

From Superfortress to Poseidon: Strategic Nuclear Delivery Systems of the United States of America from 1945 to 1972

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Introduction

After the delivery of “Little Boy” and “Fat Man” on Hiroshima and Nagasaki in August 1945, the world’s focus quickly turned from conventional armaments to nuclear weapons. Four years, one month, and thirteen days after “Trinity,” the United States’ first nuclear test, the Soviet Union detonated their first nuclear device code-named “First Lightning”. With United States’ monopoly on nuclear weapons a thing of the past, the two countries began a massive build-up of nuclear armament, beginning in the early 1950s to the signing of the Strategic Arms Limitation Talks Agreement on May 26, 1972. Not to fall behind the two major powers of the Cold War, the United Kingdom, France, and the People’s Republic of China also became nuclear states in 1952, 1960, and 1964 respectively.¹ During this time, rapid technological advancements saw the change in the United States Armed Forces’ principal strategic nuclear delivery systems evolve from piston-powered Boeing B-29 Superfortress into ballistic missiles launched from nuclear-powered submarines that can remain under the ocean waves for months on end. With the transition from mutually assured destruction to flexible response, nuclear delivery systems also adapted with the change in mindset to prevent a limited nuclear exchange from propagating into a full-scale nuclear war.

Propeller-driven Bombers

The first nuclear weapons were delivered by the four-engine Boeing B-29 Superfortress bombers developed between 1942 and 1944. The aircraft was flown with an eleven-man crew, from the airplane commander, copilot, navigator, to the three gunners tasked with defending the aircraft from enemy interceptors.² The nuclear bomber variants of the Superfortress reduced their suite of defensive armament and used the

¹ “Nuclear Weapons Timeline” (International Campaign to Abolish Nuclear Weapons. Accessed November 25, 2019) <https://www.icanw.org/the-facts/the-nuclear-age/>.

² *B-29: Pilots' and Flight Engineers' Training Manual for the Superfortress* (Washington, D.C.: Headquarters Army Air Forces, 1945) 5-7.

additional payload for increased range and bomb-carrying capacity. The nuclear-weapons compatible B-29s were initially given the codename “Silverplate” until May 1947, when newly introduced strategic bombers such as the Convair B-36 Peacemaker and Boeing B-50 Superfortress would collectively be referred to under the new codename, “Saddletree.”³ The introduction of newer, more powerful bombers relegated the original B-29 Superfortress – equipped with less-powerful Wright R-3350 Duplex-Cyclone radial engines – to non-nuclear missions, and it will be used extensively during the Korean War against North Korean ground forces and infrastructures.⁴

The B-36 Peacemaker, with its 10,000 nautical miles intercontinental range, could deliver any nuclear weapons in the United States nuclear arsenal at the time. However, its introduction was plagued with technical challenges and alleged irregularities during its procurement process.⁵ The choice of using six Pratt & Whitney R-4360 Wasp Major radial engines and four General Electric J47 turbojet engines to power the behemoth bomber posed tremendous technical challenges for both engineers and aviators alike. The Pratt & Whitney engines were prone to in-flight fire due to the design choice of placing the radial engines in a pusher configuration rather than the more conventional tractor configuration, posing “difficulty with the propellers and inability to cool the engines.”⁶ Those very same radial engines were proved to be more successful when fitted onto the B-50 Superfortress in the conventional tractor configuration.

Aside from technical challenges, the B-36 also faced backlashes due to the high cost of the program. The newly independent United States Air Forces – separated from the Army under the National Security Act of 1947 – advocated for a 70-group peacetime air force to serve as primary

³ Alling, Frederick A, Margaret C Bagwell, Robert L Perry, John C Robinson, Dudley L Saunders, and Delmer J Trester. *A History of the Air Force Atomic Energy Program, 1943-1953: Atomic Weapon Delivery Systems* (Vol. 5. Washington, D.C.: Headquarters Air Force, 1955) 391-392.

⁴ *B-29: Pilots' and Flight Engineers' Training Manual for the Superfortress*, 10.

⁵ United States, Congress. House. Committee on Armed Services. *Investigation of the B-36 Bomber Program: Hearings before the Committee on Armed Services, House of Representatives, Eighty-first Congress, First Session, on H.Res. 234, a Resolution Authorizing and Directing Thorough Studies and Investigations Relating to Matters Involving the B-36 Bombers.*, 1949. 7-9.

⁶ *Investigation of the B-36 Bomber Program: Hearings before the Committee on Armed Services*, 10.

means of deterrence against Soviet aggression. After the massive build-up of the Army Air Forces between 1942 and 1945, the number of aircraft in service plummeted due to the demobilization following Germany and Japan's surrender, reaching a low of 38 groups in June 1947. The Air Force wishes to have "55 groups in full operational status by June 30, 1948, 66 groups by June 30, 1949, and 70 groups during the 1950 fiscal year and thereafter."⁷ The B-36 Peacemaker, being the crown jewel of the Strategic Air Command's nuclear strike fleet at the time, consumed a large part of \$1.9 billion appropriated for aircraft procurement during the 1948 fiscal year. An announcement from the White House made in December 1948 would limit the size of the Air Force in the 1949 fiscal year to be 48 groups, but the Air Force would already have 59 groups activated at the time.⁸

Revolt of the Admirals

The heavy emphasis on the built-up of strategic bombers as the nation's sole means of nuclear deterrence sparked outrage throughout the Navy on April 23, 1949, when the construction of the aircraft carrier USS *United States* (CVA-58) was canceled, five days after her keels were laid.⁹ The *United States* was the first post-war aircraft carrier design, and its unique all-flat deck design allowed for the effective operations of the Lockheed P2V Neptune patrol aircraft as an interim seaborne nuclear bomber before the introduction of the North American AJ Savage, a dedicated nuclear bomber.¹⁰ As a result of the cancellation of the project, Secretary of the Navy John L. Sullivan and Under Secretary of the Navy W. John Kenney resigned within months of each other and led to major backlashes within the Navy against Secretary of Defense Louis A. Johnson, who was a strong supporter of the B-36 Peacemaker project.¹¹ Johnson, who served as the Assistant Secretary of War before the outbreak

⁷ Ibid., 15.

