals and then forced them to pay exorbitant medical bills.

In 1990, Asahara and 24 other members stood unsuccessfully for the General Elections for the House of Representatives under the banner of *Shinri - tō* (Supreme Truth Party) . Asahara made a couple of appearances on TV talk shows in 1991, however at this time the attitude of the cult's doctrine against society started to grow in hostility. In 1992 Aum's "Construction Minister" Kiyohide Hayakawa published a treatise called *Principles of a Citizen's Utopia*which has been described as a "declaration of war" against Japan's constitution and civil institutions. At the same time, Hayakawa started to make frequent visits to Russia to acquire military hardware , including AK74 s , a MIL Mi - 17 military helicopter, and reportedly an attempt to acquire components for a nuclear bomb.

The cult is known to have considered assassinations of several individuals critical of the cult, such as the heads of Buddhist sects Soka Gakkai and The Institute for Research in Human Happiness and the attempted assassination of the controversial cartoonist Yoshinori Kobayashi in 1993 .

At the end of 1993, the cult started secretly manufacturing the nerve agent sarin and later VX gas . They also attempted to manufacture 1000 automatic rifles but only managed to make one.[18] Aum tested their sarin on sheep at Banjawarn Station, a remote pastoral property in Western Australia, killing 29 sheep. Both sarin and VX were then used in several assassinations (and attempts) over 1994 – 1995. In December 1994 and January 1995,Masami Tsuchiya of Aum Shinrikyo synthesized 100 to 200 grams of VX which was used to attack three persons. Two persons were injured and one 28 - year - old man died, who is believed to be the only fully documented victim of VX ever in the world . The VX victim, whom Shoko Asahara had suspected as a spy, was attacked at 7:00 am on December 12, 1994 on the street in Osaka by Tomomitsu Niimi and another AUM member, who sprinkled the nerve agent on his neck. He chased them for about 90 metres before collapsing, dying 10 days later without ever coming out of a deep coma. Doctors in the hospital suspected at the time he had been poisoned with an organophosphate pesticide. But the cause of death was pinned down only after cult members arrested for the subway attack confessed to the killing. Ethyl methylphosphonate, methylphosphonic acid and diisopropyl-2- (methylthio) ethyl amine were later found in the body of the victim. Unlike the cases for sarin (Matsumoto incident and Sarin gas attack on the Tokyo subway) , VX was not used for mass murder. Most notably, on the night of 27 June 1994, the cult carried out achemical weapons attack against civilians when they released sarin in the central Japanese city of Matsumoto, Nagano. This Matsumoto incident killed eight and harmed 200 more. However, police investigations focused only on an innocent local resident, Yoshiyuki Kouno, and failed to implicate the cult at the time.

In February 1995, several cult members kidnapped Kiyoshi Kariya, a 69 - year old brother of a member who had escaped, from a Tokyo street and took him to one of their compounds atKamikuishiki near Mount Fuji, where he was killed and his body destroyed in a microwave - powered incinerator before being disposed of in Lake Kawaguchi . Before Kariya was abducted, he had been receiving threatening phone calls demanding to know the whereabouts of his sister, and he had left a note saying, "If I disappear, I was abducted by Aum Shinrikyo".

Police made plans to simultaneously raid cult facilities across Japan in March 1995 .

3 – 3 - Tokyo subway sarin attack and related incidents

On the morning of 20 March 1995, Aum members released sarin in a coordinated attack on five trains in the Tokyo subway system, killing 13 commuters, seriously injuring 54 and affecting 980 more. Some estimates claim as many as 6,000 people were injured by the sarin. It is difficult to obtain exact numbers since many victims are reluctant to come forward . Prosecutors allege that Asahara was tipped off about planned police raids on cult facilities by an insider, and ordered an attack in central Tokyo to divert attention away from the group. The plan evidently backfired, and the police conducted huge simultaneous raids on cult compounds across the country.

Over the next week, the full scale of Aum's activities was revealed for the first time. At the cult's headquarters in Kamikuishiki on the foot of Mount Fuji, police found explosives, chemical weapons and biological warfare agents , such as anthrax and Ebola cultures , and a Russian Mil Mi-17 military helicopter. The Ebola virus had been delivered from Zaire in 1994.[23] There were stockpiles of chemicals that could be used for producing enough sarin to kill four million people.[24] Police also found laboratories to manufacture drugs such asLSD methamphetamine, and a crude form of truth serum, a safe containing millions of US dollars in cash and gold, and cells, many still containing prisoners. During the raids, Aum issued statements claiming that the chemicals were for fertilizers. Over the next six weeks, over 150 cult members were arrested for a variety of offenses. The media were stationed outside their Tokyo headquarters on Komazawa Dori in Aoyama for months after the attack and arrests waiting for action and to get images of the cult's other members.

On 30 March 1995, Takaji Kunimatsu, chief of the National Police Agency, was shot four times near his house in Tokyo and was seriously wounded. While many suspected Aum involvement in the shooting, the *Sankei Shimbun* reported that Hiroshi Nakamura is suspected of the crime, but nobody has been charged.

On 23 April, Murai Hideo, the head of Aum's Ministry of Science, was stabbed to death outside the cult's Tokyo headquarters amidst a crowd of about 100 reporters, in front of cameras. The man responsible, a Korean member of Yamaguchi-gumi, was arrested and eventually convicted of the murder . His motive remains unknown.

On the evening of 5 May, a burning paper bag was discovered in a toilet in Shinjuku stationin Tokyo , the busiest station in the world. Upon examination it was revealed that it was ahydrogen cyanide device which, had it not been extinguished in time, would have released enough gas into the ventilation system to potentially kill 20,000 commuters . Several undetonated cyanide devices were found at other locations in the Tokyo subway .

During this time, numerous cult members were arrested for various offenses, but arrests of the most senior members on the charge of the subway gassing had not yet taken place.

Shoko Asahara was finally found hiding within a wall of a cult building known as "The 6th Satian" in the Kamikuishiki complex on 16 May and was arrested. On the same day, the cult mailed a parcel bomb to the office of Yukio Aoshima, the governor of Tokyo, blowing off the fingers of his secretary's hand. Asahara was initially charged with 23 counts of murder as well as 16 other offenses. The trial, dubbed "the trial of the century" by the press, ruled Asahara guilty of masterminding the attack and sentenced him to death. The indictment was appealed unsuccessfully. A number of senior members accused of participation, such asMasami Tsuchiya, also received death sentences.

The reasons why a small circle of mostly senior Aum members committed atrocities and the extent of personal involvement by Asahara remain unclear to this day, although several theories have attempted to explain these events. In response to the prosecution's charge that Asahara ordered the subway attacks to distract the authorities' away from Aum, the defense maintained that Asahara was not aware of events, pointing to his deteriorating health condition. Shortly after his arrest, Asahara abandoned his post as the organization's leader, and since then has maintained silence, refusing to communicate even with lawyers and family members.

2 – 4 - After 1995

Anti - Aum Shinrikyo protest in Japan.

