PANAMA IN WORLD WAR 2: THE INTRODUCTION OF RADAR

Before starting, just a warning, I do not pretend to be any sort of expert on radar.

There had been concerns over the air defences of the Canal Zone, leading to its fighter strength being supplemented by large numbers of the more effective P-36 Hawks in 1939, and then the much better P-40 from 1940. Alongside this enhancement, before the attack on Pearl Harbor in December 1941, the first radar sets had arrived[1] (as they had in Hawaii, where the warning they provided was, of course, ignored). However, these early sets were much less effective than later microwave models, were not useful for low-flying attacking aircraft, had problems tracking targets over the land and, in any case, turned out to be badly sited. Also lacking was the coordinated ground control system that had proved invaluable during the Battle of Britain.

In due course, more and better radar was received, with improved systems of control. Radar would also be found on aircraft, for air interception on P-70 night fighters, and carried by patrolling bombers and flying-boats searching for U-boats and attacking enemy naval forces. As the perceived threat to the Canal receded, Panama became, as with other elements of the US forces, more of a training and testing region, and several radar types were sent there for operational testing in what could be difficult environments.

[1] Operations began with the early sets in Panama on 7 October 1940: https://www.cecom.army.mil/PDF/Historian/Feature%203/Radar/Davis_SC_Development_of_Army_Radar_III_1945.pdf

A mobile anti-aircraft "Big Ears" sound locator unit of the Coast Artillery Corps, with a searchlight, in 1932

Pre-war, the US Army, like other armies, used sound location devices, including the so-called "Big Ears" mobile detector units. In the Canal Zone, these were operated by the Coastal Artillery Corps. These were the first practical means of detecting aircraft at a distance and used horns, with larger horns increasing the range of detection. One pair of horns funnelled sound into the earphones of the azimuth operator; the other pair was used by the elevation operator.

Until radar became available, just before World War 2, acoustic detection devices were, apart of the human eyeball, the only way to detect approaching aircraft, giving only a few minutes warning at most, given aircraft speed. Even in Britain, with its highly developed radar network which proved crucial during the Battle of Britain, there were acoustic location stations which remained as a back-up. In the US and Panama, as in Britain, ground-based observers were also employed as a back-up, being useful in tracking aircraft over land, where interference could hamper the effectiveness of the radar[2].

Without some means of providing early warning of an air attack, defending fighters had to rely on standing air patrols, in the hope of coming across the attackers, or being able to scramble fighters able to intercept the attacking force before it reaches its intended

[2] I was a member of the Royal Observer Corps for nine years and, even in the nuclear age (our primary role was reporting on nuclear strikes and fallout), aircraft recognition was retained as a secondary function.

target. The former is inefficient, relying on large numbers of aircraft and luck. The latter relies on the interceptors being able to reach the attackers which, if at altitude, could take several minutes, for the fighters to both reach them and place themselves in a position to attack. In the case of the Canal Zone, attackers could arrive undetected from the sea, and be over their targets (at either end of the Canal) almost immediately – so both these defence methods were, at best, problematical.

Between the wars, Army policy was for its fighters to be point-defence interceptors, able to defend key population and industrial centres of the Continental US (or those near the seacoasts), and the overseas possessions in the Philippines, Hawaii and Panama. For this role, they were to have excellent climb rates from take-off, a decent armament, a good low-to-medium altitude performance, and the range and endurance to carry out its role. For the Continental US, until at least the late 1930s, there was little chance of large numbers of enemy strategic bombers reaching targets with or without an escort, and the only fighters encountered by defenders might be those flown from aircraft carriers. Given the relative remoteness of the Canal Zone, this assumption seemed even more true.

For the Canal Zone, the Army and Navy mounted standing patrols over the Caribbean and the Pacific. There were seen to be the threat of two types of potential air attack – from bases in neighbouring states, or from vessels at sea. While the former was not totally discounted, it was the latter that was considered the most likely. Hence the air patrols were focussed on the Pacific approaches, seen to be the most vulnerable, in the hope of detecting any carrier force before it was in a position to launch its attack. The air patrols over the Caribbean, with the screen of islands through which any attacking aircraft carrier had to pass, were primarily to look for U-boats.[3]

[3] There was concern over the presence of the aircraft carrier *Bearn* (with over 100 US-built F2A Buffalo fighters and Curtiss SBC biplane dive-bombers) on the Vichy French island of Martinique. In April 1942, the island's governor agreed to immobilise warships based there, and the *Bearn* was purposely run aground in May 1943: see https://www.usni.org/magazines/proceedings/1955/february/martinique-world-war-ii

Prior to the 1930s, point air defence was regarded as relatively straightforward, with relatively fast-moving biplane interceptors defending against slow-moving biplane bombers, but this changed in the 1930s. New monoplane bomber designs[4] were achieving speeds as good as, or better than, contemporary fighters. In fact, even in 1931, before the new monoplanes were in service, a US Army Air Corps (USAAC) exercise in Ohio saw defending fighters obtain little success against attacking bombers reported on by a net of ground observers. However, some success was obtained in a subsequent exercise in 1933, using a system of observers combined with filter centres, improved plotting techniques and command and control[5].[6]

Further exercises laid the foundation for the air defence system in place in 1941, but this still largely depended on civilian ground observers and, of course, the main threat to the Continental US would come from offshore – where there were no such observers[7]. For the Canal Zone, given its small size, without defence sites in the Republic there was no facility for such a network of observers and, of course, it had the "empty" sea at either side. Furthermore, as mentioned, the most vulnerable parts of the Canal were either end, so any undetected attacking aircraft would likely reach their targets before any observer could have a chance to see them.

