**UGM-27 Polaris**

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| **UGM-27 Polaris** | |
| Polaris A-3 on launch pad prior to a test firing at [Cape Canaveral](https://en.wikipedia.org/wiki/Cape_Canaveral) | |
| **Type** | [Submarine-launched ballistic missile](https://en.wikipedia.org/wiki/Submarine-launched_ballistic_missile) |
| **Place of origin** | United States |
| **Service history** | |
| **In service** | 1961–1996 |
| **Used by** | [United States Navy](https://en.wikipedia.org/wiki/United_States_Navy), [Royal Navy](https://en.wikipedia.org/wiki/Royal_Navy) |
| **Production history** | |
| **Designed** | 1956–1960 |
| **Manufacturer** | [Lockheed Corporation](https://en.wikipedia.org/wiki/Lockheed_Corporation) |
| **Variants** | A-1, A-2, A-3, [Chevaline](https://en.wikipedia.org/wiki/Chevaline) |
| **Specifications (Polaris A-3 (UGM-27C))** | |
| **Weight** | 35,700 lb. (16,200 kg) |
| **Height** | 32 ft 4 in (9.86 m) |
| **Diameter** | 4 ft 6 in (1,370 mm) |
| **Warhead** | 3 x [W58](https://en.wikipedia.org/wiki/W58) [thermonuclear weapon](https://en.wikipedia.org/wiki/Thermonuclear_weapon) |
| **Blast yield** | 3 x 200 kT |
|  | |
| **Engine** | First stage, [Aerojet General](https://en.wikipedia.org/wiki/Aerojet_General) [Solid-fuel rocket](https://en.wikipedia.org/wiki/Solid-fuel_rocket) Second stage, [Hercules](https://en.wikipedia.org/wiki/Hercules_Inc.) rocket |
| **Propellant** | [Solid propellant](https://en.wikipedia.org/wiki/Solid_propellant) |
| **Operational range** | 2,500 nautical miles (4,600 km) |
| **Speed** | 8,000 mph (13,000 km/h) |
| **Guidance system** | [Inertial](https://en.wikipedia.org/wiki/Inertial_navigation_system) |
| **Steering system** | [Thrust vectoring](https://en.wikipedia.org/wiki/Thrust_vectoring) |
| **Accuracy** | [CEP](https://en.wikipedia.org/wiki/Circular_error_probable) 3,000 feet (910 m) |
| **Launch platform** | [Ballistic missile submarines](https://en.wikipedia.org/wiki/Ballistic_missile_submarine) |

The **UGM-27 Polaris** missile was a two-stage [solid-fueled](https://en.wikipedia.org/wiki/Solid-fuel_rocket) [nuclear-armed](https://en.wikipedia.org/wiki/Nuclear_warhead) [submarine-launched ballistic missile](https://en.wikipedia.org/wiki/Submarine-launched_ballistic_missile) (SLBM) built during the [Cold War](https://en.wikipedia.org/wiki/Cold_War) by [Lockheed Corporation](https://en.wikipedia.org/wiki/Lockheed_Corporation) for the [United States Navy](https://en.wikipedia.org/wiki/United_States_Navy).

It was designed to be used for [second strike](https://en.wikipedia.org/wiki/Second_strike) [countervalue](https://en.wikipedia.org/wiki/Countervalue) ([CEP](https://en.wikipedia.org/wiki/Circular_error_probable) not good enough for [first strike](https://en.wikipedia.org/wiki/First_strike) [counterforce](https://en.wikipedia.org/wiki/Counterforce)) as part of the Navy's contribution to the United States arsenal of nuclear weapons, replacing the [Regulus cruise missile](https://en.wikipedia.org/wiki/Regulus_missile). Known as a Fleet Ballistic Missile (FBM), the Polaris was first launched from the [Cape Canaveral, Florida](https://en.wikipedia.org/wiki/Cape_Canaveral,_Florida), missile test base on January 7, 1960.

Following the [Polaris Sales Agreement](https://en.wikipedia.org/wiki/Polaris_Sales_Agreement) in 1963, Polaris missiles were also carried on [British](https://en.wikipedia.org/wiki/United_Kingdom) [Royal Navy](https://en.wikipedia.org/wiki/Royal_Navy) submarines between 1968 and the mid-1990s.

Plans to equip the [Italian Navy](https://en.wikipedia.org/wiki/Marina_Militare) with the missile ended in the mid-60s, after several successful test launches carried out on board the [Italian cruiser *Giuseppe Garibaldi*](https://en.wikipedia.org/wiki/Italian_cruiser_Giuseppe_Garibaldi_(1936)). Despite the successful launching tests, the US never provided the missiles, due to political convenience. Instead the Italian Government set to develop an indigenous missile, called [Alfa](https://en.wikipedia.org/wiki/Alfa_(rocket)), with a successful program, officially halted by Italian [Nuclear Non-Proliferation Treaty](https://en.wikipedia.org/wiki/Nuclear_Non-Proliferation_Treaty) ratification and failure of the NATO [Multilateral Force](https://en.wikipedia.org/wiki/Multilateral_Force).