⁸ Ibid., 16.

⁹ Andrew L. Lewis, "The Revolt of the Admirals" (Master's thesis, Air Command and Staff College, Air University, 1998. Federation of American Scientists 98-166) 15.

¹⁰ J. B. Wasall, "The Development of the Lockheed P2V Neptune" (*Aircraft Engineering and Aerospace Technology* 22, no. 6 (1950): 156–62) <https://doi.org/10.1108/eb031906>, 162.

¹¹ Jeffrey G. Barlow, "Naval Aviation's Most Serious Crisis?" (U.S. Naval Institute, February 21, 2019) <https://www.usni.org/magazines/naval-history-magazine/2011/december/naval-aviations-most-serious-crisis>.

of the Second World War, was a strong believer in strategic airpower even before coming into office as Secretary of Defense. He replaced James V. Forrestal, who was an advocate for the USS *United States* as he was the Secretary of the Navy before he was appointed the first Secretary of Defense.

The Congressional inquiry on the B-36 project was a response to an anonymous document, later known to be authored by Cedric R. Worth, a civilian employee of the Department of the Navy, with the support of Commander Thomas D. Davies. Worth authored a nine-page document “detailing particular facts or rumors relating to the B-36 procurement program... a ‘billion-dollar blunder’ whose procurement continued only because Secretary Johnson and Air Force Secretary W. Stuart Symington had personal financial stakes in its production.”¹² By the end of the month-long Congressional inquiry, the committee discovered “not one scintilla of evidence... that would support charges that collusion, fraud, corruption, influence, or favoritism played any part whatsoever in the procurement of the B-36 bomber.”¹³ Worth, formerly the special assistant to the Assistant Secretary of Navy for Air, and later to the Under Secretary of Navy, was later dismissed from his employment by the Department of Navy as a result of the incident. However, the House Armed Services Committee affirmed the importance of all branches of the Armed Forces and deterred any desires from the Army and Air Force to eliminate the Navy and Marine Corps as branches of service. Advocates for the idea include General of the Army Omar Bradley and Secretary of Defense Louis A. Johnson, and Johnson was quoted with the following in December 1949:

There’s no reason for having a Navy and Marine Corps. General Bradley tells me that amphibious operations are a thing of the past. We’ll never have any more amphibious operations. That does away with the Marine Corps. And the Air Force can do anything the Navy can do nowadays, so that does away with the Navy.¹⁴

Johnson’s optimism would quickly be proven to be misplaced, as less than a year later, the 1st Marine Division would spearhead Operation Chromite, an amphibious invasion of Inchon to recapture the South Korean capital city of Seoul as a part of the United Nations Command during the Korean

¹² Ibid.

¹³ *Investigation of the B-36 Bomber Program: Hearings before the Committee on Armed Services*, 33.

¹⁴ *Marine Corps Doctrinal Publication 3 - Expeditionary Operations* (Washington, D.C.: U.S. Marine Corps, 1998) 69.

War.¹⁵

Jet Bombers and Around-the-Clock Readiness

By the early 1950s, the Air Force's B-36 Peacemaker fleet would be supplemented by the Boeing B-47 Stratojet and later the Boeing B-52 Stratofortress all-jet bombers. The straight-wing, piston-driven Peacemaker could no longer effectively penetrate Soviet air defense due to its slow speed, but while the B-47 Stratojet cruises at over twice the speed of the Peacemaker, it lacked the intercontinental range and required aerial refueling provided by the Strategic Air Command's Boeing KC-97 Stratofreighter tanker fleet for any missions within the Soviet Union.¹⁶ The B-52 Stratofortress entered service in 1955 and is still a vital part of the American nuclear triad today, over 60 years from its first operational sortie. On September 1, 1962, Strategic Air Command would enter the supersonic age with the introduction of the Convair B-58 Hustler at Bunker Hill Air Force Base (now Grissom Air Reserve Base) in Indiana. However, the Hustler's reign would be short, with the final aircraft retired in 1970 due to the shift towards low altitude penetration rather than high-altitude, high-speed flights the Hustler was designed for. The immense operating cost of the fleet, three times higher than the Stratofortress, and the difficulty in maintaining the state-of-the-art lightweight construction also contributed to the Hustler's early retirement.¹⁷

Beginning in 1960, the U.S. Air Force began deploying B-52 bombers armed with free-fall thermonuclear weapons on 24-hour continuous airborne alert missions under the codename "Chrome Dome". The bomber, supported by Boeing KC-135 Stratotanker tanker aircraft, would depart from airbases in the contiguous United States, and take one of two routes that will bring them near Soviet airspace. The first route "stretched south across the Atlantic to a refueling over the Mediterranean Sea [and the] other was a northern route tracing a big box around Canada with a crucial late air refueling near Alaska."¹⁸ With at least 12 armed

¹⁵ *Ibid.*, 49.