On 10 October 1995 , Aum Shinrikyo was ordered to be stripped of its official status as a "religious legal entity" and was declared bankrupt in early 1996. However the group continues to operate under the constitutional guarantee of freedom of religion, funded by a successful computer business and donations, and under strict surveillance. Attempts to ban the group altogether under the 1952 Subversive Activities Prevention Law were rejected by the Public Security Examination Commission in January 1997.

The group underwent a number of transformations in the aftermath of Asahara's arrest and trial. For a brief time, Asahara's two preteen sons officially replaced him as guru. It re-grouped under the new name of **Aleph** in February 2000. It has announced a change in its doctrine: religious texts related to controversial Vajrayana Buddhist doctrines and Bible were removed. The group apologized to the victims of the sarin gas attack and established a special compensations fund. Provocative publications and activities that alarmed society during Aum times are no longer in place .

Fumihiro Joyu, one of the few senior leaders of the group under Asahara who did not face serious charges, became official head of the organization in 1999. Kōki Ishii, a legislator who formed an anti-Aum committee in the Diet in 1999, was murdered in 2002.

In July 2000, Russian police arrested Dmitri Sigachev, an ex-KGB and former Aum Shinrikyo member, along with four other former Russian Aum members, for stockpiling weapons in preparation for attacking Japanese cities in a bid to free Asahara. In response, Aleph issued a statement saying they "do not regard Sigachev as one of its members".

In August 2003, a woman believed to be an ex-Aum Shinrikyo member took refuge in North Korea via China.

For over 15 years, only three fugitives were being actively sought. At 11 : 50 pm 31 December 2011, Makoto Hirata surrendered himself to the police and was arrested on suspicion of being involved in the 1995 abduction of Kiyoshi Kariya, a non-member who had died during an Aum kidnapping and interrogation . On June 3, 2012 police captured Naoko Kikuchi, the second fugitive, acting on a tip from local residents . Acting on information from the capture of Kikuchi, including recent photographs showing a modified appearance, the last remaining fugitive, Katsuya Takahashi, was captured on 15 June 2012 after surveillance video of him was released. He is said to have been the driver in the Tokyo gas attack and was caught in Tokyo near a comic book coffee shop. He had been on the run for 17 years.

4 - Current activities

According to a June 2005 report by the National Police Agency, Aleph had approximately 1650 members, of whom 650 lived communally in compounds . The group operated 26 facilities in 17 prefectures, and about 120 residential facilities. An article in the Mainichi Shimbun newspaper on 11 September 2002 showed that the Japanese public still distrusts Aleph, and compounds throughout Japan are usually surrounded by protest banners from local residents demanding they leave.

There have been numerous cases where local authorities have refused to accept resident registration for cult members when it is discovered that Aleph has set up a facility within their jurisdiction. This effectively denies cult members social benefits such as health insurance; five cases have been taken to court by cult members, who won every time. Local communities have also tried to drive the cult away by trying to prevent cultists from finding jobs, or to keep cult children out of universities and schools. Right-wing groups also frequently conduct marches near Aum - related premises such as apartments rented by Aum followers with extremely loud music broadcast over loudspeakers installed on minivans, which add to their neighbors' displeasure.

4 – 1 – Monitoring

In January 2000, the group was placed under surveillance for a period of three years under an anti-Aum law, in which the group is required to submit a list of members and details of assets to the authorities . In January 2003 Japan's Public Security Intelligence Agency received permission to extend the surveillance for another three years, as they found evidence which suggested that the group still revered Asahara . According to the Religious News Blog report issued in April 2004, the authorities still considered the group "a threat to society".

In January 2006, the Public Security Intelligence Agency was able to extend the surveillance for another three years. Despite the doctrinal changes and banning of Vajrayana texts, the PSIA advocates an increase of its budget in order to expand its surveillance activities. Periodically, the agency expresses concerns that the Vajrayana texts are still in use and that danger remains while Asahara remains leader. Aleph leaders carefully insert passages rejecting the Vajrayana texts into almost everything they say or write, including karaokesongs, to publicly distance Aleph from Vajrayana.

On 15 September 2006, Shoko Asahara lost his final appeal against the death penalty imposed on him after his trial for the sarin attacks. The following day Japanese police raided the offices of Aleph in order to "prevent any illegal activities by cult members in response to the confirmation of Asahara's death sentence", according to a police spokesperson.[37]Thirteen cult members were eventually sentenced to death.

4 – 2 – Split

On 8 March 2007, Fumihiro Joyu, former Aum Shinrikyo spokesman and head of Aum's Moscow operation, formally announced a long - expected split . Joyu's group , called Hikari no Wa ("The Circle of Light") claims to be committed to uniting science and religion and creating "the new science of the human mind", having previously aimed to move the group away from its violent history and toward its spiritual roots.

In April 2011, the Public Security Intelligence Agency stated that Aum currently had about 1,500 members . At the end of July 2011 the cult reported its membership as 1,030. The group was reportedly active in trying to recruit new members among Japan's youth via social media websites and proselytizing on college campuses.

Automatic Fire Suppression

Automatic system in a computer room

Contents

1 - Introdution

Automatic fire suppression systems control and extinguish fires without human intervention. Examples of automatic systems include fire sprinkler system, gaseous fire suppression, andcondensed aerosol fire suppression.

The first fire extinguisher patent was issued to Alanson Crane of Virginia on Feb. 10, 1863. The first fire sprinkler system was patented by H.W. Pratt in 1872. But the first practical automatic sprinkler system was invented in 1874 by Henry S. Parmalee of New Haven, CT. He installed the system in a piano factory he owned.

2 - Types of automatic systems

Today there are numerous types of Automatic Fire Suppression Systems. Systems are as diverse as the many applications. In general, however, Automatic Fire Suppression Systems fall into two categories: *engineered* and *pre - engineered* systems.

Engineered Fire Suppression Systems are design specific. Engineered systems are usually for larger installations where the system is designed for the particular application. Examples include marine and land vehicle applications, computer clean rooms, public and private buildings, industrial paint lines, dip tanks and electrical switch rooms. Engineered systems use a number of gaseous or solid agents. Many are specifically formulated. Some, such as 3M Novec 1230 Fire Protection Fluid, are stored as a liquid and discharged as a gas.

Pre - Engineered Fire Suppression Systems use pre - designed elements to eliminate the need for engineering work beyond the original product design. Typical industrial solutions use a simple wet or dry chemical agent, such as potassium carbonate or mono ammonium phosphate (MAP), to protect spaces such as paint rooms and booths, storage areas and commercial kitchens. In Europe, a small number of residential designs have also emerged. These units often employ water mist with or without a surfactant additive, and target retrofit applications where the risk of fire or fire injury is high but where a conventional fire sprinkler system would be unacceptably expensive.

3 – Components

By definition, an automatic fire suppression system can operate without human intervention. To do so it must possess a means of detection, actuation and delivery.

In many systems, detection is accomplished by mechanical or electrical means. Mechanical detection uses fusible-link or thermo-bulb detectors. These detectors are designed to separate at a specific temperature and release tension on a release mechanism. Electrical detection uses heat detectors equipped with self-restoring, normally-open contacts which close when a predetermined temperature is reached. Remote and local manual operation is also possible.

