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Night Falls, Fighters Fly: The Development and Evolution Of Navy Night Fighters In World War II

Mark A. Urbon
Gettysburg College

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Abstract

It is nearly impossible to overestimate the importance of radar in the Second World War. This piece of Allied technology was one which the Axis were never able to truly overcome. This paper will comprehensively explore how radar was used in the development of U.S. Navy carrier-borne night fighters in World War II. It seeks not just to demonstrate the effectiveness with which night fighters to use, but also the understudied and under-appreciated technological accomplishment that was night fighting. Whereas other works on the subject serve largely as roadmaps or timelines detailing the key moments in night fighter history, this paper differs in that it will attempt to fill in those gaps by including the historical context, technological development, and the evolving tactical implementation of night fighters throughout the war. In addition to drawing on numerous secondary sources it also seeks out the admittedly scarce primary sources in an attempt to convey the stories of the men who lived through it as accurately as possible.

Keywords

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Comments

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It is nearly impossible to overestimate the importance of radar in the Second World War. This piece of Allied technology was one which the Axis were never able to truly overcome. This paper will comprehensively explore how radar was used in the development of U.S. Navy carrier-borne night fighters in World War II. It seeks not just to demonstrate the effectiveness with which night fighters to use, but also the understudied and under-appreciated technological accomplishment that was night fighting. Whereas other works on the subject serve largely as roadmaps or timelines detailing the key moments in night fighter history, this paper differs in that it will attempt to fill in those gaps by including the historical context, technological development, and the evolving tactical implementation of night fighters throughout the war. In addition to drawing on numerous secondary sources it also seeks out the admittedly scarce primary sources in an attempt to convey the stories of the men who lived through it as accurately as possible.

"The atomic bomb may have ended World War Two, but radar won it"
-Lee Alvin Dubridge, MIT Radiation Laboratory Director

Mark Urbon
Professor Birker
History 421
3 May 2020

Introduction

On the night of 26 February 1991 American Air Force, Marine Corps, and Naval aircraft bombed Iraq's Highway 80 destroying thousands of vehicles and inflicting hundreds of casualties. So absolute was the destruction that the highway was dubbed "the highway of death." The immense damage dealt in a matter of hours is perhaps the most poignant testament to America's unrivaled air superiority. Day or night, rain or shine, American aircraft are able to reach from the heavens wielding the wrath of God. The history of American air superiority is a long one, but it is not ageless.

In the first half of World War II, Allied forces found themselves defanged when night fell. Unable to see and therefore hunt down incoming bombers, fighters were unable to provide adequate defense. The skies were protected only by searchlights and anti-aircraft fire which was far from enough to defend from Axis raids. Night fighters would prove to be invaluable in extending American air superiority to all hours of the day.

Historiography

The history of night fighters is not one which has been left unstudied. Numerous scholars have published pieces on the topic. Indeed many of them are cited below. However these authors have historically taken a narrow approach to the subject. There exists no comprehensive full-length books written about the U.S. Navy's night fighters in the Second World War. Instead the topic of night fighters has largely been limited to book chapters or short articles. Not only do these brief histories neglect to convey the true importance of the role of night fighters, they also ignore the massive challenges faced by the scientists, engineers, and pilots. William C. Odell, a

retired colonel of the U.S. Air Force has written an excellent article on the topic of carrier-based naval night fighters for the U.S. Naval Institute. It functions as a sort of roadmap, touching on all of the major developments of night fighters from its infancy to the close of the war. However its utility stretches little past that of a roadmap. By brushing over a number of smaller details, the article more so tells you that night fighters were an accomplishment rather than demonstrating it. This leaves the door open for a much more detail-based approach that actually examines the various and nearly endless facets of night fighters. He briefly concludes that night fighters were an important development of the war and that the technological advances made by such projects advanced aviation by "leaps and bounds."[1] While it is certainly not the goal of this paper to refute this statement, his conclusion comes off as rather lacking in substance. Stephen L. McFarland's brief book *Conquering the Night: Army Air Forces Night Fighters at War* does a great job at exploring night fighters, though he limits his study to night fighters of the Army Air Force, and does not touch on the Navy's night fighters. Perhaps owing to its top secret nature, virtually nothing has been written about the Navy's crash course to produce airborne radar units.

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[1] William C. Odell, "The Development of Night Fighters in World War II," *Naval History Magazine.* 3, no. 1 (January 1989)

History[2]

Night time air combat operations can be traced back to the First World War. Britain's anti-aircraft defenses had made daytime zeppelin bombing raids too costly for the German Air Force to maintain. To mitigate losses, the Germans switched to a schedule of night time bombing. Even under the veil of darkness however, the Germans were unable to avoid the RAF. Late in the night of 2 September 1916 word was relayed to Royal Air Force (RAF) command that the largest zeppelin raid of the war was en route to Britain. Lieutenant William Leefe-Robinson was one of the pilots who took off to patrol the skies near London. In the early hours of the following morning he spotted a zeppelin illuminated by searchlights and taking inaccurate anti-aircraft fire. After closing to within a few hundred feet of the zeppelin and firing three drums of a new type of explosive bullet into it, the zeppelin went up in flames and crashed to the

[2] The reader will benefit greatly from a brief explanation of a few terms used by the military which may be unfamiliar to the layperson. This essay will reference "flying by instruments" frequently. This style of flying is the opposite of "flying by sight." In the latter the aviator is able to pilot his aircraft by sight. He may need to reference his instruments to get exact readouts on variables such as altitude, speed, and heading. Generally speaking though, he will have a good command of these variables just by using his sense of sight. The former refers to flying without the sense of sight. Unable to use sight, the pilot must rely solely on cockpit readouts to know the aforementioned variables. Likewise "weapons free" and "weapons tight" are largely antonymic. The former means that gunners are free to engage any target without first identifying if it is friendly. The latter means that gunners must first confirm if the target is hostile before firing. Though these are post-WW2 terms they are used herein for simplicity's sake. Naval fighter squadrons referenced herein will be referred to by their military designation of VF(N). V refers to a fixed wing aircraft, F denotes the role of fighter, and N indicates the squadron's designation as a night fighting squadron. Marine Corps squadrons will be VMF, with the M representing the Marine Corps. The size of a squadron is, unfortunately, difficult to standardize. Throughout the war the authorized size of a squadron gradually increased but was often short of the authorized size due to shortages and loses. Additionally night fighter squadrons were usually divided further to spread the limited number of night fighting aircraft across aircraft carriers. For the purposes of this paper it will be acceptable to consider a squadron at full strength to be composed of a few dozen aircraft.