¹⁶ "B-47 Stratojet. (Factory Fresh)" (*Airpower*, September 2002, *Gale OneFile: Military and Intelligence* (accessed November 27, 2019) 51.

¹⁷ *Peace... Is Our Profession: Alert Operations and the Strategic Air Command, 1957-1991* (Offutt Air Force Base, Neb.: Office of the Historian, Headquarters Strategic Air Command, 1992. 13) 77-78.

¹⁸ Rebecca Grant, "The Perils of Chrome Dome" (*Air Force Magazine*, 2011) 55.

bombers airborne at any given time and the long duration of the missions, it was a matter of time before accidents would occur. The first crash of the Chrome Dome missions occurred a week after General Thomas S. Power's – Commander-in-Chief of the Strategic Air Command at the time – public announcement of the missions near Goldsboro, North Carolina on January 23, 1961. It was caused by structural failure of the right-wing, and one of the two bombs on board shattered upon impact, sinking its nuclear core into the soggy farmland and never to be seen again. Five of the eight crew members bailed out safely before the crash, but one did not survive the landing, and two died in the crash. Less than two months later, on March 14, 1961, another B-52 crashed near Yuba City, California due to fuel exhaustion. On January 13, 1964, turbulence caused a B-52's vertical stabilizer to shear off and damaged the left horizontal stabilizer, rendering the thermonuclear bomb-laden aircraft uncontrollable and crashed onto a farm in Savage Mountain, Maryland.¹⁹ In both instances, both thermonuclear weapons on board were accounted for, and none of them detonated, unlike the later incidents in Spain and Greenland.

The introduction of Boeing LGM-30 Minutemen I and II intercontinental ballistic missiles in October 1962 and January 1966 allowed the Air Force to scale back the Chrome Dome missions to four airborne alert aircraft, one-third of the original fleet size.²⁰ Even with the reduced airborne alert fleet, accidents continued to occur, with a B-52 bomber colliding with a KC-135 tanker just off the coast of Spain on January 17, 1966, and another B-52 crashing on the sea ice in North Star Bay, Greenland on January 21, 1968, after an uncontained cabin fire. Unfortunately, the conventional explosives on the Mk.28 thermonuclear bombs detonated in both instances, leading to radioactive contamination of the surrounding areas.²¹ After the crash near Thule Air Base, Greenland, continuous airborne alert of nuclear-armed strategic bombers was suspended due to declining public perception, the increasing size of land-based and seaborne ballistic missile inventory, and the growing involvement of U.S. Armed Forces in Southeast Asia. As the number of sorties skyrocketed for Operation Arc Light – the conventional bombing campaign of Viet Cong targets in South Vietnam – Strategic Air Command was forced to divert resources to those missions, and the Command's

¹⁹ *Ibid.*, 56.

²⁰ *Peace... Is Our Profession: Alert Operations and the Strategic Air Command, 1957-1991*, 23.

²¹ Grant, "The Perils of Chrome Dome," 57.

ability to maintain the bomber fleet's continuous nuclear alert suffered as a result. For instance, on November 12, 1969, 38 percent of the regular bomber alert force and 27 percent of the required tanker alert force were not on alert due to aircraft availability and crew shortages, and some units remained below a one-to-one aircraft-to-aircrew ratio due to the strain on personnel from the Southeast Asian bombing campaigns.²² The need for safer nuclear deterrence – without causing radioactive contamination on allied soil – forced the advancement of intercontinental ballistic missile technology, as they could be positioned in the U.S. mainland and be relatively free of geopolitical influences.

Introduction of Ballistic Missiles

Technological advancements during the Second World War within Nazi Germany produced the first practical cruise missile and ballistic missile under the *Vergeltungswaffen* banner. After the surrender of Germany, Operation Paperclip brought over 1,700 scientists and engineers who once worked for Hitler's regime to the United States after they have been screened and included no "ardent Nazis" or "alleged or confirmed war criminals."²³ Those scientists included Wernher von Braun, who led the development of the V-2 ballistic missile and would later be famed for his work on the Saturn V rocket. At the beginning of the 1960s, the United States fielded three types of ballistic missiles for strategic deterrence. The Douglas PGM-17 Thor, the first deployable intermediate-range ballistic missile in the U.S. arsenal, was only deployed in limited numbers – 30 at its peak – due to its vulnerability. Thor, alongside the Chrysler PGM-11 Redstone short-range ballistic missiles and the Chrysler PGM-19 Jupiter medium-range ballistic missiles, required the use of liquid propellant and a lengthy fueling procedure, making them unattractive as weapons of deterrence.²⁴ Furthermore, all the preparation work before launch must be

²² *Peace... Is Our Profession: Alert Operations and the Strategic Air Command, 1957-1991*, 24-25.

²³ Robert Huddleton, "Operation Paperclip: The Secret Intelligence Program that Brought Nazi Scientists to America" (*Air Power History* 62, no. 1 (2015): 52 Gale OneFile: Military and Intelligence) <https://link-gale-com.ezproxy.lib.purdue.edu/apps/doc/A419268799/PPMI?u=inspire&sid=PPMI&xid=8f62c1a6>.