Actuation usually involves either a pressurised fluid and a release valve, or in some cases an electric pump.

Delivery is accomplished by means of piping and nozzles. Nozzle design is specific to the agent used and coverage desired.

4 - Extinguishing agents

In the early days, water was the exclusive fire suppression agent. Although still used today, water has limitations. Most notably, its liquid and conductive properties can cause as much property damage as fire itself.

Agent	Primary Ingredient	Applications
FM-200	Hepta fluoro propane	Electronics , medical equipment, production equipment, libraries, data centers, medical record rooms, server rooms , oil pumping stations, engine compartments, telecommunications rooms, switch rooms, engine and machinery spaces, pump rooms, control rooms
3M Novec 1230 Fire Protection Fluid	Fluorinated Ketone	Electronics, medical equipment, production equipment, libraries, data centers, medical record rooms, server rooms, oil pumping stations, engine compartments, telecommunications rooms, switch rooms, engine and machinery spaces, pump rooms, control rooms
IG - 55	Argon and nitrogen	Same applications and FM-200 and Novec 1230 fluid; less Class B style hazards
FE - 13	Fluoroform	Police evidence freezers, inerting natural gas pumping stations or trains / trucks /cranes operating in cold weather, electronics, medical equipment, production equipment, libraries, data centers, medical record rooms, server rooms, oil pumping stations, engine compartments, telecommunications rooms, switch rooms, engine and machinery spaces, pump rooms, control rooms
Wet Chemical	Potassium carbonate	Commercial kitchens
ABC Dry Chemical	Mono ammonium phosphate	Paint booths , dip tanks , coating operations, flammable liquid storage

		areas, paint mixing areas, exhaust ducts
Regular Dry Chemical	Sodium bicarbonate	Gasoline, propane and solvents, live electrical equipment, flammable liquids
Carbon Dioxide	Carbon Dioxide	Non - occupied control rooms, coating operations, paint lines, dust collectors, transformer vaults, live electrical equipment, flammable liquids, commercial fryers
Foam	Synthetic detergent , poly saccharide, fluoro akyl suffaccant	Flammable liquids
Purple KDry Chemical	Potassium bicarbonate	High hazard commercial and industrial applications, especially with flammable liquids
Solid aerosol particulate	Potassium nitrate	Used in condensed aerosol fire suppression, high hazard commercial and industrial applications, no ozone depletion or global warming potential
Halotron 1	2,2- dichloro - 1,1,1-tri fluoro ethane	Live electrical equipment, flammable liquids
Water Mist	Water	All Classes of Fire (A,B,C,F) Ordinary flammables (Paper, wood, cloth), Flammable liquids, Kitchen Fires (K,F Class), Electrical Fires
Water	Water	Ordinary flammables (Paper, wood, cloth)

5 - Health and environmental concerns

Despite their effectiveness, chemical fire extinguishing agents are not without disadvantages. In the early 20th century, carbon tetrachloride was extensively used as a dry cleaning solvent, a refrigerant and as a fire extinguishing agent. In time, it was found carbon tetrachloride could lead to severe health effects.

From the mid -1960s Halon 1301 was the industry standard for protecting high value assets from the threat of fire. Halon 1301 had many benefits as a fire suppression agent; it is fast acting, safe for assets and required minimal storage space. Halon 1301s major drawbacks are that it depletes atmospheric ozone and is potentially harmful to humans.

Since 1987, some 191 nations have signed The Montreal Protocol on Substances That Deplete the Ozone Layer. The Protocol is an international treaty designed to protect the ozone layer by phasing out the production of a number of substances believed to be responsible for ozone depletion. Among these were halogenated hydrocarbons often used in fire suppression. As a result manufacturers have focused on alternatives to Halon 1301 and Halon 1211 (halogenated hydrocarbons).

A number of countries have also taken steps to mandate the removal of installed Halon systems. Most notably these include Germany and Australia, the first two countries in the world to require this action. In both of these countries complete removal of installed Halon systems has been completed except for a very few essential use applications. The European Union is currently undergoing a similar mandated removal of installed Halon systems.

6 - Modern systems

Since the early 1990s manufacturers have successfully developed safe and effective Halon alternatives. These include DuPont FM-200, American Pacific's Halotron and 3M Novec 1230 Fire Protection Fluid. Generally, the Halon replacement agents available today fall into two broad categories, in-kind (gaseous extinguishing agents) or not in - kind (alternative technologies) . In - kind gaseous agents generally fall into two further categories, Halocarbons and Inert Gases. Not in-kind alternatives include such options as water mist or the use of early warning smoke detection systems.

AZF (factory) Toulouse , France 2001

Contents

1 - Introduction

AZF (French initialism for *AZote Fertilisant*, i.e. nitrogen fertiliser) was the name of a chemical factory inToulouse, France, which exploded on 21 September 2001. The blast was equivalent to 20-40 tons of TNT, measuring 3.4 on the Richter scale, and was heard 80 km away . The explosion caused 29 deaths, with 2,500 wounded, around 30 of them heavily. Damages already paid by insurance exceed 1.5 billion euros.

Although authorities were initially confident it was an accident, an Environment Minister later concluded the explosion could have been "a terrorist attack" in the wake of the September 11 attacks. The body of a worker with Islamic fundamentalist sympathies was found in the blast and investigated. An official enquiry found the blast to be accidental. In Spring 2004, a terrorist group adopted the same name and threatened the French government with bombings on railways.

2 - Toulouse chemical factory explosion

On 21 September 2001, a huge explosion occurred in the **AZF** fertiliser factory in Toulouse, France, belonging to the *Grande Paroisse* branch of the Total group.

Three hundred tonnes of ammonium nitrate was stored (the maximum capacity was 2,000 tones) in the hangar # 221. The whole factory was destroyed making a crater of depth 20 to 30 m , with a diameter of 200 m ; steel girders were found 3 km away from the explosion. The blast measured 3.4 on the Richter scale,[1] with an estimated power equivalent to 20 - 40 tons of TNT . The explosion was heard 80 km away . Due to the acoustics of the hills and the large sound, the explosion was reported as occurring in multiple places. Police at first believed that at least five bombs had simultaneously gone off. There is still controversy over the exact number of explosions.

The factory was close to the city: one of the most inhabited areas, *Le Mirail*, is just one kilometre away (0.6 miles). Several schools, one university campus, one hospital and a psychiatric hospital had to be evacuated.

2 – 1 – Victims

The disaster caused 29 deaths (28 from the factory, 1 secondary school pupil from a neigh bouring school) , about 30 seriously wounded, and 2,500 light casualties . Two thirds of the city's windows were shattered, causing 70 eye wounds and several thousand wounds which had to be sutured. The full environmental consequences of the catastrophe are not yet completely known. The total damages already paid by insurance groups currently exceed 1.5 billion euros.

2 – 1 - After math

The results of the official enquiry were that a warehouse of ammonium nitrate had exploded following improper handling of this dangerous material.

