

“They Developed it but apparently have no
Requirements for it:”
Why the USAF was the Last Major Air Arm to
Adopt All-Cannon Armaments for its Fighter
Aircraft

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The United States Air Force (USAF) was the last of the world’s major air arms to operate day fighter aircraft armed with machine guns instead of cannon.¹ The fighter forces of most other air services made

¹For the purposes of this work, a “fighter” (also referred to as an “air superiority aircraft”) is defined as an airplane designed to destroy other aircraft as its primary role. Note that this definition, and most of the ones below, must be qualified with “generally” and “usually.” There are no hard-and-fast rules regarding aircraft categorization, and there is often considerable overlap from one classification to another, even within a single air force.

The generic term “fighter” usually implies a “day fighter” which, as its name implies, is designed to operate only in clear weather, its crew relying on “the Mark I eyeball” to detect the enemy (although they can and have been used at night, usually in desperation when no dedicated night fighter types are available). A “night fighter” (note the qualifying adjective, further evidence that the generic “fighter” operates primarily in daylight) is one designed for nocturnal combat, and usually possesses a radar with which the crew searches for targets. It is usually employed against bombers. The term “night fighter” is rarely used today, having been supplanted by the term “all-weather fighter,” which better describes its abilities.

An interceptor is a fighter designed for a defensive role. Its purpose is to engage and destroy incoming bomber and attack aircraft before they reach their targets. They are often referred to as “point-defense aircraft” or “home defense fighters.” They usually

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the transition from machine guns to cannon before or during World War Two.² The USAF, however, continued to specify machine guns for its day fighter designs well into the jet age. This work is an examination of the reasons the US Air Force, traditionally one of the most technologically advanced air arms in the world, lagged so far behind its counterparts in this particular area.

have a good rate of climb but are often short ranged.

The term “bomber destroyer” has passed in and out of vogue but its adherents have never explained precisely how one such differs from an interceptor.

An “escort fighter” is a fighter that accompanies attack and bomber aircraft to their targets. Their function is to protect the strike aircraft from defending interceptors. They are sometimes referred to as “penetration fighters,” a term coined in the mid-1940s.

A “fighter bomber” is a fighter able to carry ordnance for air-to-surface missions. It differs from an “attack aircraft” in that it has an air-to-air ability. Note that attack aircraft are usually designed for the role while fighter-bombers are often air superiority designs that have been relegated to the attack role after having been succeeded by newer, more advanced types.

Although some air forces assign different designations to day and night fighters, and/or fighters and attack aircraft, no air arm in history has ever deemed the difference between interceptors and escort fighters significant enough to warrant separate designations.

²Machine guns and cannon are both types of automatic weapons. The generally accepted difference between the two is size. Anything with a bore diameter of 20 millimeters or greater is considered a cannon. Note that in the non-metric United States, indigenous weapons designs are usually referred to by “calibre” (the bore diameter expressed in inches), while imported types commonly retain their metric identifications, at least until the 1980s.

Another distinction is that a machine gun (MG) almost invariably fires a solid projectile. There are several types of machine gun ammunition: “ball” (an ordinary solid bullet), incendiary, tracer, armor-piercing, and a few less common varieties. Aircraft machine guns are divided into two classes, light rifle-calibre guns, with a bore diameter (calibre) of .30 or .303 inches (7.62 mm), and heavy guns of .50 calibre (12.7 mm). A cannon may fire a solid round but is usually loaded with explosive shells. The most common calibres of fighter-borne cannon are 20, 23, 30, and 37 millimeter. Larger cannon have been installed on aircraft but these were intended for air-to-surface attacks (although the Germans experimented with an airborne 50 mm cannon for use against American bombers during World War Two, and several other services have attempted using 40-mm cannon for air-to-air combat).

Cannon projectiles are larger and heavier than simple bullets, so cannons generally have a lower rate of fire (or “cyclic rate”) than machine guns. However, the invention of the “Gatling”-style cannon (one with multiple revolving barrels) makes it possible to fire at a rate of four or even twelve thousand rounds per minutes (although most modern aircraft rarely carry more than 1,000 rounds per gun).

A number of possible explanations for this phenomenon present themselves. One is that the drastic reductions in the American defense budgets after World War Two prevented the USAF from investing in new armaments. Another is that the leaders of the USAF were resistant to change—military officers have a reputation for conservatism. A third is that there was no perceived need for weapons upgrades. Or it could be that the USAF had experimented with cannon and found them wanting.

This last thesis is very attractive, given that the USAF's predecessor organization, the United States Army Air Forces (USAAF or, for convenience, AAF) operated two types of cannon-armed day fighters, the Lockheed P-38 Lightning and the Bell P-39 Airacobra, during World War Two.³ Neither aircraft, however, possessed an all-cannon armament. The prototype of the P-38 was equipped with a single 37-mm cannon and four .50-calibre machine guns but production models replaced the cannon with a 20-mm weapon (either an M1 or an AN-M2C, both of which were variants of the Swiss-designed Hispano-Suiza HS404, built in the United States under license).⁴ The P-39 had a single 37-mm Browning M4 cannon (an export variant carried a 20-mm weapon) and, depending on the model, various combinations of .30- and .50-calibre machine guns.

All of the American-built “Hisso” cannons, as Hispano-Suiza designs were known, were unreliable, suffering a high rate of misfires. Their chambers were too long (by a mere one-sixteenth of an inch), which prevented their firing pins from making full contact with a round's primer at times.⁵ Additionally, the Hispano required a rigid installation but American aircraft designers often failed to create gun mounts stiff enough to support them properly.⁶ As a result, the guns were difficult to maintain as the stresses of flight and gunfire could

³ The USAF became independent of the United States Army in 1947.

⁴ Note that there are a number of accepted abbreviations for weapons sizes. In the text, the terms “x-mm” and “y-calibre” will be used. However, all direct quotations will retain their original language to demonstrate the fascinating variety of styles developed over the years.

⁵ George M. Chinn, *The Machine Gun: History, Evolution and Development of Manual, Automatic, and Airborne Repeating Weapons*, v. 1 (Washington: USGPO, 1951), 577-578, 588-590.

⁶ Anthony G. Williams and Emmanuel Gustin, *Flying Guns: The Development of Aircraft Guns, Ammunition and Installations, 1933-45* (Shrewsbury, UK: Airlife, 2003), 151.

cause their parts to fall out of alignment. During World War Two, the AAF trained thousands of armorers; these men were processed far too hastily to develop fully the skills they needed to take care of such temperamental weapons.