The Polaris missile was gradually replaced on 31 of the 41 original [SSBNs](https://en.wikipedia.org/wiki/Ballistic_missile_submarine) in the US Navy by the [MIRV](https://en.wikipedia.org/wiki/MIRV)-capable [Poseidon](https://en.wikipedia.org/wiki/UGM-73_Poseidon) missile beginning in 1972. During the 1980s, these missiles were replaced on twelve of these submarines by the [Trident I](https://en.wikipedia.org/wiki/UGM-96_Trident_I) missile. The ten [*George Washington*](https://en.wikipedia.org/wiki/George_Washington-class_submarine)- and [*Ethan Allen*-class](https://en.wikipedia.org/wiki/Ethan_Allen-class_submarine) SSBNs retained Polaris A-3 until 1980 because their missile tubes were not large enough to accommodate Poseidon. With [USS *Ohio*](https://en.wikipedia.org/wiki/USS_Ohio_(SSBN-726)) commencing sea trials in 1980, these submarines were disarmed and redesignated as [attack submarines](https://en.wikipedia.org/wiki/Attack_submarine) to avoid exceeding the [SALT II](https://en.wikipedia.org/wiki/SALT_II) strategic arms treaty limits.

Many new project management techniques were introduced during the development of the Polaris missile program, to deal with the inherent system complexity. This includes the use of the [Program Evaluation and Review Technique](https://en.wikipedia.org/wiki/Program_Evaluation_and_Review_Technique) (PERT). This technique replaced the simpler [Gantt chart](https://en.wikipedia.org/wiki/Gantt_chart) methodology which was largely employed prior to this program.

**History and development**

The Polaris missile replaced an earlier plan to create a submarine-based missile force based on a derivative of the U.S. Army [Jupiter](https://en.wikipedia.org/wiki/PGM-19_Jupiter) [Intermediate-range ballistic missile](https://en.wikipedia.org/wiki/Intermediate-range_ballistic_missile). [Chief of Naval Operations](https://en.wikipedia.org/wiki/Chief_of_Naval_Operations) Admiral [Arleigh Burke](https://en.wikipedia.org/wiki/Arleigh_Burke) appointed Rear Admiral [W. F. "Red" Raborn](https://en.wikipedia.org/wiki/William_Raborn) as head of a Special Project Office to develop Jupiter for the Navy in late 1955. The Jupiter missile's large diameter was a product of the need to keep the length short enough to fit in a reasonably-sized submarine. At the seminal [Project Nobska](https://en.wikipedia.org/wiki/Project_Nobska) conference in 1956, with Admiral Burke present, [nuclear physicist](https://en.wikipedia.org/wiki/Nuclear_physicist) [Edward Teller](https://en.wikipedia.org/wiki/Edward_Teller) stated that a physically small one-megaton warhead could be produced for Polaris within a few years, and this prompted Burke to leave the Jupiter program and concentrate on Polaris in December of that year. Polaris was spearheaded by the Special Project Office's Missile Branch under Rear Admiral Roderick Osgood Middleton, and is still under the Special Project Office. Admiral Burke later was instrumental in determining the size of the Polaris submarine force, suggesting that 40-45 submarines with 16 missiles each would be sufficient. Eventually, the number of Polaris submarines was [fixed at 41](https://en.wikipedia.org/wiki/41_for_Freedom).

There is a contention that the Navy's "Jupiter" missile program was unrelated to the Army program. A huge surfaced submarine would carry four "Jupiter" missiles, which would be carried and launched horizontally. This was probably the never-built [SSM-N-2 Triton](https://en.wikipedia.org/wiki/SSM-N-2_Triton) program. However, a history of the Army's Jupiter program states that the Navy was involved in the Army program, but withdrew at an early stage.

Originally, the Navy favored cruise missile systems in a strategic role, such as the [Regulus missile](https://en.wikipedia.org/wiki/Regulus_missile) deployed on the earlier [USS *Grayback*](https://en.wikipedia.org/wiki/USS_Grayback_(SSG-574)) and a few other submarines, but a major drawback of these early cruise missile launch systems (and the Jupiter proposals) was the need to surface, and remain surfaced for some time, to launch. Submarines were very vulnerable to attack during launch, and a fully or partially fueled missile on deck was a serious hazard. Rough weather was another major drawback for these designs, but rough sea conditions did not unduly affect Polaris' submerged launches.

It quickly became apparent solid-fueled ballistic missiles had advantages over cruise missiles in range and accuracy, and unlike both Jupiter and cruise, were able to be launched from a submerged submarine, improving submarine survivability.