What in 1930 had become the US Signal Corps Laboratories[8] had been experimenting at its facility in New Jersey with some radar concepts as early as the late 1920s, although the Army had focused primarily on infra-red detection systems (which was a popular idea at

---

[4] Such as the Martin B-10, which entered service in 1934, see https://wordpress.com/post/raytodd.blog/44146

[5] The system was devised by Claire Chennault, famous during the war as leader of the American Volunteer Group (the "Flying Tigers") in China, but then an instructor at the Air Corps Tactical School.

[6] *Technology Not Realized: Army Air Forces Radar Employment in the Early Pacific War* by William M. Cahill (*Air Power History*, Vol. 56, No. 2, Summer 2009) Air Force Historical Foundation https://www.jstor.org/

[7] *Technology Not Realized: Army Air Forces Radar Employment in the Early Pacific War* by William M. Cahill (*Air Power History*, Vol. 56, No. 2, Summer 2009) Air Force Historical Foundation https://www.jstor.org/

[8] The US Army's homing pigeon service was also headquartered there until disbanded in 1957.

the time). In 1935, work turned to radar once more, as was happening in other countries, like Germany and Britain[9]. Although hampered by a lack of funds and personnel, the Laboratories were able to provide a practical demonstration in a successful test in 1936, following which a hand-built prototype was completed in 1937. This was the prototype of what became the SCR-268 (Signal Corps Radio, Model 268[10]) short-range, searchlight controlling radar[11].

The SCR-268 was the US Army's first radar that was designed to direct searchlights and anti-aircraft guns, and continued in use with the Army in spite of problems with the accuracy of its elevation data due to ground reflections (ground clutter)[12]. It was unable to detect targets over land and below 1,000 feet (305 metres) altitude. See below for more on the SCR-268.

It has been said of radar pre-war that the US Army "simply did not have the funds or manpower . . . to fool with it", but it has also been suggested that a better explanation was simply the absence through pre-war years of any urgent sense of need for such a device. In contrast, Britain, with potential enemies much closer, had pressed ahead with their radar development programme from 1934, with the result that it saw a fully-formed and effective radar-based air defence system in place in time for the Battle of Britain in 1940[13].

---

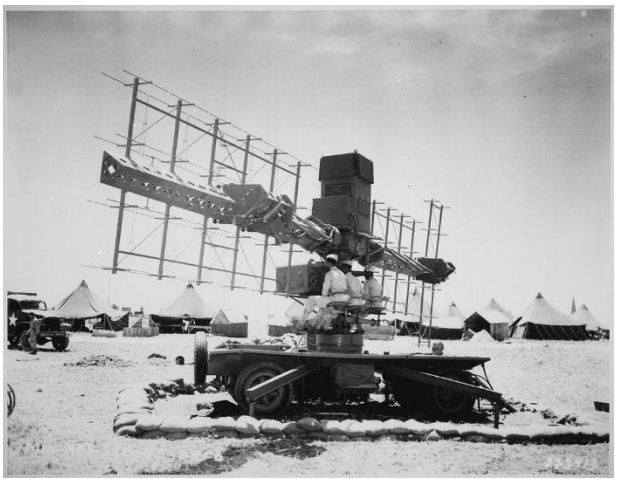
[9] https://www.antoineonline.com/Product.aspx?productCode=0009781156651797

[10] I have also seen the designation said to stand for "Set, Complete, Radio".

[11] *Technology Not Realized: Army Air Forces Radar Employment in the Early Pacific War* by William M. Cahill (*Air Power History*, Vol. 56, No. 2, Summer 2009) Air Force Historical Foundation https://www.jstor.org/

[12] One was present at Corregidor in the Philippines and fell into Japanese hands. It was shipped to Japan and gave the Japanese their first indications that they had fallen seriously behind in radar technology: http://pwencycl.kgbudge.com/S/c/SCR-268_fire_control_radar.htm

[13] *The Army Air Forces in World War II*, edited by Wesley Frank Craven and James Lea Cate (Office of Air Force History, Washington DC, 1983): https://media.defense.gov/2010/Nov/05/2001329891/-1/-1/0/AFD-101105-019.pdf



Three soldiers operate an SCR-268 radar used by the 90th Coast Artillery in Casablanca
(US National Archives & Records Administration)

SCR-268 SEARCHLIGHT CONTROL RADAR

This was the US Army's first radar system, introduced in 1940. It was developed to provide accurate aiming information for anti-aircraft artillery and was also used for gun-laying systems and directing searchlights against aircraft. The radar was widely utilised by both Army and US Marine Corps air defence and early warning units during the war.

Operating in the long wave at 205 MHz, the complete set required four trucks and a trailer. The trucks carried equipment providing primary power, high voltage for the transmitter, as well as radar components. The radar aerial was mounted on the trailer, being rotatable with three antenna arrays, and behind each was a corresponding receiver.

However, by the end of the war the system was already considered out of date, having been replaced by the much smaller and more accurate SCR-584 microwave-based system. It used lobe switching to achieve a high directional accuracy and was standard equipment in 90mm anti-aircraft batteries as late as January 1944, despite problems with the accuracy of its elevation data due to ground reflections.[14]

[14] http://pwencycl.kgbudge.com/S/c/SCR-268_fire_control_radar.htm

The SCR-270 was one of the first operational early warning radars[15]. Operating at a nominal 106 MHz in the long wave, it was also the US Army's primary long-distance radar throughout World War 2, and it was a SCR-270 type set that saw the incoming raid on Pearl Harbor in December 1941, about half an hour before the attack began (but was ignored)[16].

