(U) Intercontinental Ballistic Missile

From Intellipedia

Order of Battle Page

An **intercontinental ballistic missile**, or **ICBM**, is a long-range (greater than 5,500 km or 3,500 miles) ballistic missile typically designed for nuclear weapons delivery, that is, delivering one or more nuclear warheads. Due to their great range and firepower, in an all-out nuclear war, submarine and land-based ICBMs would carry most of the destructive force, with nuclear-armed bombers the remainder.

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Overview

ICBMs are differentiated by having greater range and speed than other ballistic missiles: intermediate-range ballistic missiles (IRBMs), short-range ballistic missiles (SRBMs), and the newly-named theatre ballistic missiles. Categorizing missiles by range is necessarily subjective and the boundaries are chosen somewhat arbitrarily, and so exact boundaries between range classes are not (and never can be) authoritative except within a community which has agreed to a set of definitions.

A Minuteman III ICBM test launch from Vandenberg AFB, California, United States.

All five of the nations with permanent seats on the United Nations Security Council have operational ICBM systems: all have submarine-launched missiles, and Russia, the United States and China also have land-based missiles.

India is developing the Surya-I ICBM after successfully test firing Agni-III IRBM. North Korea is believed to be developing an ICBM;[1] two tests of somewhat different developmental missiles in 1998 and 2006 were not fully successful.[2][3]

In 1991, the United States and the Soviet Union agreed in the START I

treaty to reduce their deployed ICBMs and attributed warheads.

History

The development of the first two-staged ICBM A9/10 to bomb New York and other American cities was undertaken by Nazi Germany by team of Wernher von Braun under *Project Amerika*. The ICBM A9/A10 rocket firstly was intend to be guided by radio and then (after failure of *Elster operation*) by pilot (astronaut de-facto due to highest point of sub-orbital flight traectory above 80 km). The second stage of A9/A10 rocket was tested few times in January and February 1945 (that was no confirmed widely as manned). The progenitor for the A9/A10 was the German V2 (Vergeltung, or "Reprisal", officially called A4) rocket designed by von Braun also and widely used at the end of World War II to bomb English and Belguim cities and goals. All of these rockets used liquid propellant. Following WWII von Braun and other lead Nazi scientists were secretly transferred to the United States to work directly for the U.S. Army through Operation Paperclip developing the IRBMs and ICBMs and space launchers.

The USSR had no similar territory in the 1950s, so under the direction of reactive propulsion engineer Sergei Korolev a program to develop an ICBM was accelerated. Korolev was given access to some captured V2 materials but found the V2 design weak and developed his own distinct design, the R-7, that was tested in August 1957 and, on 4 October 1957, placed the first Sputnik (satellite) in space -- thus opening the era of space exploration for humankind.

In the USA, competition between the U.S. armed services meant that each force developed its own ICBM program, slowing progress. The U.S.'s first ICBM was the Atlas, operational in 1959. Both the R7 and Atlas required a large launch facility, making them vulnerable to attack, and could not be kept in a ready state. Early ICBMs formed the basis of many space launch systems. Examples include: Atlas, Redstone rocket, Titan, R-7, and Proton, which was derived from the earlier ICBMs but never deployed as an ICBM. The UK built its own ICBM Blue Streak but it was never made operational due to the difficulty of finding a launch site away from population centers. The Eisenhower administration supported the development of solid-fueled missiles such as the LGM-30 Minuteman, Polaris and Skybolt. Modern ICBMs tend to be smaller than their ancestors (due to increased accuracy and smaller and lighter warheads) and use solid fuels, making them less useful as orbital launch vehicles. Deployment of these systems was governed by the strategic theory of Mutually Assured Destruction.

In the 1970s development began on Anti-Ballistic Missile Systems by both the U.S. and USSR but these were restricted by treaty in order to preserve the value of the existing ICBM systems. President Ronald Reagan launched the Strategic Defense Initiative as well as the MX and Midgetman ICBM programmes. This led to the agreement of a series of Strategic Arms Reduction Treaty negotiations.

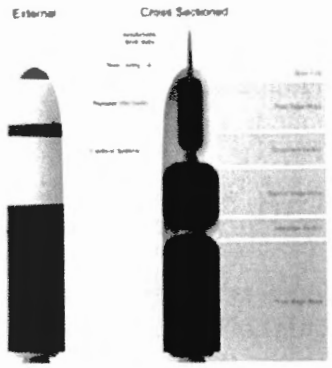
Countries in the early stages of developing ICBMs have all used liquid propellants for the sake of simplicity.