The American-made Browning cannon used in the P-39 was equally problematic. “In service the M4 revealed itself to be a very troublesome weapon, quite often jamming after the first shot and almost always after a few rounds. Pilots complained vociferously about this ‘single-shot cannon.’”⁷ Although AAF Material Command blamed the problem on poor maintenance in the field, the M4 was indeed defective. Its chute for the ejection of spent cartridges was poorly designed, although this fault was eventually rectified.

The other day fighters operated by the AAF during World War Two carried machine guns exclusively. At the start of the war, there was no standard armament for Army fighters, most types carrying a mix of .30- and .50-calibre machine guns, but by 1944 it was obvious that the “day of the 30 ha[d] long since passed”⁸ and so all AAF fighters were equipped with a battery of six or eight Browning M2 .50-calibre machine guns.⁹ There are many advantages associated with mounting a single type of weapon in an aircraft. One is that it reduces maintenance requirements and another is that it eliminates the need to stock different types of ammunition, both being important concerns for units in the field. The most important, however, is that there is no need for pilots and armorers to account for variations in the ballistic characteristics of the guns. “The differing trajectories of the projectiles meant that they could only be adjusted to strike a single aiming mark at a particular range ... [and d]ifferent times of flight could also cause significant problems in deflection shooting [calculating the point where moving projectiles will

⁷ Ibid., 154.

⁸ J. P. Monroe, quoted in Joint Fighter Conference, Report of Joint Fighter Conference: NAS Patuxent River, MD, 16-23 October 1944 (Naval Air Station Patuxent River MD: n.p., 1944; reprint, ed. by Francis H. Dean, Atglen, PA: Schiffer, 1998), 158. The work will hereafter be referred to as Report of Joint Fighter Conference.

⁹ The majority carried six, three in each wing. The Republic P-47 Thunderbolt carried eight.

reach a moving target by “leading” it, as hunters do with ducks and quarterbacks do with receivers].”¹⁰

The Browning M2 was a remarkably reliable weapon and was easy to maintain. In 1943, General Henry “Hap” Arnold, the commander of the Army Air Forces, noted that

[t]his weapon, together with its ammunition, is the backbone of offensive and defensive guns for American aircraft and was brought to such a state of perfection by the Ordnance Department during the years of peace prior to the present conflict that it has enabled the Army Air Forces, the U. S. Navy [USN], and Marine Corps [USMC] to show a definite superiority in aircraft gun power throughout this global war.¹¹

A year later, an American naval officer observed, “As it is, we have the 50-cal. gun which has reached its peak. The only improvements will be minor.”¹² The “Ma Deuce,” as the M2 became known, remains in production to this day, testifying to the quality of its design, which dates to 1918. The Navy had similarly good experiences with the M2. On a single combat cruise, one aircraft carrier expended some 200,000 rounds of .50-calibre ammunition “with only two serious jams and two dozen stoppages of all types.”¹³ Whether the ammunition was fired by guns on the ship itself or by the guns on the airplanes it carried is not specified. Either is possible, as the M2 was the standard weapon for American naval fighters as well as those of the AAF.

The USN, like the USAAF, began World War Two with a day fighter force made up exclusively of machine-gun armed aircraft,

¹⁰ Anthony G. Williams, *Rapid Fire: The Development of Automatic Cannon, Heavy Machine Guns and their Ammunition for Armies, Navies and Air Forces* (Shrewsbury, UK: Airlife, 2000), 147.

¹¹ Quoted in Chinn, *The Machine Gun*, 338. The specific report from which this quotation was taken is not identified, except as having been written in November 1943, and its author is referred to as simply “the commanding general of the Army Air Forces.”

¹² J. P. Monroe, quoted in *Report of Joint Fighter Conference*, 157.

¹³ Malcolm F. Schoeffel, quoted in Chinn, *The Machine Gun*, 338.

although all of its fighter types had carried only .50-calibre Brownings since before the conflict. The types on hand at the beginning of the war, the Grumman F4F-3 Wildcat and Brewster F2A Buffalo, carried four, while those introduced during the conflict (the -4 model of the Wildcat, the Grumman F6F Hellcat, and the early models of the Vought F4U Corsair) were, like their AAF counterparts, armed with six. However, in April, 1945—just five months before the end of the conflict—the USN began operating another Corsair variant, the F4U-1C, which differed from its predecessors by having four 20-mm cannon. The Navy had high hopes for the more heavily-armed fighter. One officer said, “I am personally very anxious for the first report on that [the F4U-1C], and I think that the first time they open up on a Jap[anese] fighter, it’s going to fly into a million pieces.”¹⁴

The Navy's anticipatory enthusiasm for the cannon-armed Corsair is difficult to explain given the AAF's problems with its cannon armaments; it is almost as if the USN's leaders were unaware of the Army Air Force's trouble. Indeed, at the Joint Fighter Conference of 1944 (a meeting of aircraft engineers and manufacturers, combat and test pilots, naval and military officers, and aerodynamicists to discuss the current state of fighter aircraft design), Commander J. P. Monroe of the Armaments Branch of the USN's Bureau of Aeronautics asked outright “if somebody in the Army could explain why the Army is not interested in the 20-mm gun. They [sic] developed it but apparently have no requirements for it while the Navy feels quite differently about the gun.”¹⁵

Colonel Lee Coats, a representative of the AAF's Proving Ground Command at Eglin Field, Florida, responded not by referring to the cannon's shortcomings but by observing that:

the feeling in the Army generally is that we would like to have a lethal density pattern. The most bullets going across one place at a given instance. We would like to have the smallest caliber gun that can do the job. If it takes a 22-mm [sic] to tear a Messerschmitt or a Mitsubishi apart, we want 20's, but as long as a 50 [calibre] will do the job we feel that if we can carry a

¹⁴ J. P. Monroe, quoted in Report of Joint Fighter Conference, 157.

¹⁵ J. P. Monroe, quoted in Report of Joint Fighter Conference, 169.

greater number of guns and a greater amount of ammunition with the same weight, with an equal or greater fire power, that is the gun we want ... A Jap[anese soldier] doesn't care whether he gets killed by 20 mm's or a 50 caliber.¹⁶

“Density pattern” refers to how concentrated an aircraft’s fire is. An airplane with all of its guns in its nose, such as a P-38, can deliver a compact burst of firepower, all of its projectiles traveling in a relatively tight grouping. An aircraft with wing-mounted weapons (such as most of the AAF’s World War Two fighters) will have a gap between the lines of fire from its left- and right-side guns, greatly increasing the chances that its target might be hit by the rounds of just one or two weapons rather than its entire battery. This problem can be alleviated by “harmonizing” its guns, aligning them so that its shells or bullets will meet at a specific point ahead of the airplane (“The most bullets going across one place at a given instance”). The closer the target is to that position, the more projectiles will strike it.¹⁷

Colonel Coats went on to observe that the Army believed that standardized bore sight patterns gave “the mediocre pilot a better opportunity to hit an airplane in flight.”¹⁸ The leaders of the AAF knew that most of the thousands of pilots it trained during the conflict were not born marksmen. They reasoned that their pilots would be more effective endeavoring to score many damaging hits rather than a single killing blow.