By 1939, both the mobile SCR-270 and fixed-site SCR-271 version had been developed; with the former having been used in a successful demonstration in June 1939[17]. These two models used the same electronics. But the SCR-271 had an antenna of somewhat greater resolution[18]. An upgraded version, the SCR-289, was also produced, but would see little use.

The Army's 1st Aircraft Warning Company was formed on 1 March 1940[19] and the initial production SCR-270A sets were received by this unit for operational testing. These was formally accepted in May 1940, and a production contract awarded to Westinghouse Electric and Manufacturing Company in August 1940[20].

The SCR-270 variants would later be replaced by newer microwave radars after the cavity magnetron was introduced.[21] This device would be used in the only microwave early

---

[15] As we shall see, its first operational use was at Fort Sherman, at the Caribbean end of the Panama Canal.
[16] https://weaponsandwarfare.com/2019/11/19/defense-of-panama-canal-batteries-and-accommodation/ https://www.radartutorial.eu/19.kartei/11.ancient2/karte003.en.html
[17] *Technology Not Realized: Army Air Forces Radar Employment in the Early Pacific War* by William M. Cahill (*Air Power History*, Vol. 56, No. 2, Summer 2009) Air Force Historical Foundation
[18] https://radionerds.com/index.php/SCR-270
[19] This was described as "a new kind of military unit" in contemporary documents: https://www.cecom.army.mil/PDF/Historian/Feature%203/Radar/Davis_SC_Development_of_Army_Radar_III_1945.pdf
[20] The Radio Corporation of American (RCA), which had been involved in development of certain elements, was a major subcontractor.
[21] Developed by the British, with the first working example tested in February 1940, producing power nearly 100 times more power than anyone else had ever produced at such a short wavelength (about 4 inchs or 9.8cm). By May 1940, other researchers were using the device in a radar set that could detect a submarine periscope at a range of 6 mils (9.6 km). In September 1940, the British provided the cavity magnetron and persuaded the US to begin large-scale development of the device.

warning system to see action during the war[22], the AN/CPS-1 Microwave Early Warning (MEW) radar, produced by General Electric, but this would only be available in late 1944 – in time for D-Day. The more advanced sets like the AN/CPS-1[23] never replaced the SCR-270 family in active service during the war, and the older radars even served on into the postwar period, with half a dozen being used during the initial stages of the Korean War until more advanced radars could be deployed[24].

The SCR-270 mobile unit could have all necessary equipment carried on a total of four trucks – an operating truck where the radar operators worked, a power truck, a prime mover/trailer carrying the main antenna, and a "stake truck" carrying the rest of the antenna assembly. The SCR-271 included all the same equipment but was fixed in position, construction of which could be completed in about two weeks[25]. The SCR-271 had its the antenna on a tower, and the transmitter and receiver were in a building, but it was otherwise the same as the mobile version.

Both types of Westinghouse radar had a crew of seven and, for 24-hour operations, a total of around 50 men would be required to operate the radar and communication radio and camp[26].

The manufacturer, Westinghouse, quickly ramped up production, and 112 SCR-270/271 series radars had been manufactured by December 1941.[27] [28]

---

[22] Just six hand-built sets were made during the war, with the radar being used to counter V-1 flying bombs in Britain in 1944.

[23] The AN/CPS-1, aka Microwave Early Warning (MEW) radar, operated in the S-band. It resolved two serious problems with earlier radars – their poor angular resolution of targets and blindness to low-flying targets: https://www.radartutorial.eu/19.kartei/11.ancient2/karte005.en.html

[24] https://pacificeagles.net/scr-270-scr-271-radar/

[25] https://pacificeagles.net/scr-270-scr-271-radar/

[26] *US Radar Operational Characteristics of Radar Classified by Tactical Application FTP 217* (US Navy, 1 August 1943): https://www.history.navy.mil/research/library/online-reading-room/title-list-alphabetically/u/operational-characteristics-of-radar-classified-by-tactical-application.html

[27] https://weaponsandwarfare.com/2019/11/19/defense-of-panama-canal-batteries-and-accommodation/ The set involved was an SCR-270B at Kahuku Point on Oahu. Unfortunately, the sighting report called in to Pearl Harbor by the two assigned radarmen was ignored.

[28] https://pacificeagles.net/scr-270-scr-271-radar/

During Summer 1939, with the Signal Corps' breakthroughs in developing the SCR-268 short-range and SCR-270 long-range radars, the Army announced that new secret electronic "detectors" would soon replace sound locater equipment for air defence. Further, the Signal Corps was ordered to begin researching possible detector sites and information centre locations that would be required in the future to defend the Continental US.[29]

The security of the strategic Panama Canal was of such immediate concern to the War Department that, on 1 January 1940, the Signal Company, Aircraft Warning, Panama was established and ordered to prepare for deployment to the Canal Zone. Consisting of 93 men from numerous Signal Corps units, this company was the first-of-its-kind and it began emergency training at Fort Monmouth in the US. Using a fixed SCR-271 research radar set, they practiced "the strange and uncertain business of electronic detection". It was uncertain that it would actually have its own radar set by the time the unit deployed to the Canal Zone later that year[30]. Having completed its brief training, it left for the Canal Zone in May 1940. Its mission had such high priority that they took the research SCR-271 set to use there[31], they were also accompanied by two engineers from the Signal Corps Laboratories to advise on the initial installation.[32]