Specifically it is believed by mandated official experts that "a mislabeled 500 kg bin ofsodium dichloroisocyanurate mistakenly thought to be ammonium nitrate was dumped in the off spec ammonium nitrate warehouse. Here under sufficiently hot and humid conditions it could have reacted with the ammonium nitrate to form nitrogen trichloride which is an exceedingly unstable compound. The decomposition of the nitrogen trichloride could have provided the heat and pressure required to detonate the ammonium nitrate which when used as an industrial explosive typically requires detonators " .

2 – 2 – Investigation

On 4 October 2001 , France's then Environment Minister Yves Cochet announced that the explosion "may have been a terrorist attack" (the explosion occurred in the weeks following the September 11 attacks) and identified Hassan Jandoubi, a plant sub-contractor killed in the blast, as a person under investigation. French anti terrorist authorities were prohibited by the Toulouse prosecutor from searching Jandoubi's house for five days after the incident.

Police declared that Jandoubi had "possible Islamic fundamentalist sympathies," yet by the time the search was finally conducted, they alleged that Jandoubi's girlfriend had disposed of all traces of his clothes or photos. French authorities described the delay as damaging to the investigation.

Azide

The azide anion

Contents

1 - Introduction

Azide is the anion with the formula N_3^-. It is theconjugate base of hydrazoic acid (HN_3). N_3^- is a linear anion that is isoelectronic with CO_2 and N_2O. Pervalence bond theory, azide can be described by several resonance structures, an important one being $N^-=N^+=N^-$. Azide is also a functional group in organic chemistry, RN_3. The dominant application of azides is as a propellant in air bags.

2 – Preparation

The principal source of the azide moiety is sodium azide. Sodium azide is made industrially by the reaction of nitrous oxide, N_2O with sodium amide, $NaNH_2$, in liquid ammonia as solvent. The overall stoichiometry is given by

$N_2O + 2NaNH_2 \rightarrow NaN_3 + NaOH + NH_3$

Most inorganic and organic azides are prepared directly or indirectly from sodium azide. For example, lead azide, used in detonators, may be prepared from the metathesis reaction between lead nitrate and sodium azide. An alternative route is direct reaction of the metal with silver azide dissolved in liquid ammonia.

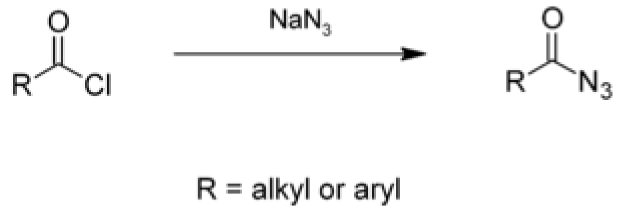
As a pseudo halogen compound, sodium azide generally displaces an appropriate leaving group (e.g. Br, I, OTs) to give the azido compound.

Aryl azides may be prepared by displacement of the appropriate diazonium salt with sodium azide, or trimethylsilyl azide; nucleophilic aromatic substitution is also possible, even with chlorides. Anilines and aromatic hydrazines undergo diazotization, as do alkyl amines and hydrazines.

Appropriately functionalized aliphatic compounds undergo nucleophilic substitution with sodium azide. Aliphatic alcohols give azides via a variant of the Mitsunobu reaction, with the use of hydrazoic acid. Hydrazines may also form azides by reaction with sodium nitrite:

$$Ph\ NH\ NH_2 \rightarrow Ph\ N_3$$

Alkyl or aryl acyl chlorides react with sodium azide in aqueous solution to give acyl azides , which give isocyanates in the Curtius rearrangement.

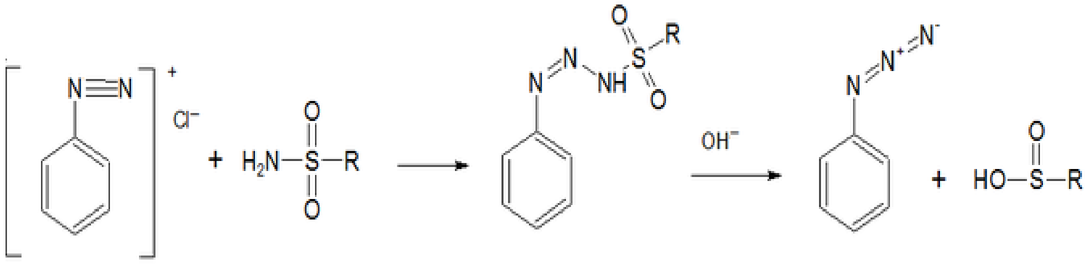


The azo - transfer compounds , tri fluoro methane sulfonyl azide and imidazole -1- sulfonyl azide, are prepared from sodium azide as well. They react with amines to give the corresponding azides:

$$R\ NH_2 \rightarrow R\ N_3$$

2 - 2 – Dutt – Wormall reaction

A classic method for the synthesis of azides is the **Dutt – Wormall reaction** in which adiazonium salt reacts with a sulfonamide first to a diazo amino sulfinate and then on hydrolysis the azide and a sulfinic acid.



3 – Reactions

3 – 1 - Inorganic azides

Azide salts can decompose with release of large volumes of nitrogen gas as discussed under Applications.

Protonation of azide salts gives toxic hydrazoic acid in the presence of strong acids:

$$H^+ + N_3^- \rightarrow HN_3$$

Azide salts may react with heavy metals or heavy metal compounds to give the corresponding azides, which are more shock sensitive than sodium azide alone. They decompose with sodium nitrite when acidified. This is a method of destroying residual azides, prior to disposal.

$$2\ NaN_3 + 2\ HNO_2 \rightarrow 3\ N_2 + 2\ NO + 2\ NaOH$$

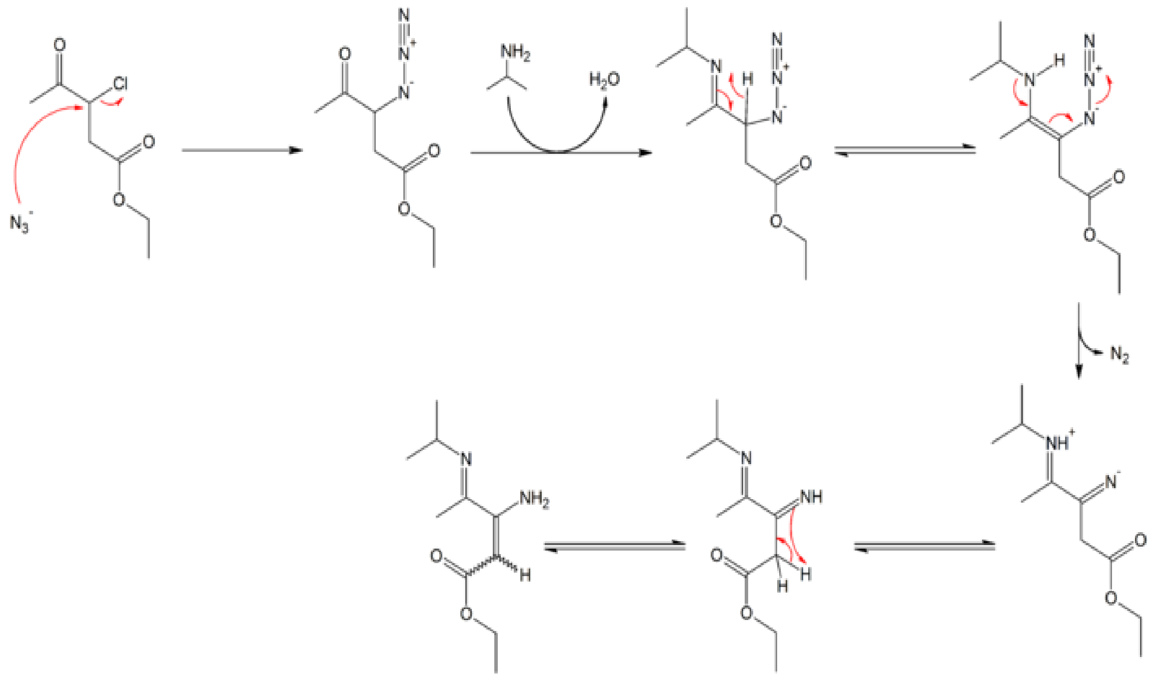
Many inorganic covalent azides, e.g. chlorine, bromine, and iodine azides, have been described.