The F4U-1C was the Navy’s first operational cannon-armed fighter. When it was introduced, all of the other major air arms in the world except the USAAF had already made the transition from fighters armed with machine guns to fighters armed with cannon (in other words, the USN was the second-to-last air service in history to do so). The Japanese Navy had begun using cannon-armed day fighters about a year

¹⁶ Lee Coats, quoted in Report of Joint Fighter Conference, 169. Messerschmitt and Mitsubishi were Axis aircraft manufacturers; the former German, the latter Japanese.

¹⁷ This is a gross oversimplification, of course. Most guns have a small but significant amount of scatter inherent in their designs. Additionally, an airplane’s wings twist and flex in flight, shifting the alignment of the guns within them. There are a host of other factors that degrade accuracy of an airplane’s guns as well, the effects of which are, of course, exaggerated by distance.

¹⁸ Lee Coats, quoted in Report of Joint Fighter Conference, 170

before Pearl Harbor; the Japanese Army did not introduce its first until 1943 (although neither service had fighters armed exclusively with cannons for another year). Many European air arms had cannon-armed fighters in operation before the war began, although the British and Italians delayed, introducing their first cannon-armed fighters in 1941 and 1943, respectively.

There was a time when all fighter aircraft, no matter their country of origin, were armed with machine guns. Yet, as was noted above, almost every major air arm in the world except for the two American services had cannon-armed fighters in action before the United States entered the conflict. The Americans were not unaware of this development, having observers in the war zones. Their decision to eschew cannon-armed fighters thus seems particularly curious. What did the Americans see and not realize, or, perhaps, what did they see and choose to ignore?

The majority of the American observers were assigned to the United Kingdom, and so were able to watch developments in the British air service, the Royal Air Force (RAF), especially closely. The RAF began the war with two basic fighter types, the Supermarine Spitfire and Hawker Hurricane, each of which carried eight .303-calibre machine guns. When these aircraft were designed in the early 1930s, the RAF's leadership calculated that, given the speeds of aircraft available during that period, a fighter pilot would usually be able to fire upon another airplane for just over two seconds.¹⁹ However, “[t]he belief held in Whitehall [before World War Two] was that a single-seat fighter was too light to accommodate cannon” and thus the only way to produce a weight of fire sufficient to ensure the destruction of the target in such a short time was to install eight .303 (rifle-calibre) machine guns, the

¹⁹ Squadron Leader Ralph Sorley (later Air Marshal Sir Ralph Sorley) is often given credit for having originated the idea of an eight-gun fighter (Paul Jacobs and Robert Lightsey, *Battle of Britain Illustrated* [New York: McGraw-Hill, 2003], 44, 96). However, Sorley's role is exaggerated, the result of a self-promoting article he wrote in 1957 (Colin [Sinnott](#), *The RAF and Aircraft Design, 1923-1939: Air Staff Operational Requirements* [London: Frank Cass, 2001], 115-1160).

standard aircraft weapon of the era, in each fighter.²⁰ Until the 1930s, most fighters carried just two of these guns.²¹

In the summer of 1940 Germany began a strategic bombing campaign against England, soon called the Battle of Britain. Within three months, the Spitfires and Hurricanes of RAF Fighter Command had shot down enough bombers to compel the Germans to suspend daylight bombardment operations. Yet the victory revealed a glaring weakness in the two British fighters. Rifle-calibre machine guns—even eight of them—were not powerful enough to destroy a medium-sized bomber expeditiously.

As a result the Spitfire and Hurricane were modified to carry heavier armaments. A version of the Hurricane with twelve .303s was produced, but proved disappointing. Far better were the Spitfire Vc and Hurricane IIc, both introduced in 1941, each carrying four 20-mm cannon. The four-cannon battery made short work of most bombers, contributing to the German decision to stop bombing by day.²² No longer having to devote itself exclusively to defensive operations, RAF Fighter Command began offensive fighter sweeps over occupied Europe. The heavy cannon armament proved to be as effective at attacking surface targets as it was at shooting at German aircraft and became the standard armament for British fighters.

Yet the AAF's leaders believed that none of the RAF's experiences applied to their service. The United States was well beyond the range of any potential enemy's bombers, and so did not need interceptors. Other fighter types were equally superfluous. "The No. 1 job of an air force is bombardment. We must have long-range bombers which can hit the enemy before he hits us; in short, the best defense is

²⁰ Harry Woodman, "Armament Development," in *Biplane to Monoplane: Aircraft Development 1919-1939*, ed. Philip Jarrett (London: Putnam, 1997), 190. "Whitehall" is a common synecdoche indicating the British government.

²¹ The standard of a single pair of light machine guns was established in World War One. The underpowered aircraft of the era could rarely carry heavier loads, although most air services experimented with three- and even four-gun armaments irregularly throughout the conflict. In the interwar period, most fighters carried just the one pair of guns. It was the British who began the trend towards the heavier batteries in the early 1930s, although other air services were quick to follow suit (Sinnott, *RAF and Fighter Design*, 111-114).

²² The most important reason, however, was the Germans' need to conserve their bombers for the invasion of the Soviet Union, planned for early 1942.

attack,”²³ was the prevailing attitude in the AAF. Its bombers could reach targets far beyond the range of any fighter, and as a result, “close pursuit [fighter] support of modern long-range bombardment can no longer be provided clear to the target or objective, [because] the high speed and great defensive fire power of modern bombers makes close support by large numbers of pursuit airplanes no longer so vitally necessary as heretofore.”²⁴ A well-armed bomber, AAF leaders believed, could fight its way to any target, despite the evidence of the Battle of Britain, and American aircraft, unlike their European counterparts, were particularly well protected, being equipped with heavy .50-calibre, not rifle-calibre, machine guns.²⁵

They were wrong. Antiaircraft guns and interceptors exacted a high toll of AAF bombers during the early years of the American strategic bombing campaign against Nazi Germany. There was little that could be done about the former, but the latter threat could be reduced by assigning fighters to escort the bombers. Doing so, however, had the effect of forcing the Americans to eschew the deep-penetration missions they had theretofore practiced until the range of their fighters could be improved. “The equipment of our escort fighter aircraft with extra long-range disposable fuel tanks now enables them to give our bombers

²³ H. H. Arnold, First Report of the Commanding General of the Army Air Forces, January 4, 1945, to the Secretary of War, in Reports of General of the Army George C. Marshall, Chief of Staff; General of the Army H. H. Arnold, Commanding General, Army Air Forces; Fleet Admiral Ernest J. King, Commander-in-Chief, United States Fleet and Chief of Naval Operations (New York: Lippincott, 1947), 304. Hereafter referred to as “Arnold, First Report.”