[29] https://www.airuniversity.af.edu/Portals/10/AUPress/Books/B_0152_DeGering_Radar_Contact.pdf
[30] https://www.airuniversity.af.edu/Portals/10/AUPress/Books/B_0152_DeGering_Radar_Contact.pdf
[31] https://www.airuniversity.af.edu/Portals/10/AUPress/Books/B_0152_DeGering_Radar_Contact.pdf
In March 1940, only one SCR-270 existed (still at Fort Hancock in Panama and completing final Army service testing), plus one fixed SCR-271 (in fact, the first research example, such was the urgency of the deployment) were available.
[32]https://www.cecom.army.mil/PDF/Historian/Feature%203/Radar/Davis_SC_Development_of_Army_Radar_III_1945.pdf

An SCR-271 radar site in Panama (photograph from "US Army in World War II: The Technical Services: The Signal Corps: The Emergency" (Office of the Chief of Military History, 1956)

Hence, it was the first-ever example of a SCR-271A fixed-site radar set produced by Westinghouse (naturally enough, Serial Number 1) that was deployed in the Canal Zone in October 1940 at Fort Sherman, at the Atlantic end of the Canal.[33] In initial tests it was able to detect aircraft at 118 miles (189 km) range[34]. The Fort Sherman site was, in fact, the US Army's first operational radar station.

A second set was installed on the island of Taboga, about 12 miles offshore, at the Pacific end of the Canal in December 1940. Therefore, at the time of Pearl Harbor in December 1941, there were still only the two radar sets in use in the Canal Zone – one at each end of the Canal, with visual sighting and sound detection also still in use.

[33] https://weaponsandwarfare.com/2019/11/19/defense-of-panama-canal-batteries-and-accommodation/

[34] The Signal Corps had been urged to enlarge its radar development programme to include development of a long-range set which could provide early warning for air defence forces. By 1939, a prototype of SCR-270, a mobile set with a range of over 120 miles, and its fixed-installation companion, SCR-27 I, were ready for tests. However, not until 1940 were operational models available for use, with the first example being installed that year for defence of the Panama Canal: https://media.defense.gov/2010/Nov/05/2001329891/-1/-1/0/AFD-101105-019.pdf

Construction of these first sites were affected by the fact that, while the steel framework required for the antenna tower had been delivered to Brooklyn, New York and loaded onto a ship, the *American Legion*, for shipment to the Canal Zone, that ship was then requisitioned by the US Government to evacuate US nationals from wartime Europe. The steel had to be unloaded, and spent some time before being shipped later, following a series of urgent telegrams from the Canal Zone enquiring about its whereabouts.[35]

It took about a month to complete each of the two sites, that at Fort Sherman being ready in September 1940, and on Taboga in October. However, to begin with there were no regular filter or control rooms, just telephone links to the Army headquarters at Quarry Heights, so that the initial effectiveness of the sites would be limited. However, as mentioned, the Fort Sherman site made history by becoming the first operational US Army radar station, on 7 October 1940. The following day it successfully tracked a commercial flight from Miami, at a range of 118 miles (189 km).[36]

Meanwhile, in the Continental US, the Air Defense Command had been formed on 26 February 1940. Later that year, its head was sent to Britain to obtain information about the successful defence mounted by the RAF during the Battle of Britain, where the use its radar network and control systems had enabled the British to make best use of available fighter resources. His report, and other data, informed a plan drawn up by the Plans Division of the Air Corps in October 1940, which called for a British-style air defence system, both for the Continental US and overseas possessions, including the Canal Zone[37].[38]

---

[35] https://www.cecom.army.mil/PDF/Historian/Feature%203/Radar/Davis_SC_Development_of_Army_Radar_III_1945.pdf

[36] Ibid.

[37] The Army also opened the Air Defense School in New Jersey in March 1941.

[38] *Technology Not Realized: Army Air Forces Radar Employment in the Early Pacific War* by William M. Cahill (*Air Power History*, Vol. 56, No. 2, Summer 2009) Air Force Historical Foundation https://www.jstor.org/

The SCR-270 was soon followed by the improved SCR-270A (which had minor changes to the antenna mount) and, by the time the US entered the war in December 1941, the SCR-270B version was in use[39].

The SCR-270B had the radar components moved from the antenna mount to an operations truck. It had a nominal range of 150 miles (241 km) – but its operating manual gave a maximum of 80 to 120 miles (129 to 193 km) for bombers at 10,000 feet (3,048 meters) altitude; and 50 to 75 miles (80 to 120 km) for (smaller) fighters. It operated in the 104-112 MHz VHF waveband, with a 55-feet (16.7 meters) vertical broadside antenna. The SCR-270B had four crew – two maintenance technicians, an operator and a communications specialist who relayed target information to the control centre.

The SCR-271 placed the antenna on a tower, with the transmitter and receiver inside a building, but it was otherwise the same as the mobile version. Both the SCR-270 and SCR-271 series lacked an IFF system in 1941[40], something which the Signal Corps was still developing[41]. Neither type of radar was able to provide altitude data of targets being tracked[42].

There were attempts to cure the altitude tracking problem by also using the SCR-268 searchlight controlling radar as well at sites, but delivery of this type was already behind schedule due to priority having been given to the SCR-270/271 series. Modifications were attempted to the SCR-270/271 and to make the SCR-268 a standalone 3D system capable of ground-controlled interceptions[43].

---

[39] At least five SCR-270B sets were deployed in the failed defence of the Philippines in December 1941, one by the US Marines, while two fixed-site SCR-271 were in storage awaiting preparation of suitable sites: *December 8, 1941: MacArthur's Pearl Harbor* by William H Bartsch (Texas A&M University Press, 2003).