ground. Lieutenant Leefe-Robinson won the Victoria Cross, Britain's highest medal for valor, for his actions that night. However he also cemented himself into history by being the first fighter pilot to shoot down a German zeppelin. And by doing so at night, he unintentionally ushered into existence the legitimacy of night fighters. His tactics would be replicated by other RAF pilots who managed to shoot down zeppelins with such efficiency that attacking even with the cover of darkness was too costly to maintain for the German Air Force.[3] The RAF were able to shoot down 79 of the 123 zeppelins that Germany had built for the war.[4]

Of course, there are glaring differences between the zeppelins of the First World War, and the propeller-driven bombers of the second. Zeppelins, with their immense size and relatively slow speeds, may seem like the perfect target to be locked onto by a searchlight and easily destroyed by a fighter. While the RAF scored multiple night kills on zeppelins, they were anything but easy to shoot down. Zeppelins could easily be lost in the clouds and slip out of sight of the searchlights. These challenges are multiplied manyfold in the smaller and quicker enemy aircraft of Second World War. If the Allied air forces were to have any shot at stopping night time bombing raids they would need to rely on something other than searchlights and luck. They would need radar.

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[3] Herman Knell, *To Destroy a City: Strategic Bombing and its Human Consequences in World War Two* (Cambridge, MA: Da Capo Press, 2003), 110; Julian Hale, "Destruction of a 'Baby Killer,'" *Royal Air Force Museum* (Royal Air Force Museum, 2016)

[4] Stephen L. McFarland, *Conquering the Night: Army Air Forces Night Fighters at War* (Washington, D.C.: Air Force History and Museums Program, 1998), 2

Interwar Years/History of Radar

Radar was discovered around the same time but independently by both the British and the Americans. The British, however, put a far greater amount of resources towards its development. Britain in the early 30's saw Hitler's build up of the Luftwaffe. The planned 4,000 German bombers would be able to easily overpower the mere 600 fighters that Britain had available.[5] This conjured distasteful memories for the British of the World War One zeppelin raids over London. Keen to prevent this and defend London, the British were largely content to give the radar researchers carte blanche. Dr. Robert Watson-Warr, the lead researcher in radio waves, had originally hoped to use radio waves as a sort of "death ray" to either incapacitate or outright destroy aircraft and their crews. Though this was proven to be impossible, he did determine in February 1935 that by using a pulse method of short-wave radio illumination enemy aircraft could be detected before reaching Britain's shores giving adequate time for fighters to intercept them.[6] Early tests proved successful and the RAF was delighted. Money poured into Waatson-Watt's team. By July 1935 the team was able to track and count the number of RAF aircraft to a range of 34 miles.[7] By September of that same year Watson-Watt's team were approved for the construction of five radar stations along the Dover coast.[8] In just ten months the Watson-Watt team took radar from a theoretical concept to a physical part of Britain's wartime security.

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[5] Randall Degering, *"Radar Contact!": The Beginnings of Army Air Forces Radar and Fighter Control* (Maxwell Air Force Base, AL: Air University Press Curtis E. LeMay Center for Doctrine Development and Education, 2018), 21

[6] Ibid., 23

[7] Ibid., 25

[8] Ibid. The radar technology was actually called "radio direction finding." This intentionally incorrect name was intended to confuse the enemy by appearing to be a navigation tool rather than a defensive warning device.

Across the pond the Americans were not facing an imminent bombing campaign against them. Consequently their radar research progressed much slower than the British. It was further hampered by doctrinal beliefs amongst the United States Army Air Force (USAAF) which dissuaded the use of fighters to pursue enemy bombers. As said by an instructor of the Air Corps Tactical School (ACTS): "a determined air attack, once launched, is most difficult if not impossible to stop."[9] Even one of the early proponents of pursuit aircraft,[10] Captain Claire Chennault who was himself a pursuit instructor at ACTS conceded: "attempts at interception were like hunting needles in a limitless haystack."[11] These doubts were reinforced up by exercises the USAAF had run testing the feasibility of bomber interception. Unfortunately, these tests maintained strict military discipline with fighters taking off orderly before slowly forming into squadrons in the air, and waiting to follow the squadron leader who took off last.[12] Had the tests better implemented the concept of a "scramble"[13] it is likely the tests would have been far more positive.

American war planners agreed that the biggest issue with bomber interception was the difficulty of tracking enemy bombers. When massive observation grids were implemented fighters were able to be vectored into the bombers with more success but such a set up was inapplicable to anything but a homeland invasion. In 1932 the U.S. Naval Research Laboratory (NRL) had accidentally stumbled upon the use of radar to detect aircraft. However in this

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[9] Degering, *"Radar Contact!",* 2

[10] Fighters designed to pursue and destroy enemy bombers.

[11] Degering, *"Radar Contact!",* 3

[12] Ibid.*,* 5

[13] A "scramble" is a tactic used to quickly mobilize interception aircraft. Pilots on the ground eschew traditional military formalities to get in the air and to the threat as quickly as possible.

rudimentary form it was only able to act like a tripwire, alerting ground crews that there was a bomber *somewhere,* but unable to give specific ranges and bearings.[14] By 1936 the technology had developed enough to aim searchlights but was still too inaccurate to direct anti-aircraft guns.[15] These radar sets were still much too large to be mounted onto aircraft, though. It would still be quite some time until the Navy's fighters could harness the full power of radar. This delay was made longer by the fact that there was as yet no pressing need for aircraft-borne radar systems.