²⁴ Oscar Westover, testimony, Military Establishment Appropriation Bill for 1938: Hearing before the Subcommittee of the Committee on Appropriations House of Representatives, 75th Congress, 1939.

²⁵ The three main American heavy bombers of World War Two, the Boeing B-17, the Consolidated B-24, and the Boeing B-29, were each armed with at least ten fifty-caliber machine guns in five positions, nose, tail, dorsal, ventral, and left and right waist. European bombers were generally equipped with thirty-caliber guns and did not have ventral or waist gun positions, although some had a single twenty-millimeter cannon (heavier than the fifty-cal) in their tails.

The most common explanation for the name “Flying Fortress” is that it refers to the B-17’s bristling defenses. However, an alternative story links the name to the aircraft’s original function. The isolationist United States needed to rely on its shore batteries to protect itself from invasion. The B-17 served to extend the range of American coastal defenses from gun range (20-some miles) to the high seas.

continuous cover to and from targets formerly out of tactical range” wrote General Arnold in early 1945.²⁶

The heavy machine-gun armaments of the American escort fighters were powerful enough to damage or destroy the interceptor aircraft they were used against. They also worked well against ground targets when the German air force had lost enough interceptors to allow American fighters to be assigned to duties outside of guarding bombers. There was thus no reason to replace them. As General Arnold proclaimed, “The Army Air Force put its faith in the American 50-caliber machine gun.”²⁷

Unlike the AAF, which was dedicated to strategic bombing, the United States Navy was not committed to any particular concept of air power. Its leaders saw the airplane as an adjunct to surface vessels, able to bombard enemy shore installations and ships (like a battleship) and to provide early detection and defense against threats to the fleet (like a destroyer). They thus had no real reason to reevaluate the armaments of the USN's fighter aircraft.

American aircraft carriers operated in the Atlantic and off of Europe and Africa, but their fighter pilots rarely got opportunities to fight against German and Italian aircraft. Most of the Navy's air-to-air fighting took place in the Pacific against the Japanese army's and navy's air arms. All Japanese aircraft were notoriously fragile. They were designed to emphasize range or agility, or both, which was generally achieved by reducing weight—usually at the expense of armor and firepower.²⁸ In the first two years of the conflict, the lightweight Japanese aircraft had a performance advantage over most Allied types, but once the Americans and British began operating well-armored airplanes with heavy guns, Japanese aircraft had trouble both inflicting and sustaining damage. In 1943 and 1944, USN fighter pilots exacted a terrible toll on the Japanese air forces.

By 1944, however, Japanese losses had been so heavy that Imperial commanders became increasingly desperate, willing to try almost anything to halt the American advance across the Pacific. During

²⁶ Arnold, First Report, 349.

²⁷ Arnold, *Ibid.*, 309.

²⁸ The Italians shared with the Japanese a belief that agility should be the primary attribute of a fighter design, one of the reasons they lagged so far behind other nations in adopting cannon-armed fighters.

the invasion of the Philippines in October, they introduced a new weapon, the kamikaze, or suicide attack airplane. Japanese pilots volunteered to fly their aircraft into allied warships, sacrificing their lives to ensure the destruction of the Emperor's enemies. A single airplane and its pilot were considered a small price to pay for the destruction of a battleship or aircraft carrier.

The USN's commanders quickly realized that it was not sufficient to merely damage a suicide airplane. As long as it could fly, it could still fulfill its mission. What was needed was a way to destroy kamikazes outright in one attempt. The solution was to develop a fighter armed with cannons. "Unimpressed with the apparent inability ... of six .50-caliber machine guns to drop a kamikaze in timely fashion, the Navy emphasized the installations of four more powerful 20-mm cannon, which ... set the new standard in [American] naval fighter design."²⁹ The USN placed orders for several types of cannon-armed fighters, but only one, the F4U-1C referred to earlier, saw action during World War Two. As a variant of an existing type, the cannon-armed Corsair was easier to put into production; two other cannon-armed fighters, Grumman's F8F Bearcat and F7F Tigercat, had to be developed from scratch and so entered service too late for combat.

Although the USN adopted the 20-mm cannon with seemingly little reservation, naval airmen found it as disappointing as their AAF counterparts did. As ace pilot Howard Finn recalled: "We also had the 20 mm cannon which was a more effective strafing weapon than the .50 cal gun, although they were not as reliable. They seemed to get jammed more often, and it was not uncommon to only have one of the four cannons able to fire. They were also prone to freezing at high altitude."³⁰ As a result, the cannon-armed Corsairs were eventually restricted to flying at low and medium altitudes when on anti-kamikaze patrols, high altitude coverage being provided by older-model F4Us equipped with machine guns.³¹

²⁹ Richard P. Hallion, "Military Technology and the Pacific War." in Pearl to V-J Day: World War II in the Pacific: A Symposium sponsored by the Air Force History and Museums Program and the Air Force Historical Foundation, July 20-21, 1995, Naval Officers' Club, Bethesda, Maryland, eds. Jacob Neufeld, William T. Y'Blood, and Mary Lee Jefferson (n.p.: Air Force History and Museums Program, 2000), 87.

³⁰ Howard Finn, quoted in Mark Styling, *Corsair Aces of World War 2* (London: Osprey, 1995), 77.

³¹ Styling, *Corsair Aces*, 84.

The Navy's problems with the cannon were far greater than the AAF's. "Records show that [the USN] mounted over 90 percent of the cannon actually placed in American aircraft."³² Most of these weapons were installed in non-fighter types, such as the Curtiss SB2C Helldiver, a dive bomber. Yet despite the weapon's shortcomings, the Navy continued to proclaim its faith in the cannon. It was "[t]he heavy artillery of the air," declared a naval training handbook issued in 1945.³³ "[F]or day-by-day use in Navy planes, it's the 20 mm that lands the heavy punch."³⁴ This manual was "written for the enlisted men of naval aviation," in part to boost their morale, and so naturally would not mention any of the weapon's liabilities.³⁵ Their superiors, however, had a different opinion of the gun. That same year that the handbook appeared, the USN's Bureau of Ordnance sent a letter to its Army counterpart in which it was observed that "[t]here is a firm requirement ... for use of 20-mm automatic guns in practically all Navy combat aircraft currently in design ..." and requested a joint effort to improve its reliability,³⁶ describing the cannon's flaws and suggesting possible solutions. The Army and Navy cooperated to improve the American cannon and by 1951 had resolved every issue identified in the letter. "Nothing was basically wrong with the weapon [except that it had been] bought in desperation, put into mass production without first having been adequately proved, and then modified regularly ... before the previous model had been made to function reliably."³⁷

Among the aircraft the Navy ordered during or shortly after the war were its first jet types, the Grumman F9F Panther and the McDonnell FH Phantom. Both were fighters and both were equipped with four 20mm guns—no air arm that had converted from machine guns to cannon ever changed back. The Phantom was withdrawn from

³²Chinn, *The Machine Gun*, 588.