[40] Identification, friend or foe. It allows systems to identify aircraft, vehicles or forces as friendly, involving interaction with a transponder on the aircraft.

[41] Although the RAF had employed such a system during the Battle of Britain in 1940.

[42] *Technology Not Realized: Army Air Forces Radar Employment in the Early Pacific War* by William M. Cahill (*Air Power History*, Vol. 56, No. 2, Summer 2009) Air Force Historical Foundation https://www.jstor.org/

[43] Ibid.

As we shall see, as was the case with the other defences in the Canal Zone, the number, type and uses of radar improved throughout the war.

Early in March 1942, US Secretary of War Stimson and Robert Watson-Watt, the British radar expert, together visited Panama to examine the defences and reported on the existence of disturbing weaknesses - including that the siting of radar units on high hills contributed to the ground clutter[44] which affected readings[45]. The British expert came to the opinion that concerns over the safety of the Canal from air attack was fully justified.[46]

In his report, Watson-Watt said that the detection system then in place recorded no more than 15% of all flights. He cited one occasion where there were 13 aircraft in the air, but the operation board in the information room showed only a single one. He also said that he had flown in a large twin-engine Douglas C-41 transport aircraft[47] at various altitudes of up to 10,000 feet (3,048 meters), only to discover on landing that the Aircraft Warning Service had failed to plot any part of his flight. He concluded that, despite the Canal Zone being the region where the Army had thus far expended its best efforts, "no measures which are economically possible within the next two years" could provide a ground warning service that would be as much as 80% reliable. He recommended that the SCR-270 and SCR-271 sets be replaced as soon as possible, and that the Canadian-built versions of the British CHL/GCI system be deployed instead[48] – although he conceded that

---

[44] "Clutter" is the term used for unwanted echoes in radar. They can be caused by a number of things, but reflections from the ground (aka surface clutter) is perhaps the most obvious, and explains why low-level ("below the radar") air attacks became more common later in the war and postwar.

[45] *Security and Defense of the Panama Canal 1903-2000* by Charles Morris, Panama Canal Commission: https://original-ufdc.uflib.ufl.edu/AA00047733/00001/6j

[46] https://www.ibiblio.org/hyperwar/AAF/I/AAF-I-8.html

[47] A version of the DC.3 airliner.

[48] Chain Home Low was the name given to the British early warning radar capable of detecting targets below the minimum effective height range of the original Chain Home radars (with which they would normally be co-located). Operating in the VHF wave band, this radar could be used as both a medium-range search radar and as a shorter range Ground Controlled Interception (GCI) radar with height-finding capability. The Canadian-built version was designated SCR-588 by the US Army: http://www.fortwiki.com/SCR-588

the Army would have to persevere with the existing systems for the time being, as the CHL/GCI systems were not yet available (it only having entered operation with the RAF in 1942).[49]

In response to the Watson-Watt report, the Commanding General of the Sixth Air Force in Panama argued that the report had been too critical. He said many of the undetected flights were training ones, with aircraft flying over mountainous terrain, where the efficiency of long-wave radars (such as the SCR-270/271 series) was very low. He claimed that comparing plots to known flights over the sea approaches (from where it was anticipated any air attack would likely come) showed 59% efficiency – compared to only 15% for approaches over land.[50]

Neverthless, in March 1942, the Secretary of War submitted a report to President Roosevelt (using what then the Navy's name for the detection system, radar). By now several sites were in operation, including at Salinas in Ecuador (a southern base for patrol aircraft operating in a giant arc over the Pacific approaches to the Canal, radar was also deployed on the Galapagos Islands, also part of the patrol arc). He said that he had been promised Canadian-built CHL systems, which would be effective against both low-flying and high-flying aircraft, with sites for them selected, and with equipment said to be on its way to Panama. He noted that one of the original radar sites in use had been found to be in the wrong place to be effective. He concluded that action underway could be expected to very considerably improve the detection of low-flying aircraft, but that the interceptor fighter force still needed to be strengthened.[51]