The prime contractor for all three versions of Polaris was [Lockheed Missiles and Space Company](https://en.wikipedia.org/wiki/Lockheed_Missiles_and_Space_Company), now [Lockheed Martin](https://en.wikipedia.org/wiki/Lockheed_Martin).

The Polaris program started development in 1956. [USS *George Washington*](https://en.wikipedia.org/wiki/USS_George_Washington_(SSBN-598)), the first US missile submarine, successfully launched the first Polaris missile from a submerged submarine on July 20, 1960. The A-2 version of the Polaris missile was essentially an upgraded A-1, and it entered service in late 1961. It was fitted on a total of 13 submarines and served until June 1974.(1). Ongoing problems with the [W-47 warhead](https://en.wikipedia.org/wiki/W47), especially with its mechanical arming and safing equipment, led to large numbers of the missiles being recalled for modifications, and the U.S. Navy sought a replacement with either a larger yield or equivalent destructive power. The result was the [W-58 warhead](https://en.wikipedia.org/wiki/W58) used in a "cluster" of three warheads for the Polaris A-3, the final model of the Polaris missile.

**Guidance**

A predecessor to the [GPS](https://en.wikipedia.org/wiki/GPS) satellite navigation system, the [Transit system](https://en.wikipedia.org/wiki/Transit_(satellite)) (later called NAVSAT), was developed because the submarines needed to know their position at launch in order for the missiles to hit their targets. Two American physicists, William Guier and George Weiffenbach, at [Johns Hopkins](https://en.wikipedia.org/wiki/Johns_Hopkins_University)'s [Applied Physics Laboratory](https://en.wikipedia.org/wiki/Applied_Physics_Laboratory) (APL), began this work in 1958. A computer small enough to fit through a submarine hatch was developed in 1958, the [AN/UYK-1](https://en.wikipedia.org/wiki/AN/UYK-1). It was used to interpret the Transit satellite data and send guidance information to the Polaris, which had its own guidance computer made with ultra miniaturized electronics, very advanced for its time, because there wasn't much room in a Polaris—there were 16 on each submarine. The Ship's [Inertial Navigation System](https://en.wikipedia.org/wiki/Inertial_Navigation_System) (SINS) was developed earlier to provide a continuous [dead reckoning](https://en.wikipedia.org/wiki/Dead_reckoning) update of the submarine's position between position fixes via other methods, such as [LORAN](https://en.wikipedia.org/wiki/LORAN). This was especially important in the first few years of Polaris, because Transit was not operational until 1964. By 1965 microchips similar to the [Texas Instruments](https://en.wikipedia.org/wiki/Texas_Instruments) units made for the [Minuteman II](https://en.wikipedia.org/wiki/Minuteman_II) were being purchased by the Navy for the Polaris. The Minuteman guidance systems each required 2000 of these, so the Polaris guidance system may have used a similar number. To keep the price under control, the design was standardized and shared with [Westinghouse Electric Company](https://en.wikipedia.org/wiki/Westinghouse_Electric_Company) and [RCA](https://en.wikipedia.org/wiki/RCA). The price came down dramatically, from $1000 to $20 to $2, and they came to be used in commercial products.

**Polaris A-3**

This missile replaced the earlier A-1 and A-2 models in the [US Navy](https://en.wikipedia.org/wiki/US_Navy), and also equipped the British Polaris force. The A-3 had a range extended to 2,500 nautical miles (4,600 kilometers) and a new weapon bay housing three Mk 2 re-entry vehicles (ReB or Re-Entry Body in US Navy and British usage); and the new W-58 warhead of 200 [kt](https://en.wikipedia.org/wiki/Kiloton) yield. This arrangement was originally described as a "cluster warhead" but was replaced with the term Multiple Re-Entry Vehicle (MRV). The three warheads were spread about a common target and were not independently targeted (such as a [MIRV](https://en.wikipedia.org/wiki/MIRV) missile is). The three warheads were stated to be equivalent in destructive power to a single one-megaton warhead. Later the Polaris A-3 missiles (but not the ReBs) were also given limited hardening to protect the missile electronics against [electromagnetic pulse](https://en.wikipedia.org/wiki/Electromagnetic_pulse) effects while in the [boost phase](https://en.wikipedia.org/wiki/Boost_phase). This was known as the A-3T ("Topsy") and was the final production model.

**Polaris A-1**



Polaris A-1 on launch pad in Cape Canaveral

The initial test model of the Polaris was referred to as the AX series and made its maiden flight from Cape Canaveral on September 24, 1958. The missile failed to perform its pitch and roll maneuver and instead just flew straight up, however the flight was considered a partial success (at that time, "partial success" was used for any missile test that returned usable data). The next flight on October 15 failed spectacularly when the second stage ignited on the pad and took off by itself. Range Safety blew up the errant rocket while the first stage sat on the pad and burned. The third and fourth tests (December 30 and January 9) had problems due to overheating in the boattail section. This necessitated adding extra shielding and insulation to wiring and other components. When the final AX flight was conducted a year after the program began, 17 Polaris missiles had been flown of which five met all of their test objectives.