³³Standards and Curriculum Division, Training, Bureau of Naval Personnel. *Aircraft Armament*, Edition of 1945 (Washington: USGPO, 1945), 73.

³⁴Ibid.

³⁵Ibid., ii.

³⁶Bureau of Ordnance (USN) to Chief of Ordnance (USA), "Reactivation of Certain 20-mm Automatic Gun Development Projects and 20-mm Ammunition Development Projects—Request For," quoted in Chinn, *The Machine Gun*, 588.

³⁷Chinn, *The Machine Gun*, 590.

service fairly quickly, its primary purpose being to familiarize naval aviators with jet operations, but a larger and more powerful derivative, the F2H Banshee, also equipped with four cannon, had a long operational career in the USN. The Banshee and Panther were in service when the Korean War began and the Navy employed both types throughout the conflict.

The USAF had also begun operating jets in the late 1940s. Three, the North American F-86 Sabre, Lockheed F-80 Shooting Star, and Republic F-84 Thunderjet, saw service in Korea. All were equipped with the same six .50-calibre machine gun battery that had served the USAAF so well during World War Two.

The F9F, F2H, F-80, and F-84 were rarely used for aerial combat in Korea, their primary role being ground attack. There were two reasons these jets were given this assignment. One was that allied ground units in Korea needed all of the air support they could get. The second was that the enemy (the North Koreans, Chinese, and Soviets, all communist nations) possessed only a handful of fighters (either jet or propeller), so opportunities for air combat were limited. Yet despite their rarity, the communists' jet fighters were far superior to the Panther, Banshee, Shooting Star, and Thunderjet in performance. Their Mikoyan-Gurevich MiG-15 was better than any airplane in American inventory at the time except the North American F-86 Sabre, which was soon given exclusive responsibility for combating the "MiG menace."³⁸

The secret of the Sabre's and MiG's performance advantages was their advanced designs; both belonged to the first generation of swept-winged jet fighters. Wing sweep improves an aircraft's high-speed performance considerably compared to conventional "straight" wings.³⁹ The F9F, F2H, F-80, and F-84 were all straight-winged designs and thus had lower critical Mach numbers (the point at which airflow over the

³⁸"MiG" is an abbreviation for Mikoyan-Gurevich, a Soviet aircraft design bureau named for its original designers. In English, however, writers employ "MiG," "MIG," and "Mig" with almost equal frequency. In this work, the preference will be for "MiG," but direct quotations will retain the spelling of the original.

³⁹Wing sweep increases performance by delaying the onset of compressibility at high speeds. Compressibility is the phenomenon of air being unable to get out of the way of a fast-moving object quickly enough—the air molecules get "bunched up." On an airplane, this increase in local density can interfere with the movement of control surfaces; it also impedes the aircraft's forward progress. It occurs because air traveling around curved shapes accelerates. Interestingly, it is possible for the air moving around the object to exceed the speed of sound even though the object itself remains subsonic.

wing exceeds the speed of sound, adversely affecting controllability) than did the MiG-15. In aerial combat, “speed is life.” The straight-winged jets were thus vulnerable to the MiG and so were relegated to ground attack duties where they would be less likely to encounter aerial opposition.

The F-86, by contrast, performed as well as the MiG in almost every way and as a result was assigned to air superiority operations in Korea. The Sabre could roll better than the MiG and, being heavier, could out-dive it. It also possessed a superior gunsight. The MiG’s advantages included a marginally better top speed, superior turning and climbing ability, and a higher service ceiling. Dogfights between the two were an almost even match (the deciding factor in most battles between MiGs and Sabres was usually pilot ability). The major difference between the two adversaries was their armaments: the F-86, as noted above, had six .50-calibre machine guns, while the MiG-15 carried two 23-mm and one 37-mm cannons.

This disparity drew much attention. A British pilot assigned to the USAF as an observer reported that, in theory

a mixed-caliber, low-cyclic-rate armament installation, known to be in the MIG-15 [*sic*], is not as good for jet fighter air-to-air combat as the unicaliber, high-cyclic-rate installation of the F-86E [and most other USAF fighters] Experience has shown that, with the “snapshot” tactics required in combat of the type under review [against maneuvering fighters], a high-cyclic-rate is mandatory to increase the hit probability and to insure maximum damage effect.⁴⁰

In other words, to hit a small and agile target such as a fighter, a gun with a high rate of fire—such as a Browning M2 machine gun—was in theory the best weapon, seemingly confirming the lessons the AAF’s leaders had drawn from fighting Axis interceptors during World War Two.

However, despite the rapidity of its fire, the Browning was not entirely suited for jet-age warfare. It had a limited range and fired a

⁴⁰W. Harbison, “A Critique on the F-86-E Versus the MIG-15 Aircraft in the Korean Theater,” in *The F.86 v the Mig.15* by W. Harbison (West Raynham, UK: [RAF] Central Fighter Establishment, 1952 [reprint, London: Empire Interactive, 1999]), 5.

small and light projectile. “It is the concerted opinion of experienced pilots,” continued the RAF observer, “in both fighter vs fighter [and fighter] vs bomber combat, that modern airframe and engine design requires the use of explosive shells to achieve adequate target destruction.”⁴¹ Compared to a propeller-driven airplane of the same class, jet airplanes have far fewer moving parts. They are thus more difficult to shoot down than conventionally-powered aircraft.⁴²

The pilots who flew the MiG-15s agreed with the British observer’s opinion. One has observed that “[t]he American .50cal (12.7mm) guns acted on our MIG-15s [*sic*] like peas. Our aircraft would return to airfields with 40-50 bullet holes. The Americans claimed them as shot down, while our pilots were safe and sound.”⁴³ He also drew the same conclusion that the RAF pilot had had about the versatility of cannons. “I liked the MiG-15’s 37mm cannon, despite its low rate of fire,” he said. “In the hands of a skilled pilot firing at short distance, the cannon was good against both fighters and bombers.”⁴⁴

This MiG pilot was not speaking hypothetically. He and his comrades faced both bombers and fighters in the skies over Korea, so they knew that having a weapon versatile enough to work effectively against a variety of targets was not a luxury but a necessity. The primary bomber employed by the USAF during the conflict was the Boeing B-29 Superfortress, a four-engined propeller-driven heavy bomber originally produced during World War Two. It was employed in the strategic bombing role in Korea, just as an earlier Boeing design, the B-17 Flying Fortress, had been used against Germany between 1942 and 1945. The F-86s were often assigned to fly as escorts to the slow B-29s, playing the

⁴¹Ibid.