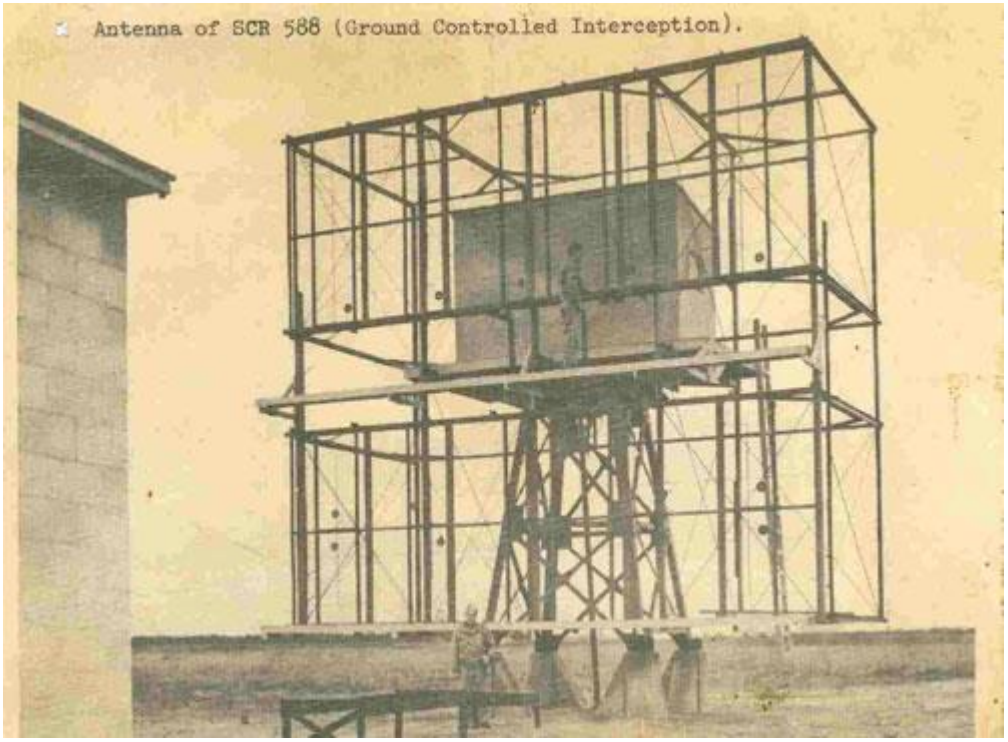
---

[49] The Canadian sets were designated SCR-588, initially being without height-finding. The CHL/GCI combination was the SCR-588B. However, production by Research Enterprises Ltd in Canada began slowly and operational versions would remain few in number until the end of the war.

[50] *United States Army in World War II.: The technical services* by George Raynor Thompson, Dixie R Harris, Pauline M Oates and Dulany Terrett (US Army, Office of Military History, Department of the Army, 1957).

[51] http://docs.fdrlibrary.marist.edu/PSF/BOX6/t71q06.html

By the end of March 1942, there were no less than eight early warning radar stations in operation in Panama, with six more under construction. However, there remained concern that equipment in use at these stations was inadequate for early warning and "quite useless" for purposes of controlled interception.



Sites had been selected for four of the British-type CHL/GCI radars, to be supplied from Canadian production, but improvement in the equipment in use could not overcome shortcomings in operating personnel. The combination of inadequate equipment, poor site selection, and untrained operators was said to have produced such inefficiency that even the best station in Panama was "far below any acceptable standard of operational utility".[52]

There were continued shortages, not so much of equipment as of trained operators and maintenance crews, which hampered the build-up of anti-aircraft defences in Panama;

[52] https://www.ibiblio.org/hyperwar/AAF/I/AAF-I-8.html
From June 1941 to May 1943 the Japanese occupied two islands in the Aleutians, part of the Territory of Alaska, in the far north of the Pacific. They and Guam were the only US territory invaded during the war.

and in spite of more and better equipment and more expert, scientific placing of the radar sets there still remained a blind spot at low altitudes over the Bay of Panama, something not corrected until the end of 1942.

Furthermore, the special equipment required for ground-controlled interception (GCI) had been slow to arrive, with the first two sets not installed until September 1942 and not begin operating until the following month.[53]

The early warning system that evolved included –

- patrol aircraft, operating at about a 900-mile (1,448 km) radius, over the Pacific approaches, which were depended upon for the initial warning of the approach of a hostile vessel (such as an aircraft carrier)[54] ;
- long-range radar (the SCR-271 and its mobile version, the SCR-270), which was relied upon for the detection of enemy aircraft at distances up to about 150 miles (241 km); and
- still closer-in, the fixed anti-aircraft defences relied upon the short-range, height-finding radar (SCR-268) for searchlight and fire control.[55]

The 860th Signal Service Company, Aviation had arrived in Panama in April 1942, with the original Signal Aircraft Warning Company, Panama having been redesignated the 558th Signal Aircraft Warning Battalion on 15 January 1942. Also in Panama at the same time were the 687th, 688th and 706th Signal Aircraft Warning Companies.

In mid-1942, the Commanding General at the time, General Andrews, still concerned about the possibility of a carrier-based air attack, had asked that Panama be used as the test area for the newest and best radar. As a result, the scientists at the Radiation

[53] https://www.ibiblio.org/hyperwar/USA/USA-WH-Guard/USA-WH-Guard-16.html#page431
[54] In fact, when the Japanese did devise an attack, they planned to use aircraft-carrying submarines, which were far less likely to have been detected. See https://wordpress.com/post/raytodd.blog/43177
[55] https://www.ibiblio.org/hyperwar/USA/USA-WH-Guard/USA-WH-Guard-16.html#page431

Laboratory at MIT[56], who were developing the new radars, were asked to consider the problems of the defence of Panama – in particular, problems presented by the reflections from mountains affecting the efficiency of the systems. In fact, Panama proved to be the best place to trial microwave radar, which proved better able to detect aircraft over high land masses than the original, long wave radar. Hence, Panama did become the testing ground for new radars, especially microwave radars, such as the SCR-615 10 cm fixed-site, height-finding radar for ground-controlled interception.[57]

Two scientists from the Radiation Laboratory[58] also visited the Canal Zone soon after and worked out plans to send two SCR-582 and an SCR-615 microwave radars for use there. These would be the first Signal Corps microwave radars to be used on the ground[59].

Based on the Navy's shipboard HPG radar, the SCR-615 had been developed after it became apparent that the Canadian-built CHL/GCI radar (as SCR-588) would not be available for some months, and that the Signal Corps copy of the British GCI, being produced by General Electric, would also not be available soon. Modified by the scientists at the Radiation Laboratory at MIT, while not actually being ready before the SCR-588 was available in quantity, the SCR-615 proved a superior system.[60]

---

[56] https://www.ll.mit.edu/about/history/mit-radiation-laboratory
Established at the Massachusetts Institute of Technology in Autumn 1940, to research into detection methods for aircraft and ships using microwave technology. During the war the Radiation Laboratory made a number of important contributions to the development of microwave radar technology, including in airborne bombing radars, shipboard search radars, harbour and coastal defence radars, gun-laying radars, ground-controlled approach radars for blind landing of aircraft, IFF beacon systems, and the long-range navigation (LORAN) system.