A Pressing Need

As was touched on earlier, Allied forces were not committing great effort into the development of bomber interceptors due to doctrinal beliefs. This belief was further magnified by the new wave of bombers being developed which could fly farther, faster, and higher than their fighter counterparts. In its first test flight the new American Boeing B-17 Flying Fortress set a world record flying 2,270 nonstop miles at 252 miles per hour. It is possible that had England pushed all its chips into the development of airborne radar for night interception that they would have succeeded. However due to the belief that bombers would be able to operate with impunity during the day little attention was devoted to the seemingly futile exercise of attacking them. Why waste precious resources in an endeavor you know to be hopeless? Because the allies expected bombers to operate during the day they put no effort into the development of night fighters.[16] They never expected to face night time raids.

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[14] Degering, *"Radar Contact!",* 17

[15] Ibid., 22

[16] McFarland, *Conquering the Night,* 3-4

When war finally came to England's shores the nation's radar system had expanded to defend the whole of Britain. The German war machine pounded British soil but the RAF put up quite the fight.[17] German daylight loses were reaching unsustainable levels and the Luftwaffe transitioned to a purely night time bombing campaign. British ground controllers were able to vector fighters towards their targets to within around 5 or 10 miles. This was adequate during the day, indeed it was responsible in large part for the great slaughter of German planes. Intercepting pilots could then visually spot their targets and move in for the kill. At night, however, the ground controllers could not reliably get interceptors close enough to make visual contact with the enemy. The effects of this are acutely seen in an example from the night of 14 November 1940. The Luftwaffe sent 437 bombers over the city. The RAF mounted 165 sorties yet failed to bring down a single enemy aircraft.[18]

The RAF's reaction was hasty and improvised. Boulton-Paul Defiant, Bristol Beaufigher, and de Havilland Mosquito aircraft were modified to include radar. These planes worked with ground-based radar control intercept stations (GCI), anti-aircraft fire, and searchlights to track, identify, and engage German bombers. They achieved meager results though.[19] The improvised night fighters were simply incapable of combatting the Nazi onslaught.

In the years leading up to war and in the early years of it American forces boasted a very well trained corps of pilots. However the one major drawback of American flight schools was the minimal amount of attention given to instrument flying and, by extension, night flying. There

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[17] Ron Dick, "Battle of Britain." *Air Power History* 37, no. 2 (1990)

[18] McFarland, *Conquering the Night,* 4-5

[19] British night fighters managed to shoot down a little over one percent of raiding German bombers in the last major campaign of the Blitz. See McFarland, *Conquering the Night,* 5

was an incredibly small number of pilots who were truly competent flying only by instruments and even an experienced pilot considered himself well-versed in instrument flying if he could fly by instruments for a few minutes without crashing.[20]

It was during the Guadalcanal Campaign in late 1942 that the need for night fighters was first acutely seen in the Pacific. American fighter pilots had no problem maintaining air superiority during the day. Japanese aircraft attempting to bomb Henderson Airfield were turned back time and time again by the field's fighters. It was vital for the Japanese to knock Henderson Field out of commission because the large slow transport ships needed to bring in Japanese reinforcements and supplies could not make the trip entirely under darkness and would be easy targets for the American fighters stationed at the airfield. American supremacy during the day was absolute but when darkness fell so too did American combat effectiveness. Japanese aircraft were able to harass the Americans at night with near impunity. One particularly effective tactic employed by the Japanese was to fly over American positions all night in twin engine Mitsubishi G4M "Betty" bombers. The pilots, dubbed "Washing Machine Charlie" by the American grunts, would fly with intentionally unsynchronized propellers and randomly drop bombs.[21] A Marine on Guadalcanal, Richard Greer, said of Charlie: "That rascal had philosophy figured out." Charlie would drop a bomb on one go around, and on the next drop a wine bottle which made the same noise as a falling bomb.[22] The ever-persistent threat that tonight's attack may be the real thing sent men on the ground diving out of beds and into foxholes at all hours of the night. The choppy

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[20] William I. Martin, "Night Is My Ally," in *Carrier Warfare in the Pacific: An Oral History Collection,* ed. E.T. Wooldridge (Washington, DC.: Smithsonian Institution Press, 1993), 145

[21] Odell, "The The Development of Night Fighters in World War II"

[22] Richard Greer, Interview, The National WWII Museum, https://www.ww2online.org/view/richard-greer#segment-11

noise of Washing Machine Charlie's engines churning through the night sky combined with the occasional bomb threat and the immense retaliatory anti-aircraft fire was enough to keep the weary Marines awake. Greer said: "everyone hated that rascal cause you weren't gonna get any sleep when he was around there."[23] The repeated sleepless nights took a toll on morale and combat effectiveness.

While the large Japanese transports necessary to bring in the number of reinforcements needed for victory could not make the trip at night, smaller fast transports could. These ships could not bring enough men and materiel to secure a Japanese victory.[24] Nonetheless, each transport that slipped through prolonged the battle. This generated more casualties, which increased the already pressing need for night fighters. Not only were American forces unable to stop Washing Machine Charlie, they could not stop other attacks either. The 1943 Japanese night torpedo attacks posed a real threat to surface ships and helped spur on night fighter development.[25]

American forces had to improvise. One early carrier-borne attempt saw radar-equipped torpedo planes taking off with two non-radar-equipped fighters. The torpedo plane would then attempt to locate Japanese aircraft and vector the friendly fighters in with the hope that they would be able to make visual contact with the target. This attempt failed spectacularly and resulted in the likely friendly fire death of the Navy's fist ace and first Medal of Honor recipient

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[23] Greer, Interview, The National WWII Museum, https://www.ww2online.org/view/richard-greer#segment-11

[24] Trent Hone, "'Give Them Hell': The US Navy's Night Combat Doctrine and the Campaign for Guadalcanal." *War in History* 13, no. 2 (April 2006), 172