⁴²Technology advanced so rapidly after World War Two that the term “conventional” had four different meanings in the context of aerial warfare. One was to distinguish types of weapons: there were “conventional” bombs and atomic bombs. Another applied to powerplants: propeller-driven aircraft were “conventional” in the early jet age. A third referred to wing layout: “conventional” designs had straight wings (as discussed earlier). The last was landing gear configuration: the traditional “tail-dragger” was “conventional,” while the “tricycle” design had a nose wheel instead of a tail wheel. All four have been superseded, and, in fact, retronyms created for the earlier standards.

⁴³Evgeny Pepelyaev, quoted in Yefim Gordon and Vladimir Rigmant, *MiG-15: Design, Development, and Korean War Combat History* (Osceola WI: Motorbooks, 1993), 136.

⁴⁴Evgeny Pepelyaev, quoted in Yefim Gordon and Vladimir Rigmant, *MiG-15: Design, Development, and Korean War Combat History* (Osceola WI: Motorbooks, 1993), 136.

same role that the P-51, another North American design, had done, providing protection to the lumbering bombers.

American fighter pilots found themselves at a disadvantage when dogfighting MiGs. The MiG pilots may not have registered a hit often with their slow-firing cannons, but when they did, the explosive shell did considerable damage. Sabre pilots struck their targets more often, but found that the six-.50 battery that had proven so potent against propeller-driven airplanes during World War Two had lost much of its effectiveness. As was observed earlier, jets are hard to shoot down. Not only do they have fewer moving parts, but jet fuel is much less flammable than regular gasoline. The JP (“jet propulsion”) series of fuels are more like kerosene than gasoline and have a relatively high flashpoint.⁴⁵ The jets also had the advantage of flying and fighting at high altitudes where the air is thinner. “Incendiary bullets are not effective above 35,000 feet, presumably because of the lack of oxygen to sustain combustion.”⁴⁶ For the same reason, the risk of fire when a fuel tank or line was damaged and fuel spilled onto hot engine parts was reduced. Before 1950, fires caused by a strike on a critical component were a major cause of aircraft losses in combat. In the jet age, however, an airplane armed solely with machine-guns relied primarily on kinetic impact to damage its target—and solid bullets have far less mass and thus less destructive energy than cannon shells augmented with explosives.

A handful of Sabres were modified to carry four 20-mm cannons in Project GUNVAL (*Gun Evaluation*) late in the war. Eight aircraft were given four T-160 cannon (a revolver- or Gatling-style 20-mm gun later designated M39) in place of their six .50s.⁴⁷ These weapons promised to neutralize one of the disadvantages of cannon compared to machine guns: “The four cannon had a rate of fire similar to that of the

⁴⁵“Aviation Flashes,” *Newsweek*, 25 June 1951, 11; Gabreski, *Gabby*, 243; Bob Hoover, “Gas or Kerosene?,” in *Test Flying at Old Wright Field*, eds. Ken Chilstrom and Penn Leary (Omaha: Westchester House, 1993), 101-102.

⁴⁶Harbison, *Critique*, 5.

⁴⁷Gatling-style cannons were developed by the Germans during World War Two. To prevent excessive barrel heating (a very real concern with automatic weapons, even in the low temperatures of high altitude), they feature a set of five or six barrels that rotate into place in line with the chamber. They are capable of much higher rates of fire than a comparable single-barreled weapon.

Browning machine gun of around 1,100 to 1,200 rounds per minute.”⁴⁸ However, the T-160 was not without its faults. Test firings demonstrated that the guns’ hot exhaust gases would flow into and build up in the Sabre’s air intake, choking of the flow of oxygen to the engine and causing flameouts. “To overcome this it was necessary to fire the cannon in pairs, selecting the top pair flowed by the lower pair; and to fire in short bursts. This not only halved the anticipated impact of the weight of fire ... but increased the kill probability firing time.”⁴⁹ Yet despite these shortcomings, the GUNVAL program was successful enough to warrant further testing.

In late 1952 the GUNVAL Sabres were shipped to Korea for evaluation in combat. In 282 missions, the cannon-armed F-86s fired at 41 MiGs, of which six were destroyed, three probably destroyed, and 13 damaged. The tests concluded on 1 May 1953. They were considered successful and several cannon-armed variants of the F-86 were produced after the war, the earliest of which, the -H model, entered service in 1954.

This new type of F-86 was not, however, the first cannon-armed day fighter to enter the USAF's inventory. That distinction belongs to the North American F-100 Super Sabre, which, as its popular name suggests, was based on the F-86. The F-100 was unusual in that the manufacturer, not the USAF, initiated the program. The type did not become operational until the fall of 1954, and so did not see action in Korea.⁵⁰

The development of a fighter airplane is a lengthy process, requiring several years (today’s aircraft may need decades). The Super Sabre program was initiated in 1949, long before the Korean Conflict revealed the shortcomings of fighters carrying an all-machine gun armament.⁵¹ The USAF's decision to acquire its first cannon-armed day fighters must therefore have made in the late 1940s. The question that

⁴⁸Colin Walker Downes, *By the Skin of my Teeth: Flying RAF Spitfires and Mustangs in World War II and USAF Sabre Jets in the Korean War* (Barnsley, UK: Pen and Sword Aviation, 2005), 192.

⁴⁹Ibid., 193.

⁵⁰Marcelle Size Knaack, *Post-World War II Fighters 1945-1973* (Washington: Office of Air Force History, United States Air Force, 1986), 83-100; 113-134.

⁵¹Marcelle Size Knaack, *Post-World War II Fighters 1945-1973* (Washington: Office of Air Force History, United States Air Force, 1986), 83-100; 113-134.

must be asked is: what occurred during this period to motivate the USAF to convert its fighter armaments from machine guns to cannon?

The most significant event of the years immediately following World War Two was the beginning of the Cold War, the rivalry between the United States and the Union of Soviet Socialist Republics (USSR) that lasted almost fifty years and manifested itself primarily as a contest for the control of and influence over other nations, although the possibility of a direct conflict between the USSR and the USA always existed. Of course, the two nations are on different continents, making it almost impossible for the two to have conducted traditional surface warfare against each other. Air power, however, could bridge the enormous distances and numerous natural obstacles between the Soviet and American heartlands.

