**Intercontinental Ballistic Missile**

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*"ICBM" redirects here. For the geotag, see ICBM address.*

Test launch of an LGM-25C Titan II ICBM from an underground silo at Vandenberg AFB, during the mid-1970s

A Minuteman III ICBM test launch from Vandenberg Air Force Base, California, United States

An **Intercontinental Ballistic Missile** (**ICBM**) is a ballistic missile with a range of more than 5,500 kilometers (3,400 mi) typically designed for nuclear weapons delivery (delivering one or more nuclear warheads). Most modern designs support multiple independently targetable reentry vehicles (MIRVs), allowing a single missile to carry several warheads, each of which can strike a different target.

Early ICBMs had limited accuracy that allowed them to be used only against the largest targets such as cities. They were seen as a "safe" basing option, one that would keep the deterrent force close to home where it would be difficult to attack. Attacks against military targets, if desired, still demanded the use of a manned bomber. Second and third generation designs dramatically improved accuracy to the point where even the smallest point targets can be successfully attacked. Similar evolution in size has allowed similar missiles to be placed on submarines, where they are known as submarine-launched ballistic missiles, or SLBMs. Submarines are an even safer basing option than land-based missiles, able to move about the ocean at will. This evolution in capability has pushed the manned bomber from the front-line deterrent forces, and land-based ICBMs have similarly given way largely to SLBMs.

ICBMs are differentiated by having greater range and speed than other ballistic missiles: intermediate-range ballistic missiles (IRBMs), medium-range ballistic missiles (MRBMs), short-range ballistic missiles (SRBMs)—these shorter range ballistic missiles are known collectively as theatre ballistic missiles. There is no single, standardized definition of what ranges would be categorized as intercontinental, intermediate, medium, or short. Additionally, ICBMs are generally considered to be nuclear only, although several conceptual designs of conventionally armed missiles have been considered. The launch of a non-nuclear ICBM, however, would be considered so threatening that it would demand a nuclear response, eliminating any military value of such a weapon.

**History**

**World War II**

The development of the world's first practical design for an ICBM, A9/10, intended for use in bombing New York and other American cities, was undertaken in Nazi Germany by the team of Werner von Braun under *Projekt Amerika*. The ICBM A9/A10 rocket initially was intended to be guided by radio, but was changed to be a piloted craft after the failure of Operation Elster. The second stage of the A9/A10 rocket was tested a few times in January and February 1945. The progenitor of the A9/A10 was the German V-2 rocket, also designed by von Braun and widely used at the end of World War II to bomb British and Belgian cities. All of these rockets used liquid propellants. Following the war, von Braun and other leading German scientists were relocated to the United States to work directly for the U.S. Army through Operation Paperclip, developing the IRBMs, ICBMs, and launchers.

This technology was also predicted by US Army General Hap Arnold who wrote in 1943:

Someday, not too distant, there can come streaking out of somewhere – we won't be able to hear it, it will come so fast – some kind of gadget with an explosive so powerful that one projectile will be able to wipe out completely this city of Washington.

The Soviet R-36 (SS-18 Satan) is the largest ICBM in history, with a Throw weight of 8,800 kg, twice that of Peacekeeper.

**Cold War**

In the immediate post-war era, the US and USSR both started rocket research programs based on the German wartime designs, especially the V-2. In the US, each branch of the military started its own programs, leading to considerable duplication of effort. In the USSR, rocket research was centrally organized, although several teams worked on different designs. Early designs from both countries were short-range missiles, like the V-2, but improvements quickly followed.

World's first ICBM and orbital launch vehicle: Korolyov's R7 Semyorka.

1965 graph of USAF Atlas and Titan ICBM launches, cumulative by month with failures highlighted (pink). This clearly shows how NASA use of ICBM boosters for Projects Mercury and Gemini (blue) served as a highly visible demonstration of confidence in reliability at a time when failure rates had been substantial. (Apollo-Saturn history and projections shown as well.)

In the USSR early development was focused on missiles able to attack European targets. This changed in 1953 when Sergei Korolyov was directed to start development of a true ICBM able to deliver newly developed hydrogen bombs. Given steady funding throughout, the R-7 developed with some speed. The first launch took place on 15 May 1957 and led to an unintended crash 400 km (250 mi) from the site. The first successful test followed on 21 August 1957; the R-7 flew over 6,000 km (3,700 mi) and became the world's first ICBM. The first strategic-missile unit became operational on 9 February 1959 at Plesetsk in north-west Russia.