[25] *U.S. Naval Aviation in the Pacific* (Office of the Chief of Naval Operations United States Navy, 1947), 43

of the war Butch O'Hare. O'Hare's F6F Hellcat was caught in the crossfire of the torpedo plane's gunner and the Japanese bomber being engaged and splashed into the ocean.[26] On land, Army Douglas A-20s tried to combat the nuisance of Washing Machine Charlie with no success. Lockheed P-38s working in conjunction with searchlights and anti-aircraft fire had no better luck. Washing Machine Charlie still flew, and Marines still suffered sleepless nights.[27] The Navy was desperate for a solution but had nothing to offer. There were other instances where fighters were able to mount successful defense operations against incoming Japanese bombing raids and torpedo attacks, but they were few and far between. The dire military need for night time combat operations prompted a naval crash course in night fighting capabilities. The race to develop a radar-equipped single seat carrier-borne night fighter was on.

Research and Development

The Navy's effort to produce carrier-borne night fighters was codenamed Project Affirm and kicked off on 18 April 1942 at Quonset Point, Rhode Island. The project was very closely intertwined with MIT's Radiation Laboratory which produced virtually all of the project's technological developments. The Navy had little to build off of and suffered a number of setbacks that their British and Army counterparts did not. The RAF and USAAF could afford to use larger radar systems. These systems fit in the land-based fighters they had at their disposal such as the Boulton-Paul Defiant, Bristol Beaufigher, de Havilland Mosquito, and the Lockheed P-38 Lightning. These aircraft were large and could easily accommodate the added weight and

[26] Martin, "Night Is My Ally,"152

[27] Odell, "The The Development of Night Fighters in World War II"

space necessary for a radar system and its operator. These aircraft could not, however, be operated from aircraft carriers. It was the goal of Project Affirm to produce a radar system small enough and light enough to be fitted on a single seat carrier-borne fighter. Nonetheless, the Navy was able to draw on the technology and experience of the RAF and USAAF. The project was headed by Commander W.E.G. Taylor. A veteran of an RAF squadron composed of American volunteer pilots in the early days of the war, Taylor was keenly aware of the necessity of a successful night fighter and already closely acquainted with British technology and night tactics. The plane initially selected to be mounted with the new radar was the Vought F4U-1 Corsair.[28]

Due to its top secret nature and relative obscurity it is difficult to track down evidence on how widely supported this project was. However, a guess can be made from the facts at hand. The MIT Radiation Lab was spending $4,000,000 a week on radar technology. In today's money that is equal to roughly $64,000,000 a week, or $3,328,000,000 a year.[29] To put that into perspective, the amount of money spent by the Radiation Lab in one year could finance the construction of three *Essex*-class aircraft carriers.[30] While it is true that massive amounts of money were being pumped into all spheres of the defense industry, the bill for the Radiation Lab was testimony that the project was a high priority.

Fred Dungan had enlisted in the Navy the day after Pearl Harbor and immediately began training to become a pilot. Upon his graduation the following year from flight school he was ordered to take part in the top secret Project Affirm and was shipped out to Quonset Point. On 19

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[28] [28] Odell, "The The Development of Night Fighters in World War II"

[29] "MIT Radiation Laboratory," *Lincoln Laboratory: Massachusetts Institute of Technology,* https://www.ll.mit.edu/about/history/mit-radiation-laboratory

[30] Philip St. John, *USS Essex (CV/CVA/CVS-9)* (Nashville, TN: Turner Publishing Company, 1999) 10.

December 1942 Fred was put in the backseat of a trainer aircraft with a completely blacked out canopy to see if a plane could be landed with absolutely zero visibility. He and the pilot in the front seat had to work in cooperation with the technology in the aircraft and controllers on the ground.[31] All combined, the team was able to land the plane safely. It was proof that even with no visibility fighters could operate safely if given the right resources and training. Just over a year after his enlistment, Fred's name had been stamped into the history books of night fighting. It would not, however, be the last time.

Types of Radar

The first radar to be widely fitted on American planes was the AN/APS-4.[32] Other airborne radar systems had been developed already, but the AN/APS-4 was the first with the ability to intercept.[33] The procedure of interception is explained in a Navy Department manual on the tactical use of radar:[34]

> On intercept, the interceptor aircraft is maneuvered so as to get the target or echo pip on the central (zero-degree) lubber line with the shadow pip horizontally aligned with the

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[31] Michael Fink, "Fred 'Buck' Dungan—Hellcat Pilot—Ace—Nightfighter," *World War Two History Project* (13 March 2011) https://www.ww2historyproject.org/portfolio/fred-buck-dungan-hellcat-pilot-nightfighter/

[32] The denotations of these abbreviations are rather technical. To go into detail on their meaning is outside the scope of this paper and significantly beyond the author's ability. Nonetheless, it may benefit the more technologically savvy reader to know the meanings. They come from the 1943 Bureau of Ships classification and are as follows. The first and second A have the same meaning denoting that the radar unit is mounted on an aircraft. N denotes that it is an echo-sounding radar. P denotes that it is an automatic transmitting and receiving radar. S denotes the search capabilities of the radar.

[33] *Radar Bulletin No. 2A (RADTWO A) The Tactical Use of Radar in Aircraft* (Washington, D.C: United States Government Printing Office, 1946), 63

> echo pip. So long as the target aircraft remains in the field of the antenna beam the target pips will appear, regardless of evasive tactics employed. As the range is closed, both pips will move downward on the screen until visual contact can be made with the target aircraft.[35]

The AN/APS-4 could detect aircraft to a range of about 5 nautical miles.[36] As a result it would have to rely on larger and more powerful shipborne radar such as the SK radar set which could track aircraft out to 100 nautical miles.[37] These more powerful radar sets could be used to vector the smaller planes within range for their own radar to take over the hunt. It was not impossible to mount the AN/APS-4 on a single-seater aircraft. Indeed the earliest night fighting variants of the Vought F4U Corsairs and Grumman F6F Hellcats were equipped with this radar system. Nonetheless it was not considered suitable for use on such aircraft. The complexity of the radar unit mandated that it be operated by a dedicated radar operator onboard the plane. Consequently the AN/APS-4 was used mostly on Grumman TBF and General Motors TBM Avenger Torpedo Bombers.[38] The three man crews on these aircraft relieved the pilot from the necessity of both operating the radar unit and flying the plane.