Modern ICBMs

Modern ICBMs typically carry multiple independently targetable reentry vehicles (*MIRVs*), each of which carries a separate nuclear warhead, allowing a single missile to hit multiple targets. MIRV was an outgrowth of the rapidly shrinking size and weight of modern warheads and the Strategic Arms Limitation Treaties which imposed limitations on the number of launch vehicles (SALT I and SALT II). It has also proved to be an "easy answer" to proposed deployments of ABM systems - it is far less expensive to add more warheads to an existing missile system than to build an ABM system capable of shooting down the additional warheads; hence, most ABM system proposals have been judged to be impractical. The first operational ABM systems were deployed in the 1970s, the U.S. Safeguard ABM facility was located in North Dakota and was operational from 1975 - 1976. The USSR deployed its Galosh ABM system around

Moscow in the 1970s, which remains in service. Israel deployed a national ABM system based on the Arrow missile in 1998,[4] but it is mainly designed to intercept shorter-ranged theater ballistic missiles, not ICBMs. The U.S. Alaska-based National Missile Defense system attained initial operational capability in 2004. ICBMs can be deployed from multiple platforms:

- in missile silos, which offer some protection from military attack (including, the designers hope, some protection from a nuclear first strike)
- on submarines: submarine-launched ballistic missiles (SLBMs); most or all SLBMs have the long range of ICBMs (as opposed to IRBMs)
- on heavy trucks; this applies to one version of the RT-2UTTH Topol M which may be deployed from a self-propelled mobile launcher, capable of moving through roadless terrain, and launching a missile from any point along its route
- mobile launchers on rails; this applies, for example, to РТ-23УТТХ "Молодец" (RT-23UTTH "Molodets" -- SS-24 "Scalpel")



External and cross sectional views of a Trident II D5 nuclear missile system. It is a submarine launched missile capable of carrying multiple nuclear warheads up to 8,000 km. Trident missiles are carried by fourteen active US Navy Ohio class submarines and four Royal Navy Vanguard class submarines.

The last three kinds are mobile and therefore hard to find.

During storage, one of the most important features of the missile is its serviceability. One of the key features of the first computer-controlled ICBM, the Minuteman missile, was that it could quickly and easily use its computer to test itself.

In flight, a booster pushes the warhead and then falls away. Most modern boosters are solid-fueled rocket motors, which can be stored easily for long periods of time. Early missiles used liquid-fueled rocket motors. Many liquid-fueled ICBMs could not be kept fuelled all the time as the cryogenic liquid oxygen boiled off and caused ice formation, and therefore fueling the rocket was necessary before launch. This procedure was a source of significant operational delay, and might cause the rockets to be destroyed before they could be used. To resolve this problem the British invented the missile silo that protected the missile from a first strike and also hid fuelling operations underground.

Once the booster falls away, the warhead falls on an unpowered path much like an orbit, except that it hits the earth at some point. Moving in this way is stealthy. No rocket gases or other emissions occur to indicate the missile's position to defenders. Also, it is the fastest way to get from one part of the Earth to another. This increases the element of surprise. The high speed of a ballistic warhead (near 5 miles per second) also makes it difficult to intercept.

Many authorities say that missiles also release aluminized balloons, electronic noisemakers, and other items intended to confuse interception devices and radars (see penetration aid).

The high speed can cause the missile to get very hot as it reenters the atmosphere. Ballistic warheads are protected by heatshields constructed of materials such as pyrolytic graphite, and in early missiles, thick plywood. Plywood approaches the strength per weight of carbon fiber/epoxy composites and chars slowly, protecting the missile.

Accuracy is crucial, because doubling the accuracy decreases the needed warhead energy by a factor of four. Accuracy is limited by the accuracy of the navigation system and the available geophysical information.

Strategic missile systems are thought to use custom integrated circuits designed to calculate navigational

differential equations thousands to millions of times per second in order to reduce navigational errors caused by calculation alone. These circuits are usually a network of binary addition circuits that continually recalculate the missile's position. The inputs to the navigation circuit are set by a general purpose computer according to a navigational input schedule loaded into the missile before launch.

One particular weapon developed by the Soviet Union (FOBS) had a partial orbital trajectory, and unlike most ICBMs its target could not be deduced from its orbital flight path. It was decommissioned in compliance with arms control agreements, which address the maximum range of ICBMs and prohibit orbital or fractional-orbital weapons.

Low-flying guided cruise missiles are an alternative to ballistic missiles.