The azide anion behaves as a nucleophile; it under goes nucleophilic substitution for both aliphatic and aromatic systems. It reacts with epoxides, causing a ring - opening; it undergoes Michael - like conjugate addition to 1,4 - unsaturated carbonyl compounds.

Azides can be used as precursors of the metal nitrido complexes. Azide complexes thus is induced to release N2, generating a metal complex in unusual oxidation states .

3 – 2 - Organic azides

Organic azides engage in useful organic reactions. The terminal nitrogen is mildly nucleophilic. Azides easily extrude diatomic nitrogen , a tendency that is exploited in many reactions such as the Staudinger ligation or the Curtius rearrangement or for example in the synthesis of γ- imino - β - enamino esters .

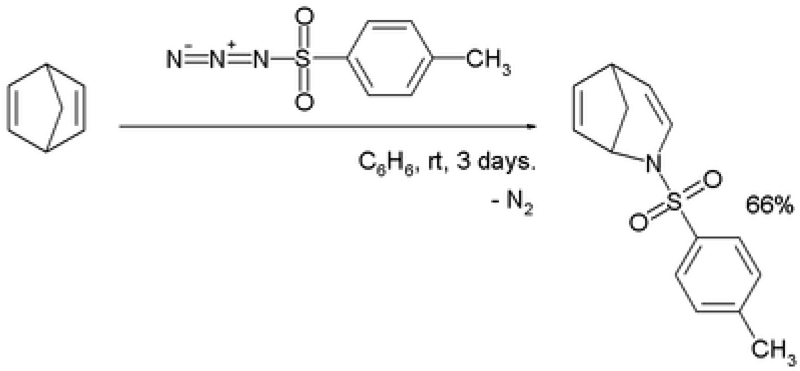


Azides may be reduced to amines by hydrogenolysis[13] or with a phosphine, e.g.triphenyl phosphine, in the Staudinger reaction. This reaction allows azides to serve as protected - NH_2 synthons, as illustrated by the synthesis of 1,1,1-tris (amino methyl) ethane :

$$3\ H_2 + CH_3C(CH_2N_3)_3 \rightarrow CH_3C(CH_2NH_2)_3 + 3\ N_2$$

In the azide alkyne Huisgen cycloaddition, organic azides react as 1,3-dipoles, reacting withalkynes to give substituted 1,2,3-triazoles. This reaction is very popular in click chemistry.

Another azide regular is tosyl azide here in reaction with norbornadiene in a nitrogen insertion reaction :



4 – Applications

About 250 tons of azide - containing compounds are produced annually, the main product being sodium azide.

4 – 1 - Detonators and propellants

Sodium azide is the propellant in automobile air bags. It decomposes on heating to give nitrogen gas, which is used to quickly expand the air bag :

$$2\ NaN_3 \rightarrow 2\ Na + 3\ N_2$$

Heavy metal salts, such as lead azide, $Pb(N_3)_2$, are shock-sensitive detonators which decompose to the corresponding metal and nitrogen, for example :

$$Pb\ (N_3)_2 \rightarrow Pb + 3\ N_2$$

Silver and barium salts are used similarly. Some organic azides are potential rocket propellants an example being 2-Dimethyl amino ethyl azide (DMAZ) .

4 – 2 – Other

Because of the hazards associated with their use, few azides are used commercially although they exhibit interesting reactivity for researchers. Low molecular weight azides especially are considered hazardous and are avoided. In the research laboratory, azides are precursors to amines. They are also popular for their participation in the "click reaction" and in Staudinger ligation. These two reactions are generally quite reliable, lending themselves to combinatorial chemistry.

The antiviral drug zidovudine (AZT) contains an azido group. Some azides are valuable asbioorthogonal chemical reporters.

5 – Safety

Azides are explosophores and toxins.

Sodium azide is toxic (LD_{50} oral (rat) = 27 mg / kg) and can be absorbed through the skin. It decomposes explosively upon heating to above 275 °C and reacts vigorously with CS_2,bromine, nitric acid, dimethyl sulfate, and a series of heavy metals, including copper andlead. In reaction with water or Brønsted acids the highly toxic and explosive hydrogen azide is released.

Heavy metal azides, such as lead azide are primary high explosives detonable when heated or shaken. Heavy- metal azides are formed when solutions of sodium azide or HN_3 vapors come into contact with heavy metals or their salts. Heavy-metal azides can accumulate under certain circumstances, for example, in metal pipelines and on the metal components of diverse equipment (rotary evaporators, freezedrying equipment, cooling traps, water baths, waste pipes), and thus lead to violent explosions.

Some organic and other covalent azides are classified as highly explosive and toxic: inorganic azides as neurotoxins; azide ions as cytochrome c oxidase inhibitors.

It has been reported that sodium azide and polymer-bound azide reagents react withdichloromethane and chloroform to form di- and triazidomethane resp., which are both unstable in high concentrations in solution. Various devastating explosions were reported while reaction mixtures were being concentrated on a rotary evaporator. The hazards of diazidomethane (and triazidomethane) have been well documented.

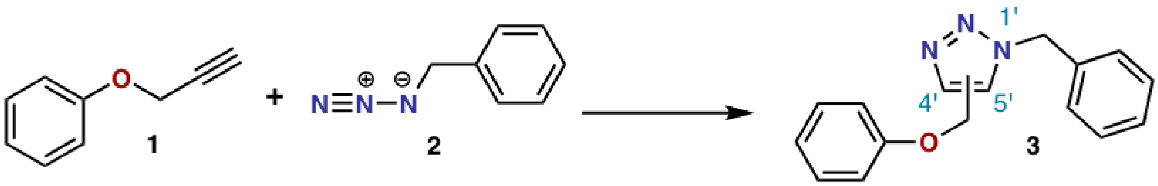
Solid iodoazide is explosive and should not be prepared in the absence of solvent.

Azide - Alkyne Huisgen Cyclo Addition

Contents

1 - Introduction

The **Azide - Alkyne Huisgen Cyclo addition** is a 1,3-dipolar cyclo addition between an azideand a terminal or internal alkyne to give a 1,2,3- triazole. Rolf Huisgen was the first to understand the scope of this organic reaction. American chemist K. Barry Sharpless has referred to this cyclo addition as "the cream of the crop" of click chemistry and "the premier example of a click reaction."