The solution to providing single-seater carrier-borne aircraft with radar lay in the AN/APS-6. This was essentially a recreation of the AN/APS-4 which had been simplified to the point that the pilot could easily operate the radar set in addition to piloting the plane. The radar unit

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[35] *Radar Bulletin No. 2A,* 64

[36] The Pacific War Online Encyclopedia, s.v. "ASH Airborne Radar"

[37] Radar Research and Development Sub-Committee of the Joint Committee on New Weapons and Equipment, *U.S. Radar: Operational Characteristics of Radar Classified by Tactical Application.* FTP 217, Washington, D.C.: Department of the Navy, 1943, https://www.history.navy.mil/content/history/nhhc/research/library/online-reading-room/title-list-alphabetically/u/operational-characteristics-of-radar-classified-by-tactical-application.html#sss.

[38] The Pacific War Online Encyclopedia, s.v. "ASH Airborne Radar"

also benefited from a number of technical improvements from the earlier AN/APS-4 model.[39] The AN/APS-6 was not without its problems, however. Due to the simplification the radar was able to detect enemy aircraft effectively at only two miles. This range was less than the 3 miles anticipated in its design, and much less than the AN/APS-4. Additionally, the AN/APS-6 was incredibly expensive. So much so that the cost of an aircraft was virtually doubled when equipped with the AN/APS-6.[40]

A portion of the protocol for interception using the AN/APS-6 is outlined as follows. Note the importance placed on the use of ground and seaborne controllers to vector the fighter to the target aircraft.

> AN/APS-6, although suitable for use in general search operations, is particularly well adapted to night interception of hostile aircraft. When specifically employed for intercept operations of this nature, the fighter aircraft, after being air-borne, is vectored by the intercept officer at the controlling station (CIC of the fighter director ship or ADCC of the shore control station), to put the intercepting aircraft on the enemy's tail.[41]

The procedure for interception can be deceptively more difficult though due to a number of factors. The AN/APS-6 determined the elevation of enemy aircraft by the difference in angle from the intercepting aircraft's longitudinal plane. In the case of an interception of an aircraft below the interceptor imagine two imaginary lines originating from the interceptor's radar. One goes forward along the longitudinal axis to the distance that the enemy aircraft is detected to be at, the other line angles down connecting with the enemy aircraft. By taking these two distances and the angle between them the radar is able to calculate the enemy's elevation relative to the interceptor. While this works perfectly when the interceptor is in level flight, issues arise when

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[39] *Radar Bulletin No. 2A,* 70

[40] The Pacific War Online Encyclopedia, s.v. "APS-6 Airborne Radar"

[41] *Radar Bulletin No. 2A,* 70

the interceptor is climbing and diving. If the enemy aircraft is inline with the interceptor's longitudinal axis in such a maneuver it will appear to be at the same altitude. Therefore extended maneuvers such as climbing and diving can have a number of negative effects on the interceptor. It could bring the enemy aircraft outside of the view of the radar and force the pilot to then reacquire the target before taking further action. It could cause the pilot to overshoot the target revealing his presence and position and thus putting the interceptor in danger. Or it could force the intercepting pilot to take a number of extreme corrective measures which may be outside of his plane's abilities.[42] There was a considerable learning curve however, as documented by one night fighting squadron in Europe wherein ground controllers simply did not know the best way to guide the airborne interceptors.[43] Luckily, these problems could largely be avoided with the help of experience and if the intercepting pilot and ground control officers acted cautiously and conservatively. In the hands of an expert, a plane with the AN/APS-6 could be quite the formidable hunter.

Night Fighter Aircraft Types

Throughout the war a number of different airframes were built for or modified into the role of night fighter through the addition of radar. The Northrop P-61 Black Widow was the first purpose-built night fighter in the American arsenal. It performed excellently and by the end of the war the P-61 was in service with 15 of the 16 dedicated USAAF night fighter squadrons

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[42] *Radar Bulletin No. 2A,* 71-72

[43] Office of the Senior Controller to All Controllers, Hq 64th Fighter Wing, 6 October 1944, in *Julius Goldstein Papers,* ed. United States Holocaust Memorial Museum*,* https://collections.ushmm.org/search/catalog/irn159419#rsc=178464&cv=22&c=0&m=0&s=0&xywh=163%2C1316%2C2330%2C1662

operating in combat theaters.[44] The first naval fighter to be converted to a night fighter was the F4U Corsair. The Corsair performed well in the air and finally gave American pilots a platform with which they could effectively combat and even outperform the legendary Japanese Mitsubishi A6M Zero. Japanese Imperial pilots maintained a healthy respect for the Corsair's abilities in combat. A Japanese fleet commander Jinichi Kusaka went as far as to call the Corsair the best aircraft America produced.[45] However the Corsair was not immediately desirable for carrier service. It had poor landing visibility and was prone to bounce violently when landing. Obviously these traits complicate the already difficult task of landing on an aircraft carrier. Consequently the Corsair was largely relegated to shore-based naval and Marine units. The first Corsairs to be used on carriers, though, were the first generation of American naval night fighters fitted with AN/APS-4 radars.[46] The job of carrier fighter was soon transferred over to the F6F Hellcat. If the Japanese respected the Corsair, they downright feared the Hellcat. Though slower than the Corsair, the Hellcat was still faster and more powerful than the Zero. Importantly, the Hellcat could dogfight with the Zero whereas the Corsair could not. A veteran Japanese pilot Sadamu Komachi recalled: "There is nothing more frightening than a Hellcat on your tail. They would just shower you with bullets. I used to have nightmares about that!"[47] Like the Corsair, the

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[44] Online Exhibit, *WWII Night Fighters,* National Museum of the United States Air Force, Dayton, OH.