Flight Phases

The following flight phases can be distinguished:

- **Boost Phase**: 3 to 5 minutes (shorter for a solid rocket than for a liquid-propellant rocket); altitude at the end of this phase is typically 150 to 400 km depending on the trajectory chosen, typical burnout speed is 7 km/s.
- **Midcourse Phase**: approx. 25 minutes - sub-orbital spaceflight in an elliptic orbit; the orbit is part of an ellipse with a vertical major axis; the apogee (halfway the midcourse phase) is at an altitude of approximately 1200 km; the semi-major axis is between 3,186 km and 6,372 km; the projection of the orbit on the Earth's surface is close to a great circle, slightly displaced due to earth rotation during the time of flight; the missile may release several independent warheads, and penetration aids such as metallic-coated balloons, aluminum chaff, and full-scale warhead decoys.
- **Reentry Phase**: (starting at an altitude of 100 km) - 2 minutes - impact is at a speed of up to 4 km/s (for early ICBMs less than 1 km/s); see also maneuverable reentry vehicle.

Specific Missiles

Land-Based ICBMs

The U.S. Air Force currently operates 500 ICBMs around 3 air force bases located primarily in the northern Rocky Mountain states and the Dakotas. These are of the LGM-30 Minuteman III ICBM variant only. Peacekeeper missiles were phased out in 2005.[5]

Testing at the Kwajalein Atoll of the Peacekeeper re-entry vehicles, all eight fired from only one missile. Each line, were its warhead live, represents the potential explosive power of about 375 kilotons.

All USAF Minuteman II missiles have been destroyed in accordance with START, and their launch silos have been sealed or sold to the public. To comply with the START II most U.S. multiple independently targetable reentry vehicles, or MIRVs, have been eliminated and replaced with single warhead missiles. However, since the abandonment of the START II treaty, the U.S. is said to be considering retaining 800 warheads on 500 missiles.

MIRVed land-based ICBMs are considered destabilizing because they tend to put a premium on striking first. If we assume that each side has 100 missiles, with 5 warheads each, and further that each side has a 95 percent chance of neutralising the opponent's missiles in their silos by firing 2 warheads at each silo. In this case, the side that strikes first can reduce the enemy ICBM force from 100 missiles to about 5 by firing 40 missiles with 200 warheads, and keeping the rest of 60 missiles in reserve. It is because of this that this type of weapon was banned

under the START II agreement.

The United States Air Force awards two badges for performing duty in a nuclear missile silo. The Missile Badge is presented to enlisted and commissioned maintainers while the Space and Missile Pin is awarded to enlisted and commissioned operators.

Sea-Based ICBMs

A *Trident* missile launch at sea from a Royal Navy submarine.

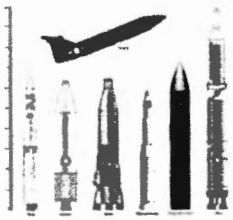
- The U.S. Navy currently has 14 *Ohio*-class SSBNs deployed. Each submarine is equipped with a complement of 24 Trident II missiles, for a total of 288 missiles equipped with 1152 nuclear warheads.
- The Russian Navy currently has 13 SSBNs deployed, including 6 Delta III class submarines, 6 Delta IV class submarines and 1 Typhoon class submarine, for a total of 181 missiles equipped with 639 nuclear warheads. Missiles includes the R-29R, R-29RM/Sineva and Bulava SLBMs (deployed on the single Typhoon SSBN as a testbed for the next generation Borei class submarines being built).
- The French Navy constantly maintains at least four active units, relying on two classes of nuclear-powered ballistic submarines (SSBN): the older *Redoutable* class, which are being progressively decommissioned, and the newer *le Triomphant* class. These carry 16 M45 missiles with TN75 warheads, and are scheduled to be upgraded to M51 nuclear missiles around 2010.
- The UK's Royal Navy has four Vanguard class submarines, each armed with 16 Trident II SLBMs.
- China's People's Liberation Army Navy has one Xia class submarine with 12 single-warhead JL-1 SLBMs. The PLAN is also developing the new Type 094 SSBN that will have up to 16 JL-2 SLBMs (possibly MIRV), which are also in development.