In the reaction above azide **2** reacts neatly with alkyne **1** to afford the triazole **3** as a mixture of 1,4-adduct and 1,5 - adduct at 98 °C in 18 hours.

The standard 1,3 - cyclo addition between an azide 1,3- dipole and an alkene as dipolarophile has largely been ignored due to lack of reactivity as a result of electron-poor olefins and elimination side reactions. Some success has been found with non-metal-catalyzed cycloadditions, such as the reactions using dipolarophiles that are electron - poor olefins or alkynes.

Although azides are not the most reactive 1,3-dipole available for reaction, they are preferred for their relative lack of side reactions and stability in typical synthetic conditions.

2 – Copper catalysis

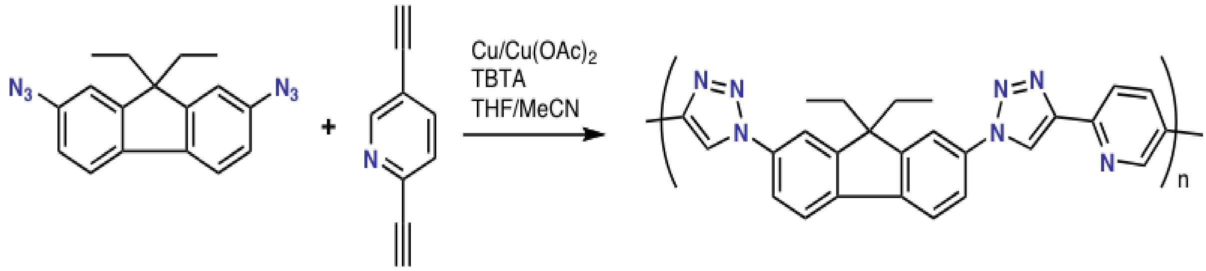
A notable variant of the Huisgen 1,3- dipolar cyclo addition is the copper (I) catalyzed variant, no longer a true concerted cycloaddition, in which organic azides and terminal alkynes are united to afford 1,4- regio isomers of 1,2,3- tri azoles as sole products (substitution at positions 1' and 4' as shown above). The copper(I)-catalyzed variant was first reported in 2002 in independent publications by Morten Meldal at the Carlsberg Laboratory in Denmark[6] and Valery Fokin and K. Barry Sharpless at the Scripps Research Institute . While the copper (I) catalyzed variant gives rise to a triazole from a terminal alkyne and an azide, formally it is not a 1,3-dipolar cycloaddition and thus should not be termed a Huisgen cyclo addition. This reaction is better termed the Copper(I)-catalyzed Azide-Alkyne Cyclo addition (CuAAC) .

While the reaction can be performed using commercial sources of copper (I) such as cuprous bromide or iodide, the reaction works much better using a mixture of copper (II) (e.g. copper (II) sulfate) and a reducing agent (e.g. sodium ascorbate) to produce Cu (I) in situ. As Cu (I) is unstable in aqueous solvents, stabilizing ligands are effective for improving the reaction outcome, especially if tris-(benzyltriazolylmethyl)amine (TBTA) is used. The reaction can be run in a variety of solvents, and mixtures of water and a variety of (partially) miscible organic solvents including alcohols, DMSO, DMF, *t* BuOH and acetone. Owing to the powerful coordinating ability of nitriles towards Cu (I), it is best to avoid acetonitrile as the solvent. The starting reagents need not be completely soluble for the reaction to be successful. In many cases, the product can simply be filtered from the solution as the only purification step required.

NH-1,2,3 - triazoles are also prepared from alkynes in a sequence called the Banert cascade.

The utility of the Cu (I) catalyzed click reaction has also been demonstrated in thepolymerization reaction of a bis- azide and a bis-alkyne with copper(I) and TBTA to aconjugated fluorene based polymer

The degree of polymerization easily exceeds 50. With a stopper molecule such as phenyl azide, well-defined phenyl end-groups are obtained.



The copper mediated azide - alkyne cycloaddition is receiving widespread use in material and surface sciences.[9] Most variations in coupling polymers with other polymers or small molecules have been explored. Current shortcomings are that the terminal alkyne appears to participate in free radical polymerizations. This requires protection of the terminal alkyne with a trimethyl silyl protecting group and subsequent deprotection after the radical reaction are completed. Similarly the use of organic solvents, copper (I) and inert atmospheres to do the cycloaddition with many polymers makes the "click" label inappropriate for such reactions. An aqueous protocol for performing the cycloaddition with free radical polymers is highly desirable.

The CuAAC click reaction also effectively couples polystyrene and bovine serum albumin (BSA) . The result is an amphiphilic biohybrid. BSA contains a thiol group at Cys-34 which is functionalized with an alkyne group. In water the biohybrid micelles with a diameter of 30 to 70 nanometer form aggregates.

2 – 1 - Copper Catalysts

The use of a Cu catalyst in water was an improvement over the same reaction first popularized by Rolf Huisgen in the 1970s, which he ran at elevated temperatures.[11] The traditional reaction is slow and thus requires high temperatures. However, the azides and alkynes are both kinetically stable.

As mentioned above, copper-catalysed click reactions work essentially on terminal alkynes. The Cu species undergo metal insertion reaction into the terminal alkynes. The Cu (I) species may either be introduced as preformed complexes, or are otherwise generated in the reaction pot itself by one of the following ways:

A Cu compound (in which copper is present in the +2 oxidation state) is added to the reaction in presence of a reducing agent (e.g. sodium ascorbate) which reduces the Cu from the (+2) to the (+1) oxidation state. The advantage of generating the Cu(I) species in this manner is it eliminates the need of a base in the reaction. Also the presence of reducing agent makes up for any oxygen which may have gotten into the system. Oxygen oxidises the Cu (I) to Cu (II) which impedes the reaction and results in low yields. One of the more commonly used Cu compounds is $CuSO_4$

Oxidation of Cu (0) metal

Halides of copper may be used where solubility is an issue. However, the iodide and bromide Cu salts require either the presence of amines or higher temperatures.

Commonly used solvents are polar aprotic solvents such as THF, DMSO, Acetonitrile, DMFas well as in non - polar aprotic solvents such as toluene. Neat solvents or a mixture of solvents may be used.

DIPEA (N,N- Di iso propyl ethylamine) and Et_3 N (tri ethyl amine) are commonly used bases.

2 – 2 – Mechanism

A mechanism for the reaction has been suggested based on density functional theory calculations . Copper is a 1st row transition metal. It has the electronic configuration [Ar] $3d^{10}$ $4s^1$. The copper (I) species generated in situ forms a pi complex with the triple bond of a terminal alkyne. In the presence of a base, the terminal hydrogen, being the most acidic is deprotonated first to give a Cu acetylide intermediate. Studies have shown that the reaction is second order with respect to Cu. It has been suggested that the transition state involves two copper atoms. One copper atom is bonded to the acetylide while the other Cu atom serves to activate the azide. The metal center coordinates with the electrons on the nitrogen atom. The azide and the acetylide are not coordinated to the same Cu atom in this case. The ligands employed are labile and are weakly coordinating. The azide displaces one ligand to generate a copper-azide-acetylide complex . At this point cyclisation takes place. This is followed by protonation; the source of proton being the hydrogen which was pulled off from the terminal acetylene by the base. The product is formed by dissociation and the catalyst ligand complex is regenerated for further reaction cycles.