[45] Bruce Gamble, *Target Rabaul: The Allied Siege of Japan's Most Infamous Stronghold, March 1943-August 1945,* (Minneapolis: Zenith Press, 2013), 308

[46] The Pacific War Online Encyclopedia, s.v. "F4U Corsair, U.S. Carrier Fighter"

[47] Gamble, *Target Rabaul,* 307

first night fighting Hellcats, designated the F6F-5E sported the AN/APS-4. These were replaced as quickly as possible by the F6F-3N and F6F-5N which had the easier to use AN/APS-6.[48]

Deployment and Implementation

A major challenge faced by night fighters across all theaters was the need to identify targets before engaging. Identification, Friend or Foe (IFF) is a radar technology that essentially responds to the tracking radar if the tracked aircraft is friendly. However IFF technology was still in its infancy and struggling to keep up with the new and rapidly evolving radar systems that were being pushed out. Consequently, pilots still had to get a visual confirmation, an already difficult task made more formidable in the dark of night. A combat report written by Major Julius Goldstein, a USAAF officer, recalls a mission by Captain Augspurger. The captain was flying a British Beaufort and documents that he spent upwards of ten minutes trailing the enemy before he positively identified it as a German Heinkel He 111 bomber and engaged.[49] In another account, also from Captain Augspurger, he documented closing with and engaging what he thought to be a German Junkers Ju 52. An examination of the wreckage revealed that it was in fact a German Focke-Wulf Fw 200 Condor.[50] While the two planes are not entirely dissimilar (as the captain took great pains to make clear in his report) it is interesting to note that the latter has an additional engine on each wing than the former. Considering that engine exhaust is usually the

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[48] The Pacific War Online Encyclopedia, s.v. “F6F Hellcat, U.S. Carrier Fighter”

[49] Julius Goldstein, *Interception on HE 111, 30 Sept, 1944.* (Dayton, OH: National Museum of the United States Air Force, 2015)

[50] Office of the Senior Controller to Commanding General, 64th Fighter Wing, 29 September 1944, in *Julius Goldstein Papers,* ed. United States Holocaust Memorial Museum, https://collections.ushmm.org/search/catalog/irn159419#?rsc=178464&cv=5&c=0&m=0&s=0&xywh=126%2C1315%2C2496%2C1764

most visible part of an aircraft at night, it is certainly curious to wonder just how well the captain could see his target.

The lack of visibility meant that interceptors on both sides of the war ran the risk of running into the very targets they hunted. One story is recalled by John Elliott, a Boeing B-29 Superfortress pilot. One night as his plane was flying one of his gunners yelled out frantically though the aircraft's communications system "TAKE HER DOWN!" Elliott reacted instantly and no more than a second later an enemy plane zipped right over the Superfortress's cockpit, apparently oblivious to the bomber's presence.[51] On another occasion David Fisher, also a bomber pilot, had just completed his bombing run on a Japanese target. As his plane banked back to return to the American airfield the crew observed a bright light behind them. Thinking it was an enemy interceptor Fisher gunned the engines to run away. He would later learn that the target from which he attempted to escape was actually the planet Venus.[52] For better or worse night flying had introduced the American pilot to a whole new world.

Early in the war the Japanese enjoyed a relatively high capacity for night operations compared to their American adversary.[53] This is likely due more so to the fact that the Japanese were able to operate out of bases which were unmolested at night, and faced little in the way of opposition. Their tactics for attacking American ships at night was rather crude. One detachment of planes would drop flares on one side of the American fleet while the other attacked from the

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[51] John Elliott Interview, The National WWII Museum, https://www.ww2online.org/view/john-elliott#friends-and-enemies

[52] David Fisher Interview, The National WWII Museum, https://www.ww2online.org/view/david-fisher#nighttime-combat-missions

[53] Clark G. Reynold, *On the Warpath in the Pacific: Admiral Jocko Clark and the Fast Carriers,* (Annapolis: Naval Institute Press, 2005), 118

opposite direction, using the silhouetted outlines of the fleet to aim. Although the tactic was not inherently flawed, the Japanese pilots lacked the training, and their planes the sophistication needed to effectively implement it. Many of Japan's most highly skilled and capable pilots were lost in the Battle of Midway which severely damaged their ability to engage in night time air combat.[54]

On 10 April 1943 the first night fighting squadron was commissioned as VF(N)-75 under the command of Lieutenant Commander William J. Widhelm. In just under a year Project Affirm had succeeded in getting the first radar-equipped Corsairs, designated F4U-2, into action. Contrary to what may be expected, the squadron was not made up of the nation's top aviators. Quite the opposite was true. The squadron's pilots were an assortment of whatever personnel the Navy had available at the time as there was a shortage of both men and machines. Of the eighteen pilots, five had any experience with instrument flying. Only three had completed qualification in the less-sophisticated Grumman F4F Wildcat, and only three had completed their qualification for the Corsair. The remainder were new flight school graduates who had flown nothing other than trainer aircraft.[55]

The first combat deployment of night fighters came on 1 August 1943. Six radar-equipped Corsairs were sent to the Solomon Islands to serve as a land-based night fighter force. They brought with them Commander Widhelm and the VF(N)-75 designation. Their mission was to silence Washing Machine Charlie. On the night of 31 October the Japanese plane which had been responsible for so many sleepless nights for the Marines tumbled into the ocean, shot down

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[54] Martin, "Night Is My Ally," 151-152

[55] Odell, "The The Development of Night Fighters in World War II."

by Lieutenant Hugh D. O'Neil.[56] VF(N)-75 made slow but steady progress thwarting Japanese night time raids. Washing Machine Charlie was no longer able to harass the Marines with impunity.