Current and Former Ballistic Missiles

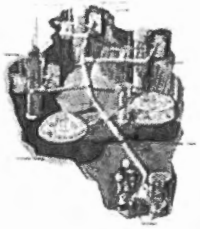
Country	Nomenclature		Notes/Alternate Designations
	Name	Numerical	
U.S.	Atlas	SM-65, CGM-16	Former ICBM launched from silo, the rocket is now used for other purposes
	Titan I	SM-68, HGM-25A	Based in underground launch complexes.
	Titan II	SM-68B, LGM-25C	Former ICBM launched from silo, the rocket is now used for other purposes
	Minuteman I	SM-80, LGM-30A/B, HSM-80	Launched from silo - as of November 2006, there are 500 Minuteman III missiles in active inventory
	Minuteman II	LGM-30F	
	Minuteman III	LGM-30G	
	Peacekeeper/MX	LGM-118A	Silo-based; decommissioned in May 2006
	Midgetman		has never been operational - launched from mobile launcher
	Polaris A1/A2/A3	UGM-27/A/B/C	Former SLBM
	Poseidon C3	UGM-73	Former SLBM
	Trident	UGM-93A/B	SLBM - Trident II (D5) was first deployed in 1990 and is planned to be deployed past 2020.
Soviet Union/Russia	Sotka	MR-UR-100	15A15/ SS-17 Spanker
	Semyorka	R7	8K71 / SS-6 Sapwood
	Desna	R-9	SS-8 Sasin
	R-16		SS-7 Saddler
	R-36		SS-9 Scarp
	Voevoda	R-36M2	SS-18 Satan
	Molodets	RT-23	SS-24 Scalpel
	Topol	RT-2PM	15Zh58/SS-25 Sickle
	Topol M	RT-2UTTKh	SS-27
	UR-100		8K84/SS-11 Sego
	UR-100N		15A30/SS-19 Stiletto
China	DF-3		Cancelled. Program name transferred to a MRBM.
	DF-5	CSS-4	Silo based
	DF-6		Cancelled
	DF-22		Cancelled by 1995.
	DF-31	CSS-9	Silo and road mobile
	DF-41	CSS-X-10	In development.
	Specific types of Chinese ICBMs called Dong Feng ("East Wind").		

Israel	Jericho III		6,000-7,800 km range suspected to be stockpiled throughout Israel
India	Agni-IV		Under development
	Surya-I		Under development
	Surya-II		Under development
Pakistan	Tippu Sultan		Under development
North Korea	Taepodong-2		Estimated 5,000 - 6,000 km range

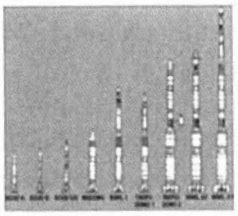
Missile Picture Gallery

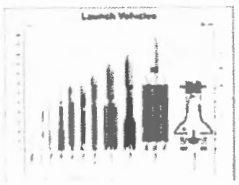


US ICBM Missile Comparrison



Titan I Silo





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Nuclear Weapons				
Arms Race	Delivery	Explosion Effects	History	Proliferation
Testing	Tests	Warfare	Weapons	
Weapon Design				
Teller-Ulam (Fusion)	Gun Type (Fission)	Implosion Type (Fission)	**ICBM**/SLBM	MIRV

Categories: Nuclear Technology | Nuclear Weapons | WMD | Intercontinental ballistic missile

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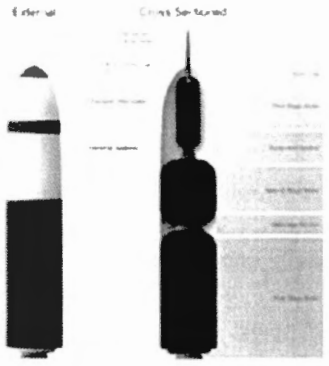

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Land-Based ICBMs and Cruise Missiles

The U.S. Air Force currently operates 500 ICBMs around 3 air force bases located primarily in the northern Rocky Mountain states and the Dakotas. These are of the LGM-30 Minuteman III ICBM variant only. Peacekeeper missiles were phased out in 2005.[5]

Testing at the Kwajalein Atoll of the Peacekeeper re-entry vehicles, all eight fired from only one missile. Each line, were its warhead live, represents the potential explosive power of about 375 kilotons.

All USAF Minuteman II missiles have been destroyed in accordance with START, and their launch silos have been sealed or sold to the public. To comply with the START II most U.S. multiple independently targetable reentry vehicles, or MIRVs, have been eliminated and replaced with single warhead missiles. However, since the abandonment of the START II treaty, the U.S. is said to be considering retaining 800 warheads on 500 missiles.