²⁴ "Unique Shelter for Use with Jupiter Missile" (*Journal of the Franklin Institute* 267, no. 5 (May 1959): 463–64) [https://doi.org/10.1016/0016-0032\(59\)90125-5](https://doi.org/10.1016/0016-0032(59)90125-5).

done above ground, a difficult task after a Soviet first strike. Second-generation ballistic missiles such as the Convair CGM-16 Atlas and the Martin HGM-25A Titan I were stored in underground silos and raised to the surface for launch, thus protecting the missile and personnel against radiation and shrapnel in the event of a Soviet first strike. Nevertheless, the Royal Air Force Bomber Command operated 60 Thor missiles to supplement the V bombers – the Avro Vulcan, Handley Page Victor, and Vickers Valiant – before the proposed Anglo-American Douglas AGM-48 Skybolt air-launched ballistic missile would enter service.²⁵

The Italian and Turkish Air Forces would also operate the Jupiter missile, much to the dismay of the Soviet Union. Despite its limited strategic deterrence abilities, the deployment of medium-range ballistic missiles to states bordering the Soviet Union was one of the contributing causes to the Cuban Missile Crisis, as the Soviets now felt the need to place strategic weapons in the Americas. Many of the obsolete ballistic missiles, such as the Thor, Redstone, and Atlas, would be converted into orbital launch vehicles following the introduction of more sophisticated and longer-range ballistic missiles. The Boeing LGM-30 Minuteman and Martin LGM-25C Titan II, entering service in 1962 and 1963 respectively, saw another evolution in missile technology as they could now be launched directly from within their silos, safeguarding United States' abilities to launch a land-based second strike against the Soviet Union.²⁶ Beyond the improved survivability provided by the Minuteman and Titan's hardened silos, the Minuteman also utilized solid propellant rather than liquid propellant, making near-instantaneous launches a reality. The improved guidance systems on the Minuteman allowed for the missiles to operate without ground control during flight and using air bearing rather than ball bearings enabled the continuous operation of the guidance system, a requirement for launches with short notice.²⁷ With the introduction of Minuteman III in 1970, it marked another major technical advancement as up to three multiple independently targetable reentry vehicles could now be fitted to a single missile, essentially tripling the number of deployable

²⁵ David M. McCourt, *Configurations: Critical Studies of World Politics: Britain and World Power Since 1945: Constructing a Nation's Role in International Politics* (Ann Arbor: University of Michigan Press, 2014. Accessed November 28, 2019. ProQuest Ebook Central) 100.

²⁶ *Peace... Is Our Profession: Alert Operations and the Strategic Air Command, 1957-1991*. 87-89.

²⁷ *Ibid.*, 13.

warheads.

Air-to-Surface Missiles and the Skybolt Crisis

Following the 1960 U-2 incident and the capture of Francis Gary Powers over the Soviet Union, altitude alone was proven to be insufficient to protect Strategic Air Command's bomber force against Soviet surface-to-air missiles and interceptor aircraft. The North American Aviation AGM-28 Hound Dog air-launched cruise missile, entering service in September 1960 – four months after the incident – provided a temporary solution to the dilemma. The turbojet-powered Hound Dog, carried by B-52 Stratofortresses, could attack Soviet ground targets beyond the range of surface-to-air missiles, thus increasing the survivability of the bomber fleet. It was intended as a stop-gap measurement before the Skybolt air-launched ballistic missile would enter service, but it would ultimately remain in service until 1977.²⁸ The actual replacement for the Hound Dog, the Boeing AGM-69 Short Range Attack Missile, would not be available until 1972, and it enhanced Strategic Air Command's ability to suppress Soviet air defense as it could be carried by aircrafts as small as the General Dynamics FB-111A Aardvark.²⁹ While the development of land-based ballistic missiles and air-launched cruise missiles were relatively successful, the Anglo-American Skybolt project would be plagued with technical challenges and ultimately sparked a crisis between the two governments.

The Skybolt was meant to be Britain's replacement for the aging Thor missiles, and it would supersede the V bombers in providing the United Kingdom her independent nuclear deterrence. The Skybolts were to be fitted on the Avro Vulcan bomber and would replace all other nuclear-armed missiles in service such as the rocket-powered Avro Blue Steel Mk. 1 in Royal Air Force service. The independent developed de Havilland Blue Streak medium-range ballistic missile was intended as the replacement for Thor, but the Blue Streak program, together with the upgraded ramjet-powered Blue Steel Mk. 2, would be canceled to preserve funding for the procurement of Skybolts.³⁰ While the missiles themselves would be imported, Royal Air Force would retain sole control of the missiles, unlike the Jupiter missiles deployed to Italy and Turkey. Prime

²⁸ *Ibid.*, 85.

²⁹ *Peace... Is Our Profession: Alert Operations and the Strategic Air Command, 1957-1991*, 28-29.

³⁰ McCourt, *Britain and World Power Since 1945*, 94.

Minister Harold Macmillan defended the project in 1960, claiming the arrangement would be “independent in the sense that it will be our property. The warhead will be manufactured by [the United Kingdom] and will be under our sole control.”³¹ In exchange for the missiles, the United Kingdom would provide facilities at Holy Loch, Scotland, as a refit and crew turnover site for U.S. Navy’s Lockheed UGM-27 Polaris-armed ballistic missile submarines. The agreement also allowed for American participation in the ground-breaking Hawker Siddeley P.1127 vertical take-off and landing jet fighter project.³²

With the Polaris ballistic missiles being a viable alternative for Skybolts in U.S. service, domestic support for the air-launched ballistic missile dwindled. Combining the lack of political support with technical challenges, such as the need for an additional star tracker system which increased cost and numerous failed launch tests, the program’s continued existence became questionable. During President John F. Kennedy and Prime Minister Macmillan’s December 1962 meeting at Nassau, The Bahamas, an agreement was made to terminate the Skybolt program, and instead the British would receive Polaris missiles in its place. Kennedy initially offered the stop-gap Hound Dog cruise missile in its place, but Macmillan refused and demanded the Polaris, which Kennedy reluctantly agreed to. The deal also stipulated that the Polaris would be “assigned to NATO under normal circumstances but would be available for independent British use in instances of ‘supreme national emergency’”.³³ With the Nassau Agreement came the Polaris Sales Agreement and British Naval Ballistic Missile System, which transferred the United Kingdom’s strategic nuclear deterrence from the Royal Air Force to the Royal Navy following the commissioning of the four *Resolution*-class ballistic missile submarines.³⁴