The reaction is assisted by the copper, which, when coordinated with the acetylide lowers the pKa of the alkyne C-H by up to 9.8 units. Thus under certain conditions, the reaction may be carried out even in the absence of a base.

In the uncatalysed reaction the alkyne remains a poor electrophile. Thus high energy barriers lead to slow reaction rates.[14]

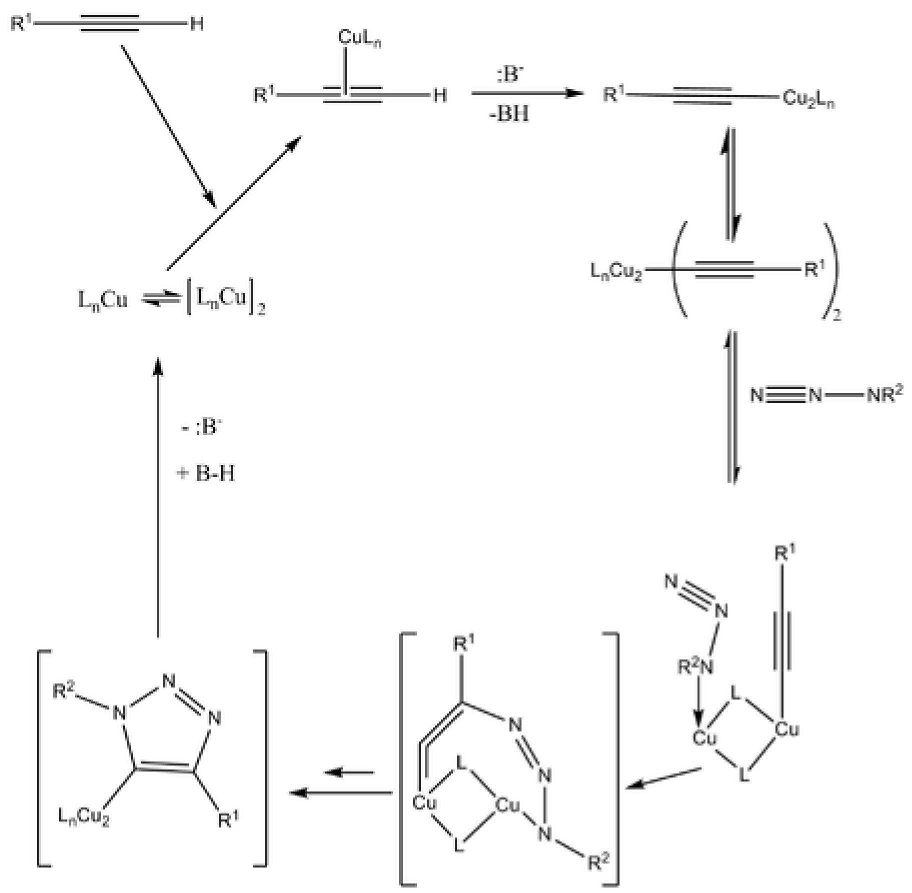


Figure 1: Copper catalysed Click reaction

2 – 3 - Ligand assistance

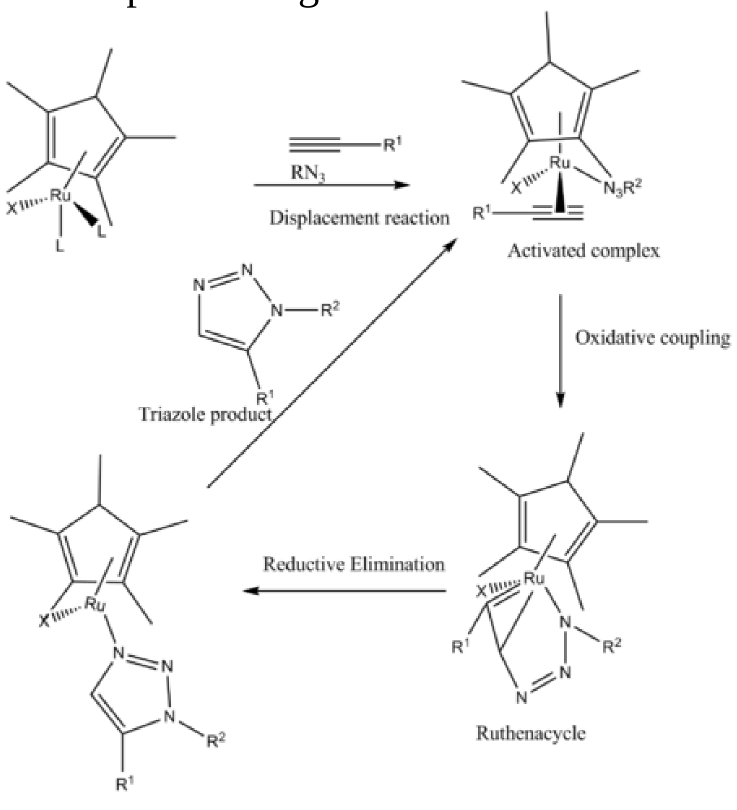
The ligands employed are usually labile i.e. they can be displaced easily. Though the ligand plays no direct role in the reaction the presence of a ligand has its advantages. The ligand protects the Cu ion from interactions leading to degradation and formation of side products and also prevents the oxidation of the Cu (I) species to the Cu (II). Furthermore, the ligand functions as a proton acceptor thus eliminating the need of a base.

3 - Ruthenium catalysis[edit]

The ruthenium - catalysed 1,3- dipolar azide-alkyne cyclo addition (**RuAAC**) gives the 1,5-tri azole. Unlike Cu AAC in which only terminal alkynes reacted, in RuAAC both terminal and internal alkynes can participate in the reaction. This suggests that ruthenium acetylides are not involved in the catalytic cycle.

The proposed mechanism suggests that in the first step, the spectator ligands undergo displacement reaction to produce an activated complex which is converted, via oxidative coupling of an alkyne and an azide to the ruthenium containing metallocyle (Ruthena cycle). The new C - N bond is formed between the more electronegative and less sterically demanding carbon of the alkyne and the terminal nitrogen of the azide. The metallacycle intermediate then undergoes reductive elimination releasing the aromatic triazole product and regenerating the catalyst or the activated complex for further reaction cycles.

$Cp^{*}Ru\ Cl\ (\ P\ Ph_3\ )_2$, $Cp^{*}Ru$ (COD) and $Cp^{*}[\ Ru\ Cl_4\ ]$ are commonly used ruthenium catalysts. Catalysts containing cyclo penta dienyl (Cp) group are also used. However, better results are observed with the penta methyl cyclo penta dienyl (Cp^{*}) version. This may be due to the sterically demanding Cp^{*} group which facilitates the displacement of the spectator ligands .