VF(N)-75 had proven the defensive potential of the new radar-equipped fighters, and Project Affirm took action to capitalize on it and create an offensive weapon and produce pilots capable of carrier flying. Landing on an aircraft in even perfect conditions requires a highly trained pilot. To land an aircraft in the darkness on a flight deck illuminated by few lights and to follow perfectly the exact instructions of the controllers on the aircraft carrier requires an expert pilot. Project Affirm aimed to create these pilots. The training portion of Project Affirm was relocated to Charleston, Rhode Island and took over the air station there to complete its mission. The facilities came to life when night fell. Lights were kept as dim as possible to recreate the atmosphere of a real aircraft carrier and preserve pilots' night vision. Catapults and arresting cables were also installed to further replicate carrier operations. From there pilots were transferred to a real carrier for even more practice and experience. Rewards were distributed liberally for trainees who logged the most flight hours to ensure the pilots were experts.[57] And they had to be. Flying combat missions and engaging in carrier operations at night was a perilous task. Robert Karr, a crewman on the USS *Laffey* recalled that when a group of fighters were forced to land on their carriers at night a number of pilots bailed out instead of risking the endeavor.[58] They should not be too harshly judged though. A Vietnam-era study on McDonnell

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[56] Odell, "The The Development of Night Fighters in World War II."

[57] Ibid.

[58] Robert Karr Interview, The National WWII Museum, https://www.ww2online.org/view/robert-karr#segment-1

Douglas F-4 Phantom pilots found that when landing on carriers at night they recorded heart rates higher than ground soldiers in combat.[59] This is understandable as the lack of visibility introduced a new level of psychological distress on the pilots. They suffered from mild to severe bouts of panic and claustrophobia was more likely to set in during night flights.[60] The training would prove to be successful.[61] In total the 29 week training regimen at the Night Attack and Combat Training Unit produced some of the finest aviators to serve in the war.[62]

Initially night fighter aircraft were equally distributed amongst carriers, which each carrier receiving around four. Prior to this distribution carrier night operations consisted solely of recovering planes when night fell and occasionally launching planes just before dawn for an early morning strike.[63] When first introduced night fighters were met with contempt. Their usefulness had not yet been proven and their presence threw a wrench in the carrier's traditional operations in a number of ways. The late night launches and early morning recoveries inconvenienced the crew which was forced to simultaneously launch and recover aircraft which was no small feat particularly in the dark of night. Furthermore, the presence of night fighters played havoc on the radar-directed anti-aircraft guns aboard the carriers. Whereas before gunners could reasonably assume that any aircraft was a hostile attack and fire weapons free, they were

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[59] Sebastian Junger, *War* (New York: Twelve, 2010), 33

[60] Odell, "The The Development of Night Fighters in World War II."

[61] "CIC [Combat Information Center] Operations On a Night Carrier," *CIC [Combat Information Center]* 2, no.2 (February 1945), 1-3., https://www.history.navy.mil/research/library/online-reading-room/title-list-alphabetically/c/cic-operations-on-a-night-carrier.html

[62] Odell, "The The Development of Night Fighters in World War II."

[63] Norman Polmar, *Aircraft Carriers: A History of Carrier Aviation and its Influence on World Events Vol. 1, 1909-1945*, (Washington, D.C.: Potomac Books, 2006), 364

now restricted to a weapons tight stance.[64] As was previously mentioned, the lack of IFF technology forced gunners to rely on unreliable radio communication or visual confirmation which was made doubly difficult in the dead of night. It is likely that this led to more than one anxious gunner. To combat these issues it was decided that night fighters would be concentrated on a single aircraft carrier which would be responsible for all night operations of the task force.

On Christmas Eve, 1944 the USS *Enterprise* slipped out of Pearl Harbor. Her designation had changed from CV-6 to CV(N)-6 to denote her capacity for night operations. She was the first carrier capable of launching and receiving aircraft both day and night. Aboard the *Enterprise* was the 76th Night Fighting Squadron (VF(N)-76).[65] The advantages of having an aircraft carrier specifically designated for night operations were numerous. The ability to have aircraft in the skies at all hours was utilized during the battle for Iwo Jima when *Enterprise* had aircraft in the air around the clock for 174 hours from 23 February to 2 March 1945.[66] Remarkably, the *Enterprise* did this "with no adverse effect on the efficiency of the crews."[67] *Enterprise* was able to take over all night flying duties for her task force which gave the pilots on other carriers a break and reduced the stress associated with having to adjust sleep schedules to fly at night and during the day. Additionally the *Enterprise's* flight deck became available as an extra and oftentimes closer area to land for critically damaged aircraft. Aircraft that had returned too late,

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[64] Polmar, *Aircraft Carriers,* 382

[65] "1944," *USS Enterprise CV-6,* http://www.cv6.org/1944/1944.htm

[66] Martin, "Night Is My Ally," 151

[67] Grover B. H. Hall, *Analysis of Night Air ops Against the Philippines, Formosa, Bonins, Japan & the Ryukyu Is, 12/24/44-5/14/45* (Department of the Navy. Office of the Chief of Naval Operations. Intelligence Division. Office of Naval Records and Library, 1945) https://catalog.archives.gov/id/4697018

and whose carriers had shifted to launching rather than recovering aircraft, could likewise find a safe space to land on the *Enterprises's* flight deck. In addition to the benefits of the physical ship, it was a massive advantage to the task force to have such a large pool of pilots who were superbly competent in flying by instruments. This proficiency in instrument flying permitted flights in otherwise prohibitive weather conditions. Like the day fliers of the American Navy, Japanese fighters would similarly find themselves grounded in such conditions resulting in relatively low-risk missions for the Americans. The benefit did not come without cost, however. The massive ship had to be reorganized to accommodate the rigors of a 24/7 flight schedule. Hours had to be extended, and machine shops and access to spare parts had to be available at all times to keep the planes air worthy.[68] Additionally task force commanders were often annoyed that they had to provide extra security for the night carrier which was not expected to defend herself during the day.[69] In general though the new technique apparently worked as the system of designated night carriers was retained though the end of the war.