The first operational version, the Polaris A-1, had a range of 1,000 nautical miles (1,900 kilometers) and a single Mk 1 re-entry vehicle, carrying a single W-47-Y1 600 kt nuclear warhead, with an [inertial guidance](https://en.wikipedia.org/wiki/Inertial_guidance) system which provided a [Circular error probable](https://en.wikipedia.org/wiki/Circular_error_probable) (CEP) of 1,800 meters (5,900 feet). The [two-stage](https://en.wikipedia.org/wiki/Two-stage) [solid propellant](https://en.wikipedia.org/wiki/Solid_propellant) missile had a length of 28.5 ft (8.7 m), a body diameter of 54 inches (1.4 m), and a launch weight of 28,800 pounds (13,100 kg).



Universal International Newsreel of first Polaris submerged firing on 20 July 1960

[USS *George Washington*](https://en.wikipedia.org/wiki/USS_George_Washington_(SSBN-598)) was the first fleet ballistic missile submarine ([SSBN](https://en.wikipedia.org/wiki/Ballistic_missile_submarine) in U.S. naval terminology) and she and all other Polaris submarines carried 16 missiles. [Forty more SSBNs](https://en.wikipedia.org/wiki/41_for_Freedom) were launched in 1960 to 1966.

Work on its [W47](https://en.wikipedia.org/wiki/W47) [nuclear warhead](https://en.wikipedia.org/wiki/Nuclear_warhead) began in 1957 at the facility that is now called the [Lawrence Livermore National Laboratory](https://en.wikipedia.org/wiki/Lawrence_Livermore_National_Laboratory) by a team headed by [John Foster](https://en.wikipedia.org/wiki/John_S._Foster,_Jr.) and [Harold Brown](https://en.wikipedia.org/wiki/Harold_Brown_(Secretary_of_Defense)). The Navy accepted delivery of the first 16 warheads in July 1960. On May 6, 1962, a Polaris A-2 missile with a live W47 warhead was tested in the "Frigate Bird" test of [Operation Dominic](https://en.wikipedia.org/wiki/Operation_Dominic_I_and_II) by [USS *Ethan Allen*](https://en.wikipedia.org/wiki/USS_Ethan_Allen_(SSBN-608)) in the central [Pacific Ocean](https://en.wikipedia.org/wiki/Pacific_Ocean), the only American test of a live strategic nuclear missile.

The two stages were both steered by [thrust vectoring](https://en.wikipedia.org/wiki/Thrust_vectoring). Inertial navigation guided the missile to about a 900 m (3,000-foot) CEP, insufficient for use against hardened targets. They were mostly useful for attacking dispersed military surface targets (airfields or radar sites), clearing a pathway for heavy bombers, although in the general public perception Polaris was a strategic second-strike retaliatory weapon.

**Strategic role**



Transfer of a Polaris missile between [USS *Proteus*](https://en.wikipedia.org/wiki/USS_Proteus_(AS-19)) and [USS *Patrick Henry*](https://en.wikipedia.org/wiki/USS_Patrick_Henry_(SSBN-599)) at [Holy Loch](https://en.wikipedia.org/wiki/Holy_Loch), Scotland, in 1961.

The Polaris A-1 missile was developed to complement the limited number of medium-range systems deployed throughout Europe. As those systems lacked the range to attack major Soviet targets, Polaris was developed to increase the level of nuclear deterrence. At this time there was little threat of [counterforce](https://en.wikipedia.org/wiki/Counterforce) strikes, as few systems had the accuracy to destroy missile systems. The primary advantages of ballistic missile submarines was their ability to launch submerged, which offered improved survivability for the submarine while also (like their Regulus predecessors) keeping shorter ranged systems within range.