Carrier-Borne Bombers

After the cancellation of the USS *United States*, the U.S. Navy adapted existing surface ships and submarines to prove the Navy’s ability to carry out nuclear deterrence against the Soviet Union. As a stop-gap measure, P2V Neptune patrol aircraft were retrofitted with jet-assisted

³¹ Ibid., 95-96.

³² Ibid., 88.

³³ McCourt, *Britain and World Power Since 1945*, 89.

³⁴ Idi., 200.

take-off equipment and deployed onboard the *Midway*-class aircraft carriers. The Neptune would be the largest aircraft deployed on carriers until that point, and as a proof of concept, trial takeoffs were made from USS *Coral Sea* (CVB-43) carrying dummy nuclear bombs.³⁵ However, due to its enormous size, landings on carriers would not be possible, and the crews were instructed to land at friendly nations after delivering their payload, or ditch in the ocean and be rescued by helicopters or flying boats. The 75,000 lb. Neptune would soon be replaced by the 51,000 lb. AJ Savage, an aircraft designed from the ground up to be a nuclear bomber. The Savage, with its straight-wing design and mixed piston and jet power, was a conservative design, especially when compared with other North American products from the same period such as the B-45 Tornado all-jet bomber and the F-86 Sabre swept-wing jet fighter. However, that allowed the Savage to be operational merely two years after the order was placed.³⁶ It still turned out to be too large and cumbersome to operate from most aircraft carriers in service even with the reduced weight and folding wings when compared with the Neptune. The Savage could be carried on board the modernized 30,000-ton *Essex* class with reinforced flight decks and on the larger 45,000-ton *Midway* class, together with the recently commissioned 60,000-ton *Forrestal* class. It would soon be replaced in service by the fully turbojet-powered Douglas A3D Skywarrior, the heaviest aircraft to be regularly operated on aircraft carriers, weighing in at 82,000 lb. at maximum takeoff weight.³⁷

The Skywarrior was designed to deliver a 10,000-pound nuclear device, have a 2,000 nautical miles combat radius, and it “would permit taking off from a carrier in one ocean, completing a mid-continent bombing mission, and continuing to a waiting carrier in an opposite ocean”.³⁸ The twin-engine Skywarrior would go on to have a long and successful career in the Navy, serving until the end of the 1991 Gulf War in secondary roles.

³⁵ Wassall, “The Development of the Lockheed P2V Neptune,” 162.

³⁶ Robert Guttman, “25-ton savage: envisioned as the U.S. Navy’s entree into the nuclear age, the North American AJ Savage proved too cumbersome for most carriers.” *Aviation History*, September 2015, Gale OneFile) <https://link-gale-com.ezproxy.lib.purdue.edu/apps/doc/A419925936/PPMI?u=inspire&sid=PPMI&xid=f4c0513c>.

³⁷ H. Dixon “Douglas’ A3D Skywarrior-Known as the ‘Whale’-was Created in Response to a Tough Design Challenge” (*Aviation History* 14, no. 1, 2003) 12. <https://search.proquest.com/docview/219850165?accountid=13360>.

³⁸ “Advertisement: Douglas A3D Sky Warrior” (*Newsweek* 45, no. 14, 1955) 113. <https://search.proquest.com/docview/1894163687?accountid=13360>.

However, the original engine – the Westinghouse J40 – “could not produce the thrust necessary to meet the forecast performance” and would later be replaced by the Pratt & Whitney J57.³⁹ The elimination of ejection seats due to weight limitations would prove to be a fatal flaw to the design and would earn the aircraft a rather unflattering nickname, “all three dead”, a spoof on the Skywarrior’s designation, A3D. The chief designer, Ed Heinemann, favored the escape tunnel system as seen on the Douglas F3D Skyknight in place of ejection seats as it results in a 3,500 lb. weight saving. The decisions would ultimately be costly as the escape tunnel would not function properly in a dive, at low altitude, nor during takeoffs and landings. The Skywarriors would transition into an electronic warfare aircraft and tanker aircraft following the introduction of the North American A3J Vigilante supersonic bomber, but in an ironic twist of fate, the Vigilante would be retired a full decade before the Skywarrior due to its lack of versatility. The A3J Vigilante, the last of the Navy’s strategic bomber, is capable of sustained flight at Mach 2 thanks to the pioneering “stores train” bomb bay design and its powerful General Electric J79 engines. Rather than using a conventional bomb bay, an Mk.28 thermonuclear bomb – similar to those carried on B-52s – would be attached to two auxiliary fuel tanks and be pushed out of the bomb bay from behind, eliminating the need for drag-inducing pylons and external payloads.⁴⁰ The design allowed for supersonic bomb delivery, but no nuclear devices would ever be fitted to the Vigilante due to the introduction of the Polaris submarine-launched ballistic missiles as the primary means for seaborne nuclear deterrence.