It was the same R-7 launch vehicle that placed the first artificial satellite in space, Sputnik, on 4 October 1957. The first human spaceflight in history was accomplished on a derivative of R-7, Vostok, on 12 April 1961, by Soviet cosmonaut Yuri Gagarin. A deeply modernized version of the R-7 is still used as the launch vehicle for the Soviet/Russian Soyuz spacecraft, marking more than 50 years of operational history of the original Sergei Korolyov's rocket design.

The U.S. initiated ICBM research in 1946 with the MX-774 project. This was a three-stage effort with the ICBM development not starting until the third stage. However, funding was cut after only three partially successful launches in 1948 of the second stage design, used to test variations on the V-2 design. With overwhelming air superiority and truly intercontinental bombers, the newly forming US Air Force did not take the problem of ICBM development seriously. Things changed in 1953 with the Soviet testing of their first hydrogen bomb, but it was not until 1954 that the Atlas missile program was given the highest national priority. The Atlas A first flew on 11 June 1957; the flight lasted only about 24 seconds before the rocket blew up. The first successful flight of an Atlas missile to full range occurred 28 November 1958. The first armed version of the Atlas, the Atlas D, was declared operational in January 1959 at Vandenberg, although it had not yet flown. The first test flight was carried out on 9 July 1959, and the missile was accepted for service on 1 September.

The R-7 and Atlas each required a large launch facility, making them vulnerable to attack, and could not be kept in a ready state. Failure rates were very high throughout the early years of ICBM technology. Human spaceflight programs (Vostok, Mercury, Voskhood, Gemini, etc.) served as a highly visible means of demonstrating confidence in reliability, with successes translating directly to national defense implications. The US was well behind the Soviet Union in the Space Race, so President Kennedy increased the stakes with the Apollo Program, which used Saturn rocket technology that had been funded by Eisenhower.

U.S. Peacekeeper missile after silo launch.

These early ICBMs also formed the basis of many space launch systems. Examples include R-7, Atlas, Redstone, Titan, and Proton, which was derived from the earlier ICBMs but never deployed as an ICBM. 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.

The Western view of the deployment of these systems was governed by the strategic theory of Mutual Assured Destruction. In the 1950s and 1960s, development began on Anti-Ballistic Missile systems by both the U.S. and USSR; these systems were restricted by the 1972 ABM treaty. The first successful ABM test were conducted by the USSR in 1961, that later deployed a fully operating system defending Moscow in the 1970s (see Moscow ABM system).

The 1972 SALT treaty froze the number of ICBM launchers of both the USA and the USSR at existing levels, and allowed new submarine-based SLBM launchers only if an equal number of land-based ICBM launchers were dismantled. Subsequent talks, called SALT II, were held from 1972 to 1979 and actually reduced the number of nuclear warheads held by the USA and USSR. SALT II was never ratified by the United States Senate, but its terms were nevertheless honored by both sides until 1986, when the Reagan administration "withdrew" after accusing the USSR of violating the pact.

In the 1980s, President Ronald Reagan launched the Strategic Defense Initiative as well as the MX and Minuteman ICBM programs.

China developed a minimal independent nuclear deterrent entering its own cold war after an ideological split with the Soviet Union beginning in the early 1960s. After first testing a domestic built nuclear weapon in 1964, it went on to develop various warheads and missiles. Beginning in the early 1970s, the liquid fueled DF-5 ICBM was developed and used as a satellite launch vehicle in 1975. The DF-5, with range of 10,000 to 12,000 km (6,200 to 7,500 mi) long enough to strike the western US and the USSR, was silo deployed with the first pair in service by 1981 with possibly twenty missiles in service by the late 1990s. China also deployed the JL-1 Medium-range ballistic missile with a reach of 1,700 kilometers (1,100 mi) aboard the ultimately unsuccessful type 92 submarine.

**Post–Cold War**

In 1991, the United States and the Soviet Union agreed in the START I treaty to reduce their deployed ICBMs and attributed warheads.

As of 2009[update], all five of the nations with permanent seats on the United Nations Security Council have operational long-range ballistic missile systems: all except China have operational submarine-launched missiles, and Russia, the United States and China also have land-based ICBMs (the US' missiles are silo-based, China and Russia have both silo and road-mobile missiles).

Israel is believed to have deployed a road mobile nuclear ICBM, the Jericho III, which entered service in 2008, an upgraded version is in development.

India successfully test fired Agni V, with a strike range of more than 5,000 km (3,100 mi) on 19 April 2012, claiming entry into the ICBM club.

It is speculated by some intelligence agencies that North Korea is developing an ICBM; two tests of somewhat different developmental missiles in 1998 and 2006 were not fully successful. On 5 April 2009, North Korea launched a missile. They claimed that it was to launch a satellite, but there is no proof to back up that claim. Likewise, North Korea attempted another test firing in April 2012, claimed also as a satellite launch, but it broke up in flight after 90 seconds. A successful launch of the 32-metre-tall (105 ft) Unha-3 put a satellite into space on 12 December 2012. (See Timeline of first orbital launches by country)

Most countries in the early stages of developing ICBMs have used liquid propellants, with the known exceptions being the Indian Agni-V, the planned South African RSA-4 ICBM and the now in service Israeli Jericho 3.