The USN had forward-basing arrangements for its Atlantic-based Polaris fleet with both the [United Kingdom](https://en.wikipedia.org/wiki/United_Kingdom) and [Spain](https://en.wikipedia.org/wiki/Spain), permitting the use of bases at the [Holy Loch](https://en.wikipedia.org/wiki/Holy_Loch) in [Scotland](https://en.wikipedia.org/wiki/Scotland) (established in 1961) and at [Naval Station Rota](https://en.wikipedia.org/wiki/Naval_Station_Rota) (Polaris base established 1964) in the Bay of Cadiz. The forward deployment bases were much closer to patrol areas than U.S. East Coast bases, avoiding the necessity for lengthy transit times. In the Pacific, a Polaris base was also established at [Guam](https://en.wikipedia.org/wiki/USS_Proteus_(AS-19)) in 1964. The [Regulus missile](https://en.wikipedia.org/wiki/Regulus_missile) program was deactivated with the advent of Polaris in the Pacific. The forward-basing arrangement was continued when [Poseidon](https://en.wikipedia.org/wiki/Poseidon_missile) replaced Polaris, starting in 1972, in what by then were the 31 Atlantic Fleet [SSBNs](https://en.wikipedia.org/wiki/SSBN). The 10 older SSBNs that could not use Poseidon were assigned to the Pacific Fleet in the 1970s. Polaris was not accurate enough to destroy hardened targets, but would have been effective against dispersed surface targets, such as airfields, radar and SAM sites, as well as military and industrial centers of strategic importance. The military authorities, however, regarded Polaris as but one part of a [nuclear triad](https://en.wikipedia.org/wiki/Nuclear_triad) including [ICBMs](https://en.wikipedia.org/wiki/ICBM) and bombers, each with its own function. The task allotted to Polaris of 'taking out' peripheral defenses was well-suited to its characteristics and limitations.

The forward deployment strategy required some infrastructure. To allow quick establishment of bases and to minimize the impact on the host country, each base was centered around a [submarine tender](https://en.wikipedia.org/wiki/Submarine_tender) and a [floating drydock](https://en.wikipedia.org/wiki/Floating_drydock), with minimal facilities on shore, mostly family support for the tender's crew. The first Polaris submarine tender was [USS *Proteus*](https://en.wikipedia.org/wiki/USS_Proteus_(AS-19)), a World War II tender that was refitted in 1959–60 with the insertion of a midships missile storage compartment and handling crane. *Proteus* established each of the three forward deployment bases. Four additional Polaris tenders ([*Hunley*](https://en.wikipedia.org/wiki/USS_Hunley_(AS-31)), [*Holland*](https://en.wikipedia.org/wiki/USS_Holland_(AS-32)), [*Simon Lake*](https://en.wikipedia.org/wiki/USS_Simon_Lake_(AS-33)), and [*Canopus*](https://en.wikipedia.org/wiki/USS_Canopus_(AS-34))) were commissioned 1962–65.

A two-crew concept was established for SSBNs, combined with forward deployment to maximize the time each submarine would spend on patrol. The crews were named Blue and Gold after the [US Naval Academy](https://en.wikipedia.org/wiki/US_Naval_Academy) colors. The crews were deployed for 105 days and at their home bases for 95 days, with a 3-day turnover period on each end of the deployed period. Crews were flown from their home bases to and from the forward deployment bases. After taking over the boat, the crew would perform a 30-day refit assisted by the tender, followed by a 70-day deterrent patrol. Sometimes a port visit would be arranged in the middle of the patrol. The home bases for Atlantic Fleet crews were [Groton](https://en.wikipedia.org/wiki/Submarine_Base_New_London), [Connecticut](https://en.wikipedia.org/wiki/Connecticut) and [Charleston](https://en.wikipedia.org/wiki/Charleston_Naval_Shipyard), [South Carolina](https://en.wikipedia.org/wiki/South_Carolina). Pacific Fleet crews were based at [Pearl Harbor](https://en.wikipedia.org/wiki/Naval_Base_Pearl_Harbor), [Hawaii](https://en.wikipedia.org/wiki/Hawaii).

Two Polaris missile depots were established in the United States, Polaris Missile Facility Atlantic (POMFLANT) at [Charleston](https://en.wikipedia.org/wiki/Naval_Support_Activity_Charleston), South Carolina in 1960 and later Strategic Weapons Facility Pacific (SWFPAC) at [Bangor](https://en.wikipedia.org/wiki/Naval_Base_Kitsap), Washington. To transport missiles and other supplies from the missile depots to the forward deployment bases, several cargo ships were converted to carry missiles and were designated as T-AKs, operated by the [Military Sealift Command](https://en.wikipedia.org/wiki/Military_Sealift_Command) with a mostly-civilian crew.