The commissioning of the USS *Forrestal* (CVA-58) marked a new era for aircraft carrier development. Aircraft carriers, now with angled decks and steam catapults, which enabled simultaneous takeoff and landings of ever-heavier aircraft, are far more efficient than ever before. Older vessels of World War II design, such as the *Essex* class and *Midway* class would receive similar upgrades to allow them to be the backbone of the Navy’s fleet for decades to come.⁴¹ The improved *Kitty Hawk* class and the one-off USS *Enterprise* (CVA(N)-65) continued the evolution of carriers, and the nuclear-powered *Enterprise* allowed for expanded

³⁹ Dixon, “Douglas’ A3D Skywarrior-Known as the ‘Whale’-was Created in Response to a Tough Design Challenge,” 12.

⁴⁰ “Advertisement: (North American Aviation)” (*Newsweek* 60, no. 18, 1962) 74-75.

⁴¹ “Fifth Forrestal-Class Carrier Ordered from New York Shipbuilding for \$119,841,034” *Marine Engineering (1953-1956)* 60, no. 12, 1955) 98.

munitions and aircraft fuel storage as the need for heavy oil storage is greatly reduced.⁴² However, the aircraft carrier-bomber pairing would soon be declared obsolete as the Navy's principal form of nuclear deterrence following the commissioning of USS *George Washington* (SSB(N)-598), the first U.S. nuclear-powered ballistic missile submarine. The task of nuclear deterrence transitioned from the surface fleet to the submarine service. Unlike aircraft carriers, ballistic missile submarines can remain under the ocean waves for months on end and be instructed to launch their deadly payload by ground-based or airborne command and control centers.⁴³

Submarine-launched Missiles

Before the commissioning of the *George Washington*, USS *Tunny* (SSG-282) and USS *Barbero* (SSG-317) of World War II vintage were converted into cruise missile submarines. The duo would be armed with the subsonic Chance Vought SSM-N-8A Regulus cruise missiles equipped with nuclear warheads, pending the commission of the dedicated diesel-electric *Grayback*-class and the nuclear-powered USS *Halibut* (SSGN-587), armed with the supersonic SSM-N-9 Regulus II. The Regulus was comparable to the Air Force's Martin MGM-1 Matador cruise missiles, and it was proposed to both services that the programs be combined to reduce defense spending.⁴⁴ Those efforts would be in vain due to differences in operational requirements, but both missiles' service would be short-lived as they lacked the range of ballistic missiles. The Matador would remain in service between 1952 and 1962, with the Regulus I in service from 1955 to 1964. The Regulus II program was terminated in 1958 in favor of the Polaris program, as Polaris could be launched while submerged, a trait neither variant of the Regulus possesses.⁴⁵

The *George Washington*-class and all other U.S. ballistic missile submarines until the *Ohio*-class would be equipped with sixteen

⁴² Joint Committee on Atomic Energy, *Tour of the U.S.S. "Enterprise" and Report on Joint AEC-naval Reactor Program: Hearing before the Joint Committee on Atomic Energy, Congress of the United States, Eighty-seventh Congress, Second Session ... , March 31, 1962., 1962, 4-5.*

⁴³ *Peace... Is Our Profession: Alert Operations and the Strategic Air Command, 1957-1991, 23.*

⁴⁴ Kenneth P. Werrell, *The Evolution of the Cruise Missile* (1985) 114-115.

⁴⁵ *Ibid.*, 110-111.

submarine-launched ballistic missiles, initially with Polaris and later with Lockheed UGM-73 Poseidon missiles. Before the commissioning of the *George Washington*, the Polaris system was tested onboard USS *Observation Island* (EAG-154), a converted *Mariner*-class merchant ship.⁴⁶ Despite the missile's limited range at 1,200 nautical miles for the A-1 variant, the enhanced survivability of the Polaris-armed submarines made the project lucrative as it safeguards United States' second-strike capabilities. Admiral William F. Raborn claims the Navy is "confident these [*George Washington*-class] submarines are going to be very safe and secure in NATO controlled waters" but advocated for the development of the A-3 variant with 2,500 nautical mile range as "the Soviets are going to put a prodigious effort to try to counter them."⁴⁷ In 1960, the Navy proposed the construction of 45 Polaris-armed ballistic missile submarines and 5 submarine tenders to support the fleet, with later ships (i.e. *Ethan Allen*-class and beyond) being clean-sheet designs rather than inserting a section containing the Polaris missiles into the existing *Skipjack*-class attack submarine design like the *George Washington*-class.⁴⁸

Ultimately, the number of American ballistic missile submarines would be limited to 41, totaling 656 ballistic missile launchers on nuclear-powered submarines because of the 1972 Strategic Arms Limitation Talks Agreement. Additionally, the treaty would also limit Soviet Union's seaborne ballistic missile capabilities to 740 ballistic missile launchers on nuclear-powered submarines.⁴⁹ Older land-based missiles – such as the Titan I – must be retired before the construction of any additional ballistic missile submarines under the one-way mix concept, and any replacement submarines could only commence sea trials after the older type was decommissioned and began dismantling.⁵⁰ The U.S. Navy's ballistic missile submarines fleet would colloquially be known as "41 for Freedom", and while the U.S. Navy has a smaller number of launchers, they would retain strategic superiority as NATO forces continued to

⁴⁶ Joint Committee on Atomic Energy, *Naval Reactor Program and Polaris Missile System: Hearings before the United States Joint Committee on Atomic Energy, Eighty-Sixth Congress, Second Session, on Apr. 9, 1960*, 4.

⁴⁷ *Naval Reactor Program and Polaris Missile System*, 3-4.

⁴⁸ *Naval Reactor Program and Polaris Missile System*, 5, 8.