**Flight phases**

See also: Missile Defense#Classified by trajectory phase and Depressed trajectory

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 (93 to 250 mi) depending on the trajectory chosen, typical burnout speed is 7 km/s (4.3 mi/s), up to the speed of Low Earth Orbit.
* midcourse phase: approx. 25 minutes—sub-orbital spaceflight in an elliptic flightpath; the flightpath is part of an ellipse with a vertical major axis; the apogee (halfway through the midcourse phase) is at an altitude of approximately 1,200 km (750 mi); the semi-major axis is between 3,186 and 6,372 km (1,980 and 3,959 mi); the projection of the flightpath 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 (62 mi)): 2 minutes – impact is at a speed of up to 4 km/s (2.5 mi/s) (for early ICBMs less than 1 km/s (0.62 mi/s)); see also maneuverable reentry vehicle.

**Modern ICBMs**

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 (5,000 mi). Trident missiles are carried by fourteen active US Navy *Ohio*-class and four Royal Navy *Vanguard*-class submarines.

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 U.S. during 1970s. Safeguard ABM facility was located in North Dakota and was operational from 1975 to 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, 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 TELs such as the Russian Topol.

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 "Sсаlреl")

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 fueled 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 allow the missiles to be destroyed by enemy counterparts 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 fueling operations underground.

Once the booster falls away, the warhead continues on an unpowered ballistic trajectory, much like an artillery shell or cannon ball. The warhead is encased in a cone-shaped reentry vehicle and is difficult to detect in this phase of flight as there is no rocket exhaust or other emissions to mark its position to defenders. The high speeds of the warheads make them difficult to intercept and allow for little warning striking targets many thousands of kilometers away from the launch site (and due to the possible locations of the submarines: anywhere in the world) within approximately 30 minutes.

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

As the nuclear warhead reenters the Earth's atmosphere its high speed causes compression of the air, leading to a dramatic rise in temperature which would destroy it if it were not shielded in some way. As a result, warhead components are contained within an aluminum honeycomb substructure, sheathed in pyrolytic graphite-epoxy resin composite, with a heat-shield layer on top which is constructed out of 3-Dimensional Quartz Phenolic.

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.

**Specific ICBMs**

**Land-based ICBMs**

* Peacekeeper (10,000 km (6,200 mi)+) (USA)
* Minuteman (10,000+ km) (USA)
* R-36M2 (SS-18) (10,000+ km) (Soviet Union, Russia)
* UR-100N (SS-19) (10,000+ km) (Soviet Union, Russia)
* RT-2PM "Topol" (SS-25) (10,000+ km) (Soviet Union, Russia)
* RT-2UTTH "Topol M" (SS-27) (10,000+ km) (Russia)
* RS-24 "Yars" (SS-29) (10,000+ km) (Russia)
* Agni-V (5500–6000 km) (India)
* Agni-VI (8000–10000 km) (India) (Under Development)
* Surya missile (12,500+ km) (India)(Speculated)
* DF-31 (10,000+ km) (China)
* DF-5 (10,000+ km) (China)
* DF-41 (10,000+ km) (China)
* Jericho III (4,800 to 11,500 km) (Israel)

Testing of the Peacekeeper re-entry vehicles at the Kwajalein Atoll. All eight fired from only one missile. Each line, if its warhead were live, represents the potential explosive power of about 375 kilotons of TNT, about twelve times larger than the detonation of the atomic bomb in Hiroshima.

Russia, the United States, China and India are the only countries currently known to possess land-based ICBMs.

The United States currently operates 450 ICBMs in three USAF bases. The only model deployed is LGM-30G Minuteman-III.

All previous 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. The powerful MIRV-capable Peacekeeper missiles were phased out in 2005. However, since the abandonment of the START II treaty, the U.S. is said to be considering retaining 800 warheads on an existing 450 missiles.