The advent of the [Trident I](https://en.wikipedia.org/wiki/Trident_I) missile, refitted to 12 Atlantic Fleet SSBNs starting in 1979 and with a much greater range than Polaris or Poseidon, meant that SSBNs could be based in the United States. The 18 [*Ohio*-class submarines](https://en.wikipedia.org/wiki/Ohio-class_submarine), slated to replace the 41 older SSBNs, also started commissioning in 1981, initially carrying 24 Trident I missiles but later refitted with the much larger and more capable [Trident II](https://en.wikipedia.org/wiki/Trident_missile) missile. In the late 1970s it was decided that Pacific Fleet *Ohio*-class SSBNs would be based at Bangor, WA, collocated with SWFPAC, and that the refitted Trident I SSBNs and additional *Ohio*-class SSBNs would be based at a new facility in [King's Bay](https://en.wikipedia.org/wiki/King%27s_Bay_submarine_base), Georgia. Also, a new missile depot, Strategic Weapons Facility Atlantic (SWFLANT), was constructed at King's Bay to replace POMFLANT. The SSBN facility at Rota was closed in 1979 as King's Bay began refitting submarines. As [USS *Ohio*](https://en.wikipedia.org/wiki/USS_Ohio_(SSBN-726)) commenced sea trials in 1980, the 10 remaining Polaris submarines in the Pacific Fleet were disarmed and reclassified as SSNs to avoid exceeding [SALT II](https://en.wikipedia.org/wiki/SALT_II) treaty limits. The SSBN base at Guam was closed at this time. By 1992, the [Soviet Union](https://en.wikipedia.org/wiki/Collapse_of_the_Soviet_Union) had collapsed, 12 *Ohio*-class SSBNs had been commissioned, and the [START I](https://en.wikipedia.org/wiki/START_I) treaty had gone into effect, so Holy Loch was closed and the remaining 31 original SSBNs disarmed. Most of these were decommissioned and later scrapped in the [Ship-Submarine Recycling Program](https://en.wikipedia.org/wiki/Ship-Submarine_Recycling_Program), but a few were converted to other roles. Two remain in service but decommissioned as nuclear power training vessels attached to Naval [Nuclear Power School](https://en.wikipedia.org/wiki/Nuclear_Power_School) at [Charleston](https://en.wikipedia.org/wiki/Naval_Support_Activity_Charleston), SC, [USS *Daniel Webster*](https://en.wikipedia.org/wiki/USS_Daniel_Webster_(SSBN-626)) and [USS *Sam Rayburn*](https://en.wikipedia.org/wiki/USS_Sam_Rayburn_(SSBN-635)).

**Later versions**

The later versions (the A-2, A-3, and B-3) were larger, weighed more, and had longer ranges than the A-1. The range increase was most important: The A-2 range was 1,500 nautical miles (2,800 kilometers), the A-3 2,500 nautical miles (4,600 kilometers), and the B-3 2,000 nautical miles (3,700 kilometers). The A-3 featured multiple re-entry vehicles ([MRVs](https://en.wikipedia.org/wiki/Multiple_Reentry_vehicle)) which spread the warheads about a common target, and the B-3 was to have [penetration aids](https://en.wikipedia.org/wiki/Penetration_aids) to counter [Soviet](https://en.wikipedia.org/wiki/Soviet_Union) [Anti-Ballistic Missile](https://en.wikipedia.org/wiki/Anti-Ballistic_Missile) defenses. The B-3 missile evolved into the C-3 [Poseidon missile](https://en.wikipedia.org/wiki/Poseidon_missile), which abandoned the decoy concept in favor of using the C3's greater throw-weight for larger numbers (10-14) of new hardened high-re-entry-speed [reentry vehicles](https://en.wikipedia.org/wiki/Reentry_vehicle) that could overwhelm Soviet defenses by sheer weight of numbers, and its high speed after re-entry. The abandoned decoy system for the B-3 (Antelope) was known to the UK where it was adopted and evolved into Super Antelope, KH.793 and later re-labeled Chevaline.

**British Polaris**

Main article: [British Polaris program](https://en.wikipedia.org/wiki/British_Polaris_programme)



British Polaris, [Imperial War Museum](https://en.wikipedia.org/wiki/Imperial_War_Museum), [London](https://en.wikipedia.org/wiki/London)

From the early days of the Polaris program, American senators and naval officers suggested that the [United Kingdom](https://en.wikipedia.org/wiki/United_Kingdom) might use Polaris. In 1957 [Chief of Naval Operations](https://en.wikipedia.org/wiki/Chief_of_Naval_Operations) [Arleigh Burke](https://en.wikipedia.org/wiki/Arleigh_Burke) and [First Sea Lord](https://en.wikipedia.org/wiki/First_Sea_Lord) [Louis Mountbatten](https://en.wikipedia.org/wiki/Louis_Mountbatten) began corresponding on the project. After the cancellations of the [Blue Streak](https://en.wikipedia.org/wiki/Blue_Streak_missile) and [Skybolt](https://en.wikipedia.org/wiki/Skybolt_missile) missiles in the 1960s, under the 1962 [Nassau Agreement](https://en.wikipedia.org/wiki/Nassau_Agreement) that emerged from meetings between [Harold Macmillan](https://en.wikipedia.org/wiki/Harold_Macmillan) and [John F. Kennedy](https://en.wikipedia.org/wiki/John_F._Kennedy), the United States would supply Britain with Polaris missiles, launch tubes, ReBs, and the [fire-control systems](https://en.wikipedia.org/wiki/Fire-control_system). Britain would make its own warheads and initially proposed to build five [ballistic missile submarines](https://en.wikipedia.org/wiki/Ballistic_missile_submarines), later reduced to four by the incoming [Labor government](https://en.wikipedia.org/wiki/Labour_Government_1964%E2%80%931970) of [Harold Wilson](https://en.wikipedia.org/wiki/Harold_Wilson), with 16 missiles to be carried on each boat. The [Polaris Sales Agreement](https://en.wikipedia.org/wiki/Polaris_Sales_Agreement) was signed on April 6, 1963.