⁴⁹ Committee on Armed Services, *Full Committee Hearings on the Military Implications of the Strategic Arms Limitation Talks Agreements* (1972) 15076.

⁵⁰ *Full Committee Hearings on the Military Implications of the Strategic Arms Limitation Talks Agreements.*, 15089.

control the majority of the Atlantic and Pacific, with the Soviet Navy's ocean access limited to a handful of chokepoints. Advancements in multiple independently targetable reentry vehicles and penetration aids, made available to the Navy with the introduction of Poseidon in 1971, allowed for a single missile to strike multiple targets, further lowering the need for additional launchers.⁵¹

Cuban Missile Crisis

United States' nuclear forces would be put to the test after President Kennedy's announcement about the quarantine around Cuban waters due to the presence of Soviet ballistic missiles on the island nation on October 22, 1962. The naval quarantine prevents any additional arms shipments to Cuba, and he demanded the removal of the missiles already delivered. While the Navy was busy deploying aircraft carriers, destroyers, and patrol aircraft around Cuban waters, Strategic Air Command went on 24-hour operations, with all leaves canceled and nuclear-armed B-47 bombers dispersed to secondary airfields.⁵² Two days after the announcement of the quarantine, Strategic Air Command increased its alert status to Defense Condition Two, with all aircrafts ready for takeoff on six hours' notice, while all other services and commands remained at Defense Condition Three. During the thirteen-day Cuban Missile Crisis from October 16 to October 28, over 90% of the United States' strategic nuclear forces were at the ready, with 1,436 bombers, 145 ballistic missiles, and 916 tankers for aerial refueling made available at the height of the alert.⁵³ Additional B-52s were placed into airborne alert beyond the scheduled Chrome Dome missions, and land-based ballistic missiles were fueled and raised out of their silos into launch positions.⁵⁴

The Navy also deployed all the eight available *George Washington*-class and *Ethan Allen*-class ballistic missile submarines towards their deterrent patrol areas, and the anti-submarine forces began locating Soviet

⁵¹ *Ibid.*, 15107.

⁵² *Peace... Is Our Profession: Alert Operations and the Strategic Air Command, 1957-1991*, 16.

⁵³ R. Beer, *The U.S. Navy and the Cuban Missile Crisis* (United States Naval Academy Annapolis MD, 1990) 148.

⁵⁴ *Peace... Is Our Profession: Alert Operations and the Strategic Air Command, 1957-1991*, 17-19.

attack submarines approaching Task Force 135.⁵⁵ Task Force 135, comprised of the carriers USS *Enterprise* and USS *Independence* (CVA-62), was cruising off the northwest coasts of the Bahama Islands pending the command to begin attacks on Cuba. However, the Task Force would be overshadowed by destroyers dropping Mk. 64 Practice Depth Charges on Soviet submarines attempting to signal them to the surface. One Soviet submarine, the *Foxtrot*-class B-59, considered the depth charges as an act of American aggression and came close to launching nuclear-armed torpedoes at its presumed attacker.⁵⁶ Low-altitude reconnaissance flights conducted by Air Force McDonnell RF-101 Voodoos and Navy Vought F8U Crusaders provided the Executive Committee with more information about Soviet and Cuban deployments, but they were met with fierce anti-aircraft fire, and “the possibility that a plane might be shot down by anti-aircraft fire or by a Cuban MiG was not far from Kennedy's mind.”⁵⁷ On October 27, an Air Force Lockheed U-2 piloted by Major Rudolf Anderson, Jr., was shot down by a Soviet SA-2 Guideline surface-to-air missile, and tension rose once again as plans were drawn up for retaliatory strikes by Air Force or Navy fighter-bombers against the responsible surface-to-air site and ballistic missile launchers.⁵⁸

Following the withdrawal of Soviet ballistic missiles and bombers from Cuba and Kennedy claiming an American victory, Strategic Air Command returned to normal alert posture on November 20, and the naval quarantine would end on the same day as well. Despite the heightened tension and increased number of sorties, Strategic Air Command maintained a perfect flight safety record during the Crisis.⁵⁹ After the Crisis ended, the now obsolete Jupiter missiles deployed to Turkey and Italy were withdrawn the year after. Officially, the missiles were withdrawn as the newer Polaris and Minuteman missiles were more effective but later declassified documents indicated that the withdrawal of the Jupiter missiles was a part of the deal made between President Kennedy and Premier Khrushchev.⁶⁰ Similarly, the Royal Air Force's Thor missiles would be returned to the U.S. in 1963, replaced by Royal Navy's Polaris-armed

⁵⁵ *The U.S. Navy and the Cuban Missile Crisis*, 137-138.

⁵⁶ *Ibid.*, 149.

⁵⁷ *Ibid.*, 135-136.

⁵⁸ *Ibid.*, 170-171.

⁵⁹ *Peace... Is Our Profession: Alert Operations and the Strategic Air Command, 1957-1991*, 16.