Both nations possessed bombers with intercontinental range by 1945.⁵² General George C. Kenney, commander of the Strategic Air Command, warned American Legion members in 1948 that the “distances from existing airdromes in Russia to New York City are less than 4,000 miles and from those airdromes the Russian copies of the [American] B-29s that flew over Moscow in the May Day parade can reach every city in the United States.”⁵³

Never before had the United States seemed so vulnerable. Americans had long relied on their oceanic moats for protection, believing that any invasion force traveling by sea would be in transit

⁵²Soviet bombers had less endurance than their American counterparts, so the USSR would have had to been prepared to expend them on one-way “suicide” missions when contemplating a bombing campaign against the United States.

⁵³George C. Kenney, quoted in “Communists Seen as Likely U.S. Foes: General Kenney Says in Spite of Threat of War We Strive for Peace in Conferences,” *New York Times*, 20 May 1948, p 10.

The B-29 copies to which Kenney referred were designated Tupolev Tu-4. Three Boeing B-29 Superfortress bombers had made emergency landings in Vladivostok during World War Two, and although their crews were eventually repatriated, the aircraft themselves were seized. As the Soviets had no heavy bombers, Josef Stalin ordered Andrei Tupolev (a noted Russian aircraft designer specializing in bombers) and his engineers to disassemble one to learn how it was built. In one of the best examples of “reverse engineering” in history, the Soviets reproduced the B-29 part-for-part (save for weapons and some minor equipment) as the Tu-4. The realization that the Soviets had avoided the expense and frustrations that the development of heavy bombers usually incurred (the B-29 program had been particularly troublesome) and had thus acquired a strategic bombing force virtually overnight caused great consternation within the American defense establishment.

long enough to be detected and intercepted. In the Air Age, however, an attack could come with just a few hours' warning and the atomic bomb promised destruction, not conquest. Moreover, as American general William Mitchell had predicted in 1925,

[r]outes between the continents will not follow the old land and water ways parallel to the equator which have been used heretofore, because our old means of transportation used to be confined to land and water The new routes will follow the meridians, straight over the top of the earth, which cut off hundreds of miles, save weeks of time, untold effort, dangers and expense.⁵⁴

Thus the most likely avenue for a Soviet air attack was through the Arctic, which the Americans had never previously considered a defensive liability. "Study your globe and you will see the most direct routes are not across the Atlantic or Pacific, but through the Arctic," General Arnold warned in 1946.⁵⁵ Later that same year, General Carl "Tooney" Spaatz, Chief of Staff of the Air Force, noted that the country was, "in fact, wide open at the top"⁵⁶

The leaders of the USAF such as Arnold and Spaatz had long regarded their service primarily as an instrument of offense. They were unused to having to consider being on the defensive. Spaatz's comments reflected this bias. His first thoughts were to offense. "Through the Arctic, every industrialized country's within reach of our strategic air force." But he also acknowledged that the United States needed protection. "America is similarly exposed Any plan or buildup for national defense which ignores the new air frontier in the Far North is a sheer waste of American time and money."⁵⁷

⁵⁴Mitchell, *Winged Defense: The Development and Possibilities of Modern Air Power--Economic and Military*. New York: G. P. Putnam's Sons, 1925, 13-14.

⁵⁵Henry H Arnold, quoted in "Gen. Arnold Urges Polar Defense," *The Washington Post*, 6 July 1946, 6.

⁵⁶Carl Spaatz, quoted in "Arctic Provides Path of Attack, Spaatz Warns: U.S. is 'Wide Open' to Devastating Blows, VFW Convention Told," *Washington Post*, 3 September 1946, p1.

⁵⁷Ibid.

This concern was reflected in the various plans the American defense establishment prepared in the late 1940s for a possible war with the Soviet Union. Those written immediately after World War Two discount the Soviets' capacity to attack the United States directly.

During the next few years, foreign capabilities for direct attack against the United States and its bases are slight. However, an abrupt change in the situation will result from foreign development of the atomic bomb and/or other weapons of mass destruction and from foreign possession of aircraft or missiles able to deliver the weapons at 4000-5000 miles distance. It appears certain that these developments will take place; only the date is still in doubt.⁵⁸

For "foreign," of course, read "Soviet."

Estimates of Soviet offensive capabilities in 1946 deemed both the peripheral American bases and commercial shipping in the Arctic area vulnerable only to small-scale air raids, although the Soviets might also be able to mount "[m]inor harassing air attacks by non-return sorties against a few targets in areas of Canada and the northern United States." The greatest threat to American security, it was concluded, would come from saboteurs and subversives.⁵⁹

By 1948, however, Soviet offensive capabilities had improved. The USSR was by then in possession of bombing and transport aircraft of sufficient range to allow it to conduct airborne and bombardment missions against targets in Alaska. Although these operations would be primarily tasked with neutralizing the American bomber forces based in

⁵⁸Appendix "B" to enclosure "B," JWPC 458/1 "Preparation for Joint Plan 'Broadview,'" 5 August 1946, 12, in Ross, Stephen T., and David Alan Rosenberg. *Design for Global War: The Pincher Plans, Part I. America's Plans for War against the Soviet Union, 1945-1950: A 15-volume set reproducing in facsimile 98 plans and studies created by the Joint Chiefs of Staff, vol. 2.* New York: Garland, 1989 (hereafter referred to as "APWSU vol. 2.")

Note that, save for some introductory material in each volume, the books in the "America's Plans for War" series are not themselves paginated. All references to page numbers in this and subsequent notes are taken from the internal pagination of the document cited.

⁵⁹JWPC 458/1 "Preparation for Joint Plan 'Broadview,'" 5 August 1946, 3-4, in APWSU vol.2.

the area, the Soviets could also seize the airfields, which would not only reduce the American threat to the Soviet Union, but could be used as bases for their own “long-range aircraft [that then] could attack any important target in the United States with small-scale, one-way missions; small-scale, two-way attacks could be launched against the Puget Sound area.” Happily for the ordinary American citizens who worried about the “next Pearl Harbor” taking place in their hometowns, the Americans believed that “the experience of the [Soviet] air crews in long-range operations [was] extremely limited. Thus their effectiveness in long-range operations ... depend[ed], mainly, upon the training received since the close of hostilities [in 1945].” The Americans expected the Soviets to dedicate significant resources to cultivating their long-range aviation units. They would also, inevitably, acquire atomic weapons. Plan “Dropshot,” submitted in January 1949, shortly before the first successful Soviet A-bomb test, noted that

[a]s the threat of Soviet A-bomb attack increases, heavy pressure on the Department of Defense for maximum protection against air attack of all large populated areas may be expected, regardless of their military importance. Complete protection is not practicable, and attempts to provide it could consume an undue proportion of our available resources without commensurate increase in the degree of protection afforded.⁶⁰

The government would have to allocate its limited air defense assets to the highest-value target regions in the USA. Some areas might have to go without. And, of course, the Americans could not leave their overseas bases defenseless.