One particularly effective way that night fighters were incorporated into naval tactics was their use in the "Big Blue Blanket" strategy devised by Admiral John S. Trach. Prior to its implementation, the common tactic of carriers was to launch half of their aircraft on a strike, and when the first set returned, the second group would be launched, and in this way they would alternate. However this approach left too much time between strikes for the Japanese to launch retaliatory strikes, particularly lethal kamikaze attacks, on the carrier task forces. Instead of splitting the carrier's aircraft into two groups, Trach split them into three. Each individual strike

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[68] Martin, "Night Is My Ally," 152

[69] Polmar, *Aircraft Carriers,* 491

was therefore composed of fewer planes, but it produced a near-constant steam of fighters which kept a "Big Blue Blanket"[70] over Japanese airfields and left such little time between strikes that as Japanese aircraft were taxing on the runway, the next strike group came in to obliterate them. By adding night fighters into the mix Trach was able to significantly extend the time that American fighters were over overhead Japanese airfields ensuring constant destruction.[71]

Another brutally effective implementation of night fighters was to disrupt the Japanese overnight redeployment of aircraft. Japanese planes would come down from the main islands and be stationed at major airfields overnight before being redeployed to smaller outlying airfields from which they would operate the following day. American night fighters were able to attack and cripple the airfields which prevented their use by aircraft and essentially trapped the Japanese attack planes. These planes were then sitting ducks for more precise daylight raids by American fighters and bombers. Even if the Japanese planes were not destroyed in the followup daylight attack the constant damaging of airfields prevented their use and kept the fleet safe for another day. Admiral Martin recalls that after this tactic was put into use there were "no strikes against our fleet for a long period of time—none from the airfields we had operated against at night."[72] The round the clock attack and covering of Japanese airfields with the "Big Blue Blanket" effectively the hitherto unstoppable use of Japanese kamikazes.

In addition to wrecking havoc on Japanese logistics the night fighters managed to rack up quite a few air-to-air kills. More than a few night fighters gained the honor of becoming an ace.

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[70] The "blue blanket" references the blue painted fighters. Trach's use of humorous codenames and tactics was a constant throughout his service in Task Force 38.

[71] John S. Trach, "The Big Blue Blanket," in *Carrier Warfare in the Pacific: An Oral History Collection,* ed. E.T. Wooldridge (Washington, DC.: Smithsonian Institution Press, 1993), 268

[72] William I. Martin, "Night Is My Ally," 154

This is made more impressive by the fact that in large part night fighters were recruited right out of flight school, and so most if not all of their kills were earned under darkness. Fred Dungan, the man mentioned above who made history by landing in a blacked-out cockpit became a night fighter ace.[73] Tracking other aces is challenging though as the initial dispersion of night fighter squadrons across multiple aircraft carriers caused many squadron records to lack the cohesion and detailed reports that might be expected.[74] Regardless, each enemy plane shot down the night fighters proved themselves to be a valuable tool in the American arsenal.

It is difficult to track down with certainty the views commanders had on night fighters. A slight glimpse of one opponent, however, is given by Admiral Trach, the developer of the aforementioned "Big Blue Blanket" strategy. Towards the end of the war, the main arm of American naval power in the Pacific was the Fast Carrier Task Force, whose designation alternated between TF 58 when under the command of Admirals Spruance and Mitscher, and TF 38 when under the command of Admirals Halsey and McCain Sr.[75] Trach served under the team of Halsey and McCain and commented of Mitscher that he was "reluctant to take up night fighting business."[76] It is, however, unclear whether Mitscher's reluctance persisted after the effectiveness of night fighters was demonstrated. Trach's use of the term "reluctant" implies that Mitscher eventually came around to the idea.[77] The pilots themselves seemed to take no issue

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[73] Fink, "Fred 'Buck' Dungan—Hellcat Pilot—Ace—Nightfighter,"

[74] "Grumman F6F-3N Hellcat," Collings Foundation. *Collings Foundation,* https://www.collingsfoundation.org/aircrafts/grumman-f6f-3n-hellcat-2/

[75] This strange alternating designation was designed to confuse the enemy and present the appearance of a larger naval force

[76] Trach, "The Big Blue Blanket," 269

[77] It is hard to imagine any naval officer who enjoyed the added peace of mind granted by night fighters *not* being a full-blown supporter of these brave men and their undertakings by war's end.

with undertaking the task of night fighting. Due to the particularly dangerous and challenging nature of night fighting the USAAF relied on volunteers to fill the ranks of night fighting squadrons. Nonetheless, there was never a shortage of men willing to sign up.[78]

Conclusion

The "worth" of night fighters is hard if not impossible to gauge. It could be argued that because the development of night fighting technology was inevitable that trying to gauge its worth is futile. The money would have been spent at some point either during World War II or after. It has been said that they were a costly waste of money due to the relatively low number of kills achieved for such a massive investment.[79] If this is the metric with which night fighters are judged then they very well may be deemed a waste of money. However, because their value is so closely connected to their deterrent effect, the use of air-to-air, or even air-to-ground kills as the decider of effectiveness paints a false picture of their true impact on the war.[80] Admiral Trach made comprehensive use of night fighters to significantly curtail the kamikaze threat.[81] To him, no doubt, night fighters were worth it. To the countless sailors who could sleep more soundly at night due under the night fighters' watchful protection, they were worth it. To

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[78] McFarland, *Conquering the Night*, 16

[79] Ibid., 42

[80] To better understand this, imagine that the night fighters were police officers. If more officers are brought into a high-crime area, it is likely that crime rates would go down by their very presence, and arrest rates would go down accordingly. This sort of analysis would be akin to calling police tactics a failure due to the decreased arrest rates, while ignoring the decreased crime rates.

[81] Trach, "The Big Blue Blanket," 267

the weary Marine fighting to stay alive on the islands of the Pacific who could finally rest after Washing Machine Charlie had been shot down, night fighters were worth it.

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