In return, the British agreed to assign control over their Polaris missile targeting to the [SACEUR](https://en.wikipedia.org/wiki/SACEUR) (Supreme Allied Commander, Europe), with the provision that in a national emergency when unsupported by the NATO allies, the targeting, permission to fire, and firing of those Polaris missiles would reside with the British national authorities. Nevertheless, the consent of the British Prime Minister is and has been always required for the use of British nuclear weapons, including SLBMs.

The operational control of the Polaris submarines was assigned to another NATO Supreme Commander, the SACLANT (Supreme Allied Commander, Atlantic), who is based near Norfolk, Virginia, although the SACLANT routinely delegated control of the missiles to his deputy commander in the Eastern Atlantic area, COMEASTLANT, who was always a British admiral.



Inert training round at the National Museum of Scotland, East Fortune

Polaris was the largest project in the Royal Navy's peacetime history. Although in 1964 the new Labor government considered cancelling Polaris and turning the submarines into conventionally armed hunter-killers, it continued the program as Polaris gave Britain a global nuclear capacity—perhaps [east of Suez](https://en.wikipedia.org/wiki/East_of_Suez)—at a cost £150 million less than that of the [V bomber](https://en.wikipedia.org/wiki/V_bomber) force. By adopting many American methodologies and components Polaris was finished on time and within budget. On 15 February 1968, [HMS *Resolution*](https://en.wikipedia.org/wiki/HMS_Resolution_(S22)), the lead ship of [her class](https://en.wikipedia.org/wiki/Resolution_class_submarine), became the first British vessel to fire a Polaris. All Royal Navy [SSBNs](https://en.wikipedia.org/wiki/SSBN) have been based at [Faslane](https://en.wikipedia.org/wiki/Faslane), only a few miles from [Holy Loch](https://en.wikipedia.org/wiki/Holy_Loch). Although one submarine of the four was always in a shipyard undergoing a refit, recent declassifications of archived files disclose that the Royal Navy deployed four boatloads of reentry vehicles and warheads, plus spare warheads for the Polaris A3T, retaining a limited ability to re-arm and put to sea the submarine that was in refit. When replaced by the Chevaline warhead, the sum total of deployed RVs and warheads was reduced to three boatloads.

**Chevaline**

Main article: [Chevaline](https://en.wikipedia.org/wiki/Chevaline)

The original U.S. Navy Polaris had not been designed to penetrate [anti-ballistic missile](https://en.wikipedia.org/wiki/Anti-ballistic_missile) (ABM) defenses, but the Royal Navy had to ensure that its small Polaris force operating alone, and often with only one submarine on deterrent patrol, could penetrate the ABM screen around Moscow. The result was a program called [*Chevaline*](https://en.wikipedia.org/wiki/Chevaline) that added multiple decoys, [chaff](https://en.wikipedia.org/wiki/Chaff_(radar_countermeasure)), and other defensive [countermeasures](https://en.wikipedia.org/wiki/Countermeasure). Its existence was only revealed in 1980, partly because of the cost overruns of the project, which had almost quadrupled the original estimate given when the project was finally approved in January 1975. The system became operational in mid-1982 on [HMS *Renown*](https://en.wikipedia.org/wiki/HMS_Renown_(S26)), and the last British [SSBN](https://en.wikipedia.org/wiki/SSBN) submarine was equipped with it in mid-1987. Withdrawn from service in 1996.

**Replacement**

The British did not ask to extend the Polaris Sales Agreement to cover the Polaris successor [Poseidon](https://en.wikipedia.org/wiki/UGM-73_Poseidon) due to its cost. The [Ministry of Defense](https://en.wikipedia.org/wiki/Ministry_of_Defence_(United_Kingdom)) upgraded its nuclear missiles to the longer-ranged [Trident (missile)](https://en.wikipedia.org/wiki/Trident_(missile)) after much political wrangling within the Callaghan [Labor Party](https://en.wikipedia.org/wiki/Labour_Party_(UK)) government over its cost and whether it was necessary. The outgoing Prime Minister [James Callaghan](https://en.wikipedia.org/wiki/James_Callaghan) made his government's papers on Trident available to [Margaret Thatcher](https://en.wikipedia.org/wiki/Margaret_Thatcher)'s new incoming [Conservative Party](https://en.wikipedia.org/wiki/Conservative_Party_(UK)) government, which took the decision to acquire the [Trident C4](https://en.wikipedia.org/wiki/UGM-96_Trident_I) missile.