The Russian Strategic Rocket Forces have 369 ICBMs able to deliver 1,247 nuclear warheads, 58 silo-based R-36M2 (SS-18), 70 silo-based UR-100N (SS-19), 171 mobile RT-2PM "Topol" (SS-25), 52 silo-based RT-2UTTH "Topol M" (SS-27), 18 mobile RT-2UTTH "Topol M" (SS-27), 6 (15 in December 2011) mobile RS-24 "Yars" (SS-29) *(Future replacement for R-36 & UR-100N missiles)*

China has developed several long range ICBMs, like the DF-31. The Dongfeng 5 or DF-5 is a 3 stage liquid fuel ICBM and has an estimated range of 13,000 kilometers. The DF-5 had its first flight in 1971 and was in operational service 10 years later. One of the downsides of the missile was that it took between 30 and 60 minutes to fuel. The Dong Feng 31 (a.k.a. CSS-10) is a medium-range, three-stage, solid-propellant intercontinental ballistic missile, and is a land-based variant of the submarine-launched JL-2.

The DF-41 or CSS-X-10 can carry up to 10 nuclear warheads, which are maneuverable reentry vehicles and has a range of approximately 12,000–14,000 km (7,500–8,700 mi).

Israel is believed to have deployed a road mobile nuclear ICBM, the Jericho III, which entered service in 2008. It is possible for the missile to be equipped with a single 750 kg (1,700 lb.) nuclear warhead or up to three MIRV warheads. It is believed to be based on the Shavit space launch vehicle and is estimated to have a range of 4,800 to 11,500 km (3,000 to 7,100 mi). In November 2011 Israel tested an ICBM believed to be an upgraded version of the Jericho III.

India has a series of ballistic missiles called Agni, of which the latest is Agni-V. On 19 April 2012, India successfully test fired Agni-V, a three stage solid fueled missile, with a strike range of more than 5,000 km (3,100 mi).

**Submarine-launched**

Main article: Submarine-launched ballistic missile

All current designs of submarine launched ballistic missiles have intercontinental range. Current operators of such missiles are the United States, Russia, United Kingdom, France and The People’s Republic of China. India has developed the K-15 Sagarika, and is working on the long range K-4 missile, which is part of the K Missile family.

**See also**

Artist's concept of [SS-24](http://en.wikipedia.org/wiki/SS-24) deployed on railway.

* [Air Force Global Strike Command](http://en.wikipedia.org/wiki/Air_Force_Global_Strike_Command)
* [Anti-ballistic missile](http://en.wikipedia.org/wiki/Anti-ballistic_missile)
* [Anti-Ballistic Missile Treaty](http://en.wikipedia.org/wiki/Anti-Ballistic_Missile_Treaty)
* [Atmospheric reentry](http://en.wikipedia.org/wiki/Atmospheric_reentry)
* [Countermeasure](http://en.wikipedia.org/wiki/Countermeasure)
* [Dense Pack](http://en.wikipedia.org/wiki/Dense_Pack)
* [Emergency Action Message](http://en.wikipedia.org/wiki/Emergency_Action_Message)
* [Fractional Orbital Bombardment System](http://en.wikipedia.org/wiki/Fractional_Orbital_Bombardment_System)
* [France and weapons of mass destruction](http://en.wikipedia.org/wiki/France_and_weapons_of_mass_destruction)
* [General Bernard Adolph Schriever](http://en.wikipedia.org/wiki/General_Bernard_Adolph_Schriever)
* [Heavy ICBM](http://en.wikipedia.org/wiki/Heavy_ICBM)
* [High-alert nuclear weapon](http://en.wikipedia.org/wiki/High-alert_nuclear_weapon)
* [People's Republic of China and weapons of mass destruction](http://en.wikipedia.org/wiki/People%27s_Republic_of_China_and_weapons_of_mass_destruction)
* [India and weapons of mass destruction](http://en.wikipedia.org/wiki/India_and_weapons_of_mass_destruction)
* [Israel and weapons of mass destruction](http://en.wikipedia.org/wiki/Israel_and_weapons_of_mass_destruction)
* [List of ICBMs](http://en.wikipedia.org/wiki/List_of_ICBMs)
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* [Nuclear disarmament](http://en.wikipedia.org/wiki/Nuclear_disarmament)
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* [Nuclear warfare](http://en.wikipedia.org/wiki/Nuclear_warfare)
* [Nuclear weapon](http://en.wikipedia.org/wiki/Nuclear_weapon)
* [Russia and weapons of mass destruction](http://en.wikipedia.org/wiki/Russia_and_weapons_of_mass_destruction)
* [SLBM](http://en.wikipedia.org/wiki/SLBM)
* [Strike Force (France)](http://en.wikipedia.org/wiki/Strike_Force_%28France%29)
* [Submarine](http://en.wikipedia.org/wiki/Submarine)
* [Throw-weight](http://en.wikipedia.org/wiki/Throw-weight)
* [United Kingdom and weapons of mass destruction](http://en.wikipedia.org/wiki/United_Kingdom_and_weapons_of_mass_destruction)
* [United States and weapons of mass destruction](http://en.wikipedia.org/wiki/United_States_and_weapons_of_mass_destruction)

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