A bomber carrying an atomic bomb is like a kamikaze aircraft: until it is totally destroyed, it can still deliver its payload and thus remains a threat. “If [a nation’s] defenses are highly efficient it may down nine planes out of every ten attacking, but [that nation] will suffer

⁶⁰Brown, Anthony Cave, ed. *Dropshot: The United States Plan for War with the Soviet Union in 1957*. New York: The Dial Press/James Wade, 1978, 189.

the destruction of its cities,” warned scholar Bernard Brodie in 1946.⁶¹ Edward Earle Mead, another educator, concurred, writing, “The threat of a knockout blow, especially with atomic weapons, is enormously enhanced, so that eternal vigilance is more than ever the price of victory.”⁶²

The need to prevent Soviet atomic bombers from reaching their targets compelled the USAF to begin acquiring dedicated interceptors, preferably machines that could destroy an enemy bomber in a single firing pass. Unfortunately, it had little prior experience with such machines. The design and production of aircraft designed expressly for destroying bombers was a low priority in a nation protected from aggression by several thousand miles of ocean. As noted earlier, during World War Two, most AAF fighters were employed as escorts, their role being to protect American bomber formations from enemy interceptors. They were optimized for fighter-versus-fighter combat, their primary attributes being range, speed, and maneuverability. The AAF’s standard battery of six .50-calibre guns was more than adequate for destroying Axis interceptors.

The only practicable experience the USAAF/USAF had with bomber destroyers during the 1941-1945 conflict was acquired during its night fighter operations. Most air forces conducted nocturnal bombing operations during the war in order to avoid day interceptors, the attendant reduction in bombing accuracy being considered a fair trade for the protection darkness afforded. The development of night bombers compelled the introduction of night fighters. These machines rarely engaged other fighters, as dogfighting is primarily a visual activity, and so do not need to be particularly fast or agile. Night fighters relied on radar to find their slow and unmaneuverable prey. This equipment and its operator required a large airframe to carry it (many night fighters were variants of bomber designs). Despite having radar, locating a target was difficult, and thus the night fighter had to carry enough firepower to be certain of destroying the target in one burst. The USAAF’s two World War Two night fighters, the Douglas P-70

⁶¹Brodie, Bernard. “Implications for Military Policy,” in Bernard Brodie, ed. *The Absolute Weapon: Atomic Power ad World Order*. New York: Harcourt Brace, 1946), 88.

⁶²Mead, Edward Earle. “The Influence of Air Power upon History.” *Yale Review*, June 1946, 58.

(sometimes called “Nighthawk”) and the Northrop P-61 Black Widow, both carried four 20-mm cannons.

The USAAF issued specifications for a point-defense (day) fighter and a night fighter after World War Two. Both were to be armed with four 20-mm cannons, a response to the development of jet bombers by the Soviets. “Formerly fighters were so much faster than bombers that they could maneuver around them at will. Against a high-speed jet bomber the fighter can make only one all-out pass.”⁶³ To ensure the destruction of the target on that single attack, the interceptor had to have as much firepower as possible. A machine gun was no longer adequate.

Thus it was that the USAF made the transition from machine guns to cannon. In so doing, the USAF was simply following the example of the other air arms that had changed their basic fighter armaments when their leaders realized that the nations they protected were at risk of aerial bombardment (an easy conclusion to reach in Europe, where every nation is within easy striking distance of a hostile power). Up until 1944, the USAAF and USN had the luxury of not having to consider defensive fighter operations, relying on the nation's geographic isolation to provide protection. The Navy's decision to change guns was motivated by the realization that its fleets were vulnerable to sudden and devastating air attacks. The USAF was spared for a little while longer, but was eventually forced to prepare for the possibility of attack during the early Cold War. The key factor in the decision was a change in technology: a potential enemy had finally achieved the means to conduct an air attack on the United States. The Air Force, conceived of as an offensive arm, had traditionally employed its fighters as bomber escorts, a role in which the .50-calibre gun was proven sufficient. The need to destroy intruders expeditiously, however, compelled the Air Force to abandon the .50 in favor of a more powerful weapon.

Epilogue

Ironically, the USAF abandoned the cannon shortly after adopting it. In the late 1950s, Air Force leaders became convinced that aerial combat in the future would be decided by guided missiles and unguided rocket projectiles, all of which had ranges far in excess of any

⁶³“The Killer Jets: With Guns and Rockets, the Interceptors will Engage the Bombers when They Come,” *Life*, 22 January 1951, 84.

machine gun or cannon. Such weapons relieved fighter pilots of the dangers associated with closing with an enemy by permitting them to shoot at extremely distant targets (even those beyond visual range). One such weapon intended for use against a formation of aircraft had a low-yield nuclear warhead. Advanced missiles had the added advantage of being “fire and forget” weapons, allowing a pilot to launch them and then break away from the enemy, allow the missile itself to find its target.

Only those aircraft that could be used offensively had guns (and these seemed to be intended more for air-to-ground work rather than air-to-air use). Airplanes designed as point-defense fighters relied exclusively on missiles and rockets. So strong was the Air Force’s faith in the missile that when it ordered a version of the Navy’s McDonnell-Douglas F-4 Phantom fleet defense fighter (USN-ese for interceptor), it requested the removal of its internal cannon.

This belief in the superiority of self-propelled projectiles over guns is reflected in *Fundamentals of Aerospace Weapon Systems*, a textbook published in 1961 for the Air Force’s ROTC program, which contains no references whatsoever to machine guns or cannon.⁶⁴

⁶⁴ *United States Air Force ROTC, Fundamentals of Aerospace Weapon Systems*. (Maxwell Air Force Base AL): Air Force ROTC, Air University, 1961, table of contents.

It is interesting to compare various USAF publications on the topic of aircraft armaments during the early Cold War. In addition to the above, see the three volumes of United States Air Force, Continental Air Command, *Air Force Armament* (CONAC Manual 50-11) (Mitchel Air Force Base NY: Headquarters, Continental Air Command, 1949) and United States Air Force ROTC, *Elements of Aerial Warfare: Weapons* (Air Science 2 v.3 (Montgomery AL: Air University, Air Force Reserve Officer Training Corps, 1953).