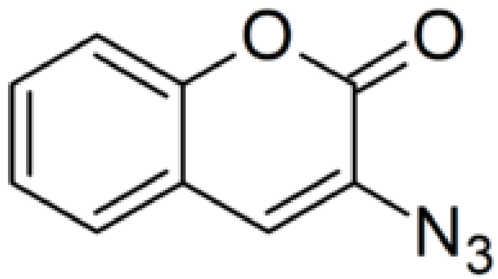
X = Cl
L = Spectator ligand

Figure 2: Mechanism of Ruthenium catalysed click reaction

4 - Silver catalysis

Recently, the discovery of a general Ag (I)- catalyzed azide–alkyne cyclo addition reaction (Ag – AAC) leading to 1,4- tri azoles is reported. Mechanistic features are similar to the generally accepted mechanism of the copper (I) -catalyzed process. Interestingly, silver(I)-salts alone are not sufficient to promote the cycloaddition. However the ligated Ag (I) source has proven to be exceptional for AgAAC reaction . Curiously, pre - formed silver acetylides do not react with azides ; however, silver acetylides do react with azides under catalysis with copper (I).

3 - Azido Coumarin



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1 - Introduction

3 - Azido coumarin is an organic compoundthat is used in the area of bioconjugation. It is a derivative of coumarin, a natural product and precursor for the widely used Coumadin. Azidocoumarin has emerged as a widely applicable labeling agent in diverse biological systems. In particular, it participates in the aptly named *click reaction* with alkynes . Bio conjugation involves the labeling of certain cellular components and is applicable to fields such a proteomics and functional genomics with a detachable, fluorescent tag .

IUPAC name 3-Azido-2*H*-chromen-2-one	
Molecular formula	$C_9\ H_6\ N_3\ O_2$
Molar mass	188 g mol^{-1}
Appearance	Brown solid
Melting point	108 - 112 °C

2 - Synthesis

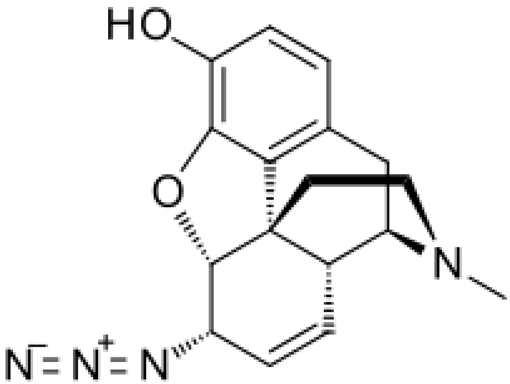
A common way to produce the 3-azidocoumarin is by condensation of salicyl aldehyde and *N*-acetyl glycine or nitro acetate

The intermediate is trapped with sodium azide to produce the 3-azido coumarin. The isomeric 4 - azido coumarin (CAS # 42373 -56 -8) product can also be prepared from 4-hydroxy coumarin via the 4-chloro derivative, which reacts with sodium azide .

3 – Uses

This compound is used for bio conjugation. The target, which contains a terminal alkynefunctional group, is treated with the azide in the presence of a Cu (I) catalyst. The resulting1,2,3 - triazole is fluorescent. The coumarin backbone is chosen to be used as the profluorophore due to its small size, biocompatibility, and its ability to be easily manipulated syntheticall . Illustrative of this is the labeling of biological compounds such as the proteincalmodulin.[5] Neither the azidocoumarin nor the alkyne substrate fluoresce. Azidocoumarin is also inert in biological systems and insensitive to pH and solvent. A variety of azidocoumarin compounds have been evaluated.

Azido Morphine

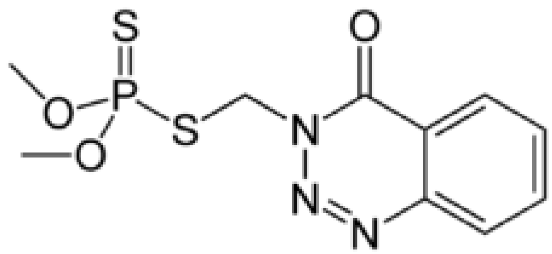


Azidomorphine is an opiate analogue that is a derivative of morphine, where the 7,8 double bond has been saturated and the 6-hydroxy group has been replaced by an azidegroup.

Azidomorphine binds with high affinity to themu opioid receptor, and is around 40x more potent than morphine *in vivo*. It has similar effects to morphine including analgesia , sedation and respiratory depression . However its addiction liability has been found to be slightly lower than that of morphine

Systematic (IUPAC) name	
(6 β) -Azido - 4,5-α- epoxy-17- methyl morphinan -3- ol	
Formula	$C_{17}H_{20}N_4O_2$
Mol. mass	312 g / mol

Azinphos – Methyl



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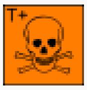
1 - Introduction

Azinphos - methyl (Guthion) (also spelled azinophos – methyl) is a broad spectrum organo phosphate insecticide manufactured by Bayer Crop Science, Gowan Co., and Makhteshim Agan . Like other pesticides in this class, it owes its insecticidal properties (and human toxicity) to the fact that it is an acetyl choline sterase inhibitor.

IUPAC name *O*,*O*-Dimethyl *S*-[(4-oxo-1,2,3-benzo triazin-3(4*H*)-yl) methyl] dithio phosphate	
Other names Guthion , azinphos methyl , azinphos	
Molecular formula	$C_{10} H_{12} N_3 O_3 P S_2$
Molar mass	317 g mol^{-1}
Appearance	Pale , dark orange , translucent crystals
Density	1.44 g cm^{-3}
Melting point	73 °C
Boiling point	> 200 °C (decomposes)
Solubility in water	28 mg dm^{-3}
Hazards	
MSDS	External MSDS

GHS pictograms	 
GHS signal word	Danger
EU classification	 **T +**  **N**
Flash point	69 °C

2 - History and uses

Azinphos - methyl is a neuro toxin derived from nerve agents developed during World War II. In the US, it is registered for use on select nut trees , vegetable crops, and fruit trees. It is not registered for consumer or residential use. It has been linked to health problems of farmers who apply it, and the U.S. Environmental Protection Agency (EPA) considered a denial of reregistration, citing, “concern to farm workers, pesticide applicators, and aquatic ecosystems". After settling a 2004 lawsuit brought by the United Farm Workers of America and other groups, the EPA accounced it would begin phasing out the remaining uses of the pesticide in 2007 with all uses ending in 2012. In January 2007, the suit was reopened, with the plaintiffs seeking a quicker phaseout.

Azinphos - methyl has been banned in the European Union since 2006.

The New Zealand Environmental Risk Management Authority made a decision to phase out azinphos - methyl over a five-year period starting from 2009.

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	Pirimiphos - Methyl
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	Piroheptine
	Pistol and rifle cartridges
	Piston engine
	Pizza delivery
	Plasmalemmal
	Plastic bullets
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	Potassium chlorate
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	Procyclidine
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	Prostate cancer
	Protechnik
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	Protesters
	Protests against the military government in Egypt
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	Psoralen
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	Reactive material
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	Thallium azide
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