A subsequent decision to upgrade the missile purchase to the even larger, longer-ranged Trident D5 missile was possibly taken to ensure that there was missile commonality between the [U.S. Navy](https://en.wikipedia.org/wiki/U.S._Navy) and the [Royal Navy](https://en.wikipedia.org/wiki/Royal_Navy), which was considerably important when the Royal Navy Trident submarines were also to use the [Naval Submarine Base Kings Bay](https://en.wikipedia.org/wiki/Naval_Submarine_Base_Kings_Bay).

Even though the U.S. Navy initially deployed the Trident C4 missile in the original set of its *Ohio*-class submarines, it was always planned to upgrade all of these submarines to the larger and longer-ranged Trident D5 missile—and that eventually, all of the C4 missiles would be eliminated from the U.S. Navy. This change-over has been completely carried out, and no Trident C4 missiles remain in service.

The Polaris missile remained in Royal Navy service long after it had been completely retired and scrapped by the U.S. Navy in 1980-81. Consequently, many spare parts and repair facilities for the Polaris that were located in the U.S. ceased to be available (such as at Lockheed, which had moved on first to the Poseidon and then to the Trident missile).

**Italy**

During its reconstruction program in 1957-1961, the [Italian cruiser *Giuseppe Garibaldi*](https://en.wikipedia.org/wiki/Italian_cruiser_Giuseppe_Garibaldi_(1961)) was fitted with four Polaris missile launchers located in the aft part of the ship.  
Successful tests held in 1961-1962 induced the United States to study a [NATO](https://en.wikipedia.org/wiki/NATO) [Multilateral Nuclear Force](https://en.wikipedia.org/wiki/Multilateral_Force) (MLF), consisting of 25 international surface vessels from the US, United Kingdom, France, Italy, and West Germany, equipped with 200 Polaris nuclear missiles, enabling European allies to participate in the management of the [NATO](https://en.wikipedia.org/wiki/NATO) nuclear deterrent.

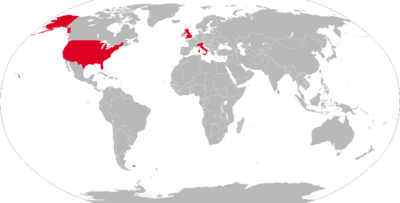
The MLF plan, as well as the Italian Polaris Program, were abandoned, both for political reasons (in consequence of the [Cuban Missile Crisis](https://en.wikipedia.org/wiki/Cuban_Missile_Crisis)) and the initial operational availability of the first [SSBN](https://en.wikipedia.org/wiki/SSBN) [*George Washington*](https://en.wikipedia.org/wiki/USS_George_Washington_(SSBN-598)), which was capable of launching [SLBMs](https://en.wikipedia.org/wiki/SLBM) while submerged, a solution preferable to surface-launched missiles.

Italy developed a new domestic version of the missile, the SLBM-designated Alfa. The program was cancelled in 1975 after Italy ratified the [Nuclear Non-Proliferation Treaty](https://en.wikipedia.org/wiki/Nuclear_Non-Proliferation_Treaty), with the final launch of the third prototype in 1976.

Two Italian Navy [*Andrea Doria*-class](https://en.wikipedia.org/wiki/Andrea_Doria_class_cruiser) cruisers, commissioned in 1963-1964, were "fitted for but not with" two Polaris missile launchers per ship. All four launchers were built but not installed, and were stored at the [La Spezia](https://en.wikipedia.org/wiki/La_Spezia) naval facility.

The Italian Navy cruiser [*Vittorio Veneto*](https://en.wikipedia.org/wiki/Italian_cruiser_Vittorio_Veneto_(550)), launched in 1969, was also "fitted for but not with" four Polaris missile launchers. During refit periods in 1980-1983, these facilities were removed and used for other weapons and systems.

**Operators**



Map with former UGM-27 operators in red

[United Kingdom](https://en.wikipedia.org/wiki/United_Kingdom)



* [Royal Navy](https://en.wikipedia.org/wiki/Royal_Navy)

[United States](https://en.wikipedia.org/wiki/United_States)



* [United States Navy](https://en.wikipedia.org/wiki/United_States_Navy)

[Italy](https://en.wikipedia.org/wiki/Italy)



* [Marina Militare](https://en.wikipedia.org/wiki/Marina_Militare) (tests only, never fully operational)

**See also**

* [List of missiles](https://en.wikipedia.org/wiki/List_of_missiles)
* [Program Evaluation and Review Technique](https://en.wikipedia.org/wiki/Program_Evaluation_and_Review_Technique)
* This page was last modified on 27 February 2016, at 01:00.