[57] *The Signal Corps: The Test (December 1941 to July 1943)* By George Raynor Thompson, Dixie R Harris, Pauline M Oates & Dulany Terrett (Center of Military History, US Army, Washington DC), 2003. https://www.ibiblio.org/hyperwar/USN/ref/Radar/Radar-7.html

[58] https://www.ll.mit.edu/about/history/mit-radiation-laboratory

[59] *The Signal Corps: The Test (December 1941 to July 1943)* By George Raynor Thompson, Dixie R Harris, Pauline M Oates & Dulany Terrett (Center of Military History, US Army, Washington DC), 2003.

[60] *The Signal Corps: The Test (December 1941 to July 1943)* by George Raynor Thompson (Center of Military History, US Army, 2003).

The new radar was sent to Panama for test in late 1942, being sited on Taboga and replacing the inadequate SCR-271 of the 708th Aircraft Warning Company. It was, in fact, one of only two that had been hand-built by the Research Construction Company (the other having gone to an Army test centre in Florida). This was the first microwave GCI radar, having a range of some 90 miles (144.8 km) – seemingly refuting Watson-Watt's contention that only long-wave radar could provide long range coverage – and providing good low-level coverage as well. The antenna of the SCR-615 was mounted on platform on top of a tower and enclosed in a turret. It had a 65-mile (104.6 km) range. It was this set that tracked General Brett, when he thought he had flown in unseen by the Canal Zone defences by adopting a very low-level approach.[61]

In June 1942, Dr Bowles, from MIT, Secretary of the Microwave Committee of the National Defense Research Committee[62], and the recently appointed expert consultant for radar to the Secretary of War, together with Ralph Bown of Bell Laboratories (and also a member of the Microwave Committee hosted at MIT) were sent to Panama. They were to urge the use of –

- microwave ASV (air-to-surface vessel) radar in place of long-wave sets then in use in the patrol bombers; and
- microwave radars for the Aircraft Warning Service to provide low-level coverage, which existing radars then in use in Panama[63] could not provide.

In his report in 1942, Watson-Watt had recommended that both the Army and Navy aircraft should get hold of airborne ASV-II radar as a matter of the "highest urgency". Such radars were considered not only necessary for hunting U-boats in the Caribbean, but would also to make patrols searching for Japanese aircraft carriers in the Pacific more

---

[61] *The Signal Corps: The Test (December 1941 to July 1943)* by George Raynor Thompson (Center of Military History, US Army, 2003).

[62] Which had established by the Roosevelt Administration in June 1940 to be a voice for the scientific community within the executive branch. Among the Committee's early priorities were studies on radar, proximity fuses, and anti-submarine warfare: https://www.atomicarchive.com/history/manhattan-project/p2s8.html

[63] SCR-270, SCR-271 and the British CHL (Chain Home Low) SCR-588.

effective[64]. As mentioned above, in June 1942, another expert group had recommended microwave ASV radar in place of long-wave sets then in use in the patrol bombers.

The efficacy of anti-submarine aircraft equipped with ASV radar had been proven by B-18 bombers fitted with the ASV 10 sets (these being modified airborne interception AI 10/SCR-540 radars, as used on a handful of P-70 night fighters sent to Panama in 1942), as used over the Caribbean, during early 1942. Later came the SCR-520 (the first 10 cm microwave radar designed for use on the P-70 night-fighter), which was converted to become SCR-517 for air-to-surface use[65], both having been developed by the Radiation Laboratory and Bell Telephone Laboratories[66].[67] It was installed in the nose of the B-18 bombers used on anti-submarine duties in the Caribbean[68]. In the battle against the U-boats in the Atlantic, it is said that it was ASV airborne radar that was the vital factor.

B-18B Bolo fitted with SCR-517 radar in a modified nose (Pima Air & Space Museum photo)

In May 1943, the SCR-547 Height Finder Radar, with its twin-dish antennae arrangement (resulting in the "Mickey Mouse" nickname), was received in Panama and installed at tactical positions, to supply slant range or altitude to anti-aircraft artillery fire control data.

---

[64] *United States Army in World War II.: The technical services* by George Raynor Thompson, Dixie R Harris, Pauline M Oates and Dulany Terrett (US Army, Office of Military History, Department of the Army, 1957)

[65] It was also used on PT Boats: http://www.ptboatworld.com/PT_Boat_Info/571ARadar.htm

[66] https://www.ibiblio.org/hyperwar/USN/ref/Radar/Radar-10.html

[67] https://www.ibiblio.org/hyperwar/USN/ref/Radar/Radar-10.html

[68] In 1942, the Navy asked for the diversion of sets for use on submarine chaser vessels, which initially was its preferred option for the radar: *The Signal Corps: the Test (December 1941 to July 1943)* (Office of the Chief of Military History, US Army, 1957).