MIRVed land-based ICBMs are considered destabilizing because they tend to put a premium on striking first. If we assume that each side has 100 missiles, with 5 warheads each, and further that each side has a 95 percent chance of neutralising the opponent's missiles in their silos by firing 2 warheads at each silo. In this case, the side that strikes first can reduce the enemy ICBM force from 100 missiles to about 5 by firing 40 missiles with 200 warheads, and keeping the rest of 60 missiles in reserve. It is because of this that this type of weapon was banned under the START II agreement.

The United States Air Force awards two badges for performing duty in a nuclear missile silo. The Missile Badge is presented to enlisted and commissioned maintainers while the Space and Missile Pin is awarded to enlisted and commissioned operators.

Sea-Based ICBMs

- The U.S. Navy currently has 14 *Ohio*-class SSBNs deployed. Each submarine is equipped with a complement of 24 Trident II missiles, for a total of 288 missiles equipped with 1152 nuclear warheads.
- The Russian Navy currently has 13 SSBNs deployed, including 6 Delta III class submarines, 6 Delta IV class submarines and 1 Typhoon class submarine, for a total of 181 missiles equipped with 639 nuclear warheads. Missiles includes the R-29R, R-29RM/Sineva and Bulava SLBMs (deployed on the single Typhoon SSBN as a testbed for the next generation Borei class submarines being built).
- The French Navy constantly maintains at least four active units, relying on two classes of nuclear-powered ballistic submarines (SSBN): the older *Redoutable* class,

A *Trident* missile launch at sea from a Royal Navy submarine.

which are being progressively decommissioned, and the newer *le Triomphant* class. These carry 16 M45 missiles with TN75 warheads, and are scheduled to be upgraded to M51 nuclear missiles around 2010.

- The UK's Royal Navy has four Vanguard class submarines, each armed with 16 Trident II SLBMs.
- China's People's Liberation Army Navy has one Xia class submarine with 12 single-warhead JL-1 SLBMs. The PLAN is also developing the new Type 094 SSBN that will have up to 16 JL-2 SLBMs (possibly MIRV), which are also in development.

Current and Former Ballistic Missiles

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Country	Nomenclature		Notes/Alternate Designations
	Name	Numerical	
U.S.	Atlas	SM-65, CGM-16	Former ICBM launched from silo, the rocket is now used for other purposes
	Titan I	SM-68, HGM-25A	Based in underground launch complexes.
	Titan II	SM-68B, LGM-25C	Former ICBM launched from silo, the rocket is now used for other purposes
	Minuteman I	SM-80, LGM-30A/B, HSM-80	Launched from silo - as of November 2006, there are 500 Minuteman III missiles in active inventory
	Minuteman II	LGM-30F	
	Minuteman III	LGM-30G	
	Peacekeeper/MX	LGM-118A	Silo-based; decommissioned in May 2006
	Midgetman		has never been operational - launched from mobile launcher
	Polaris A1/A2/A3	UGM-27/A/B/C	Former SLBM
	Poseidon C3	UGM-73	Former SLBM
	Trident	UGM-93A/B	SLBM - Trident II (D5) was first deployed in 1990 and is planned to be deployed past 2020.
Soviet Union/Russia	Sotka	MR-UR-100	15A15/ SS-17 Spanker
	Semyorka	R7	8K71 / SS-6 Sapwood
	Desna	R-9	SS-8 Sasin
	R-16		SS-7 Saddler
	R-36		SS-9 Scarp
	Voevoda	R-36M2	SS-18 Satan
	Molodets	RT-23	SS-24 Scalpel
	Topol	RT-2PM	15Zh58/SS-25 Sickle
	Topol M	RT-2UTTKh	SS-27
	UR-100		8K84/SS-11 Sego
	UR-100N		15A30/SS-19 Stiletto
China	DF-3		Cancelled. Program name transferred to a MRBM.
	DF-5	CSS-4	Silo based
	DF-6		Cancelled

	DF-22		Cancelled by 1995.
	DF-31	CSS-9	Silo and road mobile
	DF-41	CSS-X-10	In development.
	Specific types of Chinese ICBMs called Dong Feng ("East Wind").		
Israel	Jericho III		6,000-7,800 km range suspected to be stockpiled throughout Israel
	Agni-IV		Under development
India	Surya-I		Under development
	Surya-II		Under development
Pakistan	Tippu Sultan		Under development
North Korea	Taepodong-2		Estimated 5,000 - 6,000 km range

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Nuclear Weapons

Arms Race	Delivery	Explosion Effects	History	Proliferation
Testing	Tests	Warfare	Weapons	

Weapon Design

Teller-Ulam (Fusion)	Gun Type (Fission)	Implosion Type (Fission)	**ICBM**/SLBM	MIRV

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