⁶⁰ *The U.S. Navy and the Cuban Missile Crisis*, 59-60.

ballistic missile submarines in its strategic deterrence role.⁶¹

Guaranteeing a Second-strike

With the Soviet Union's increased first-strike capabilities, the need for airborne command posts and alternative means to safeguard United States' second-strike capabilities became an utmost priority. Beginning in 1962, a handful of B-47 bombers were converted into EB-47L communications relay aircraft by fitting additional communications equipment on board, and they would form the first iteration of the Post-Attack Command and Control System.⁶² These aircraft would work in conjunction with ground-based infrastructures and airborne command posts, with the airborne command post operating under the codename "Looking Glass" as it would mirror operations at air force bases. In addition to the airborne command and control structure, three Blue Scout Junior rockets – and later Minuteman II ballistic missiles – were modified to carry "UHF recorders with a prerecorded force execution message that could be transmitted to all units within line of sight of the rocket's apogee flight."⁶³ The Boeing AN/DRC-8 Emergency Rocket Communications System would preserve Strategic Air Command's ability to retaliate against a Soviet first strike, in the event of the destruction of all ground-based communication systems. With the introduction of the larger and longer-range Boeing EC-135C aircraft fitted with more sophisticated communication equipment, they would assume both "Looking Glass" and communications relay missions, and the EB-47Ls would be phased out. The retirement of B-47s and KC-97s would also mark Strategic Air Command's transition from a bomber-centric force to a missile-centric force. On April 21, 1964, the amount of intercontinental ballistic missiles equaled the number of bombers on ground alert, and with the increasing intensity of the war in Southeast Asia, the bomber alert force would steadily decline in number, gradually replaced by ballistic missiles stored in hardened silos.⁶⁴ In May 1967, the Airborne Launch Control System entered service, allowing the airborne command posts to directly issue

⁶¹ McCourt, *Britain and World Power Since 1945*, 100.

⁶² *Peace... Is Our Profession: Alert Operations and the Strategic Air Command, 1957-1991*, 83.

⁶³ *Ibid.*, 11.

⁶⁴ *Peace... Is Our Profession: Alert Operations and the Strategic Air Command, 1957-1991*, 23.

launch commands to the land-based Minuteman missiles through both onboard communication systems and the Emergency Rocket Communications System.⁶⁵

With the B-47 dispersal program proven to be a success during the Cuban Missile Crisis, the program was revived in 1968 for B-52s and KC-135s. The program would disperse bombers and tankers over a large number of airports – both military and civilians – during periods of increased tension, as it reduced the likelihood of a first strike disabling a large portion of the alert force and allowed for more aircraft to be airborne within a given time.⁶⁶ While at Strategic Air Command airbases, aircraft would be parked on the herringbone-shaped “Christmas tree” alert aprons, and aircrew on alert missions would be housed in the adjacent Readiness Crew Building, colloquially known as the “mole hole”. The Readiness Crew Building included billeting and living quarters, and each alert apron would contain nine aircraft parking spots, but while dispersed to secondary airfields, none of those amenities would be available. On a typical day, up to one-third of all available Strategic Air Command aircraft would be ground alert duties, with them “[parked] at the end of runways, bombs loaded, and crews nearby ready to take off within 15 minutes.”⁶⁷

In the case of a scramble – quick mobilization of the alert aircraft – , aircrew would run out of the “mole hole”, and either run or drive towards their aircraft and prepare the aircraft for immediate departure. Bombers and tankers would use minimum interval takeoff procedures to get airborne in a matter of seconds, and the Strategic Air Command Commander Support Aircraft, carrying generals and their staff, would also be launched to join the already airborne “Looking Glass” aircraft.⁶⁸ In addition to airborne alerts and ground alerts at bases scattered across the United States, B-47 bombers and KC-97 tankers were forward deployed to the United Kingdom, Spain, and Morocco on 90-day tours under the codename “Reflex”. Overseas bases allowed for further dispersion of the bomber fleet and complicate Soviet targeting, but the program would be short-lived,

⁶⁵ *Ibid.*, 27.

⁶⁶ *Ibid.*, 28.

⁶⁷ Jenny Gordon, “Cold War-Era Alert Facility on a New Mission” (Robins Air Force Base. United States Air Force, June 6, 2014) <https://www.robins.af.mil/News/Article-Display/Article/840154/cold-war-era-alert-facility-on-a-new-mission/>.

⁶⁸ *SAC - The Global Shield*. United States Air Force (1980) <https://www.youtube.com/watch?v=gcREJyRmZGg>.

lasting only between 1957 and 1966 due to a multitude of reasons.⁶⁹ The retirement of the antiquated Stratojet and Stratofreighter fleets, combined with the shift from bomber-based to missile-based deterrence and the United States' increasing commitment to the Southeast Asian conflict all contributed to the termination of airborne "Chrome Dome" and forward deployment "Reflex" alert missions.

Conclusion

Throughout the first three decades of American nuclear weapons development, its delivery system constantly evolved to reflect technological advancements and the need to safeguard the nation's second-strike capabilities. Beginning with the piston-powered B-29 Superfortress, there would be many iterations before arriving at the nuclear triad we know today with strategic bombers, land-based intercontinental ballistic missiles, and ballistic missile submarines. The Navy's first Atomic Age aircraft carrier, USS *United States*, would be canceled before its commissioning, but the Strategic Air Command's bomber fleet would lose its prominence as the principal form of nuclear deterrence following the commissioning of the Polaris-armed USS *George Washington* ballistic missile submarine. The Navy's surface fleet would also go from operating the interim P2V Neptune patrol aircraft to the dedicated A3J Vigilante as nuclear bombers, traveling twice the speed of sound. During these three decades, the Strategic Air Command would operate aircraft ranging from the twin-engine FB-111A Aardvark to the ten-engine B-36 Peacemaker. After trials with numerous other platforms such as the free-fall nuclear bomb, cruise missiles, and air-launched ballistic missiles, silo- and submarine-launched ballistic missiles would be proven as the definitive forms of nuclear deterrence.

⁶⁹ *Peace... Is Our Profession: Alert Operations and the Strategic Air Command, 1957-1991*, 2-3.

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