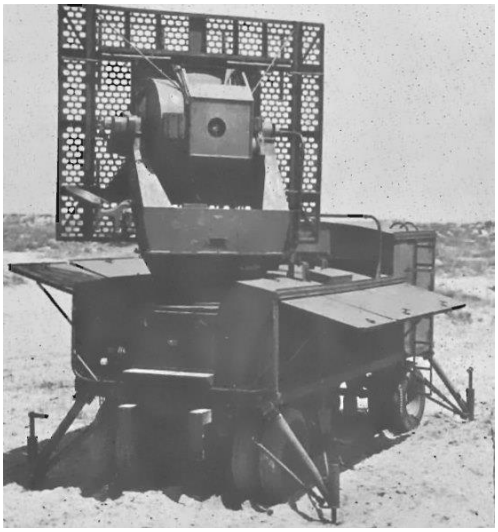
This came as a set consisting of an antenna trailer, tractor, and spare-parts truck – with early models also having a power van. However, this radar proved neither effective nor popular; and the project cancelled and all were turned over to the Signal Corps in August 1944.[69]

SCR-547 Height Finder Radar (US Army Air Defense School)

In March 1942, tests had been made to assess the effectiveness of the SCR-268 radar against low-flying aircraft, and it was found that the detection range depended on the target's altitude. The maximum range was 3,000 to 5,300 yards (2,743 to 4,846 metres), after which the target was lost in ground clutter. In May 1944, all such sets were therefore moved from anti-aircraft gun sites to searchlight positions, as the new SCR-545 sets arrived. In the Pacific sector, there would be 15 SCR-268 operating with searchlight positions and 12 SCR-545 with gun positions; in the Atlantic sector there would be 18 and 12 respectively[70].

[69] https://radionerds.com/index.php/SCR-547

[70] *Security and Defense of the Panama Canal 1903-2000* by Charles Morris, Panama Canal Commission: https://original-ufdc.uflib.ufl.edu/AA00047733/00001/6j



SCR-545 (US Army Air Defense School)

SCR-545 sets were received in April 1944 to replace the SCR-268 and SCR-547, although it suffered from the same ground clutter problem, albeit to a lesser degree. The SCR-545 was a mobile aircraft search and anti-aircraft gun-laying radar, and was produced in limited numbers by Bell Laboratories. Like the SCR-547, it came as a set, this time consisting of a trailer and a prime-mover carrying a power plant. A spare parts truck was needed for each anti-aircraft gun battalion. It was said that five men could set up the equipment and associated director within 20 minutes. It was operated by three operators and a chief operator, although if a power van was used extra personnel were required.[71]

Both the SCR-268 and SCR-545 were unable to detect targets over land and below 1,000 feet (305 metres) altitude. Due to the problems, the M-1 Height Finder device was used to determine the range of low-flying aircraft which could not be tracked by the SCR-545 radar. In addition, by 1944, daily tracking missions formed part of the training required to improve and maintain the efficiency of the crews of the radar sets.

[71] https://www.ibiblio.org/hyperwar/USN/ref/Radar/Radar-6.html

35th scale model of an M-1 Height Finder device (Commander Models Inc)

The M-1 was a mobile telescopic device, which came as a unit resting on a single-axled, two-wheeled bogie drawn by a trail. Sighting was by elbow telescopes, and it a bore sight, as well as a height-finder to determine the slant range or altitude of an enemy aircraft and to transmit the resulting data to the director. Largely perfected by the Eastman Kodak Company, this was fundamentally a 13.5-feet (4.1 metres) stereoscopic range finder that converted slant range to altitude. The remote-control system was linked by cable to an mechanical director that computed the firing data continuously. Power was supplied by a separate generating unit located nearby.[72]

SCR-582 Harbor Surveillance Radar at Fort Dawes in Boston (US Army photograph)

In mid-1942, the Army sent a new microwave ground radars to Panama for test, the SCR-582 Harbor Surveillance Radar. This could produce a map-like view of a harbour area, including all the vessels therein. It was a fixed-site sea coast artillery microwave radar set designed and built by the Radiation Laboratory. The SCR-582 was tested, alongside another microwave radar, the SCR-615 (intended for shipboard use for aircraft warning and ground-controlled interception), by the 708th Aircraft Warning Company in Panama.

[72] http://tothosewhoserved.org/usa/ts/usatso01/chapter14.html

The SCR-582 was to become the mobile SCR-682, a long-range early warning radar for Coastal Artillery for use against aircraft and surface vessels.[73] Production of the SCR-582 ended after production of 55 sets, being replaced by the SCR-682A, a mobile version (requiring three 2½-ton trucks), and modified with a tilting antenna dish for aircraft detection, that was also deployed in fixed locations[74].

While the concentration in Panama and the Canal Zone was an air defence and airborne air-to-search radars, as mentioned above, early SCR-540[75] AI (airborne interception) radars had been used on a small number of P-70 night-fighters[76] were sent to Panama in late 1942 to try to make up for the shortfall in night defences there[77]. It was an US-produced version of the British AI Mk IV radar[78], but was soon overtaken by newer microwave radars based on the cavity magnetron.

Ray Todd
Panama City
Republic of Panama
24 February 2023

[73] *The Signal Corps: The Test (December 1941 to July 1943)* By George Raynor Thompson, Dixie R Harris, Pauline M Oates & Dulany Terrett (Center of Military History, US Army, Washington DC), 2003.
[74] http://www.fortwiki.com/SCR-582
[75] The SCR-540 was soon replaced by the much larger, microwave AI radar, the SC-520. This meant that, by October 1943, the first US AI radar, SC-540, was already obsolescent.
[76] See https://wordpress.com/post/raytodd.blog/44146
[77] *The Signal Corps: The Test (December 1941 to July 1943)* By George Raynor Thompson, Dixie R Harris, Pauline M Oates & Dulany Terrett (Center of Military History, US Army, Washington DC), 2003.
[78] Used by the RAF on its Blenheim and Beaufighter night fighters.