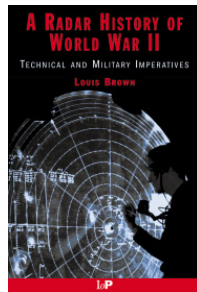


A Radar History of World War II

Technical and Military Imperatives

Louis Brown

Section 3.5 and Section 5.3



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CHAPTER 3

FIRST CLASHES

3.1. THE JAPANESE REALIZE THEY ARE BEHIND

Japan's first dealings with Nazi Germany aroused both esteem and suspicion. Hitler's ejection of constitutional government coincided with the Imperial Army's own achievement and fostered a moderate amount of political comfort. The Anti-Comintern Pact concluded between the two in 1936 and expanded to include Italy the following year was much to Tokyo's liking, being directed toward the ominous power that threatened the Manchurian border, where, in fact, two full-scale battles erupted in 1938 and 1939. But Japan was outraged when Germany concluded the Non-aggression Pact with that same Soviet Union, considered an enemy three years earlier, and renounced the 1936 treaty—not all of the outrage at the German–Soviet pact was found among the democracies. A year later, seduced by Germany's astounding defeat of France, Japan was persuaded to enter the Tripartite Pact, pledging unspecified help to Germany and Italy for equally equivocal aid in return. The Berlin–Rome–Tokyo Axis was thus formally presented to the world.

As a consequence of this renewed and presumably friendly relationship, Japan sent two missions to Germany to learn what they could of military value. An Imperial Army delegation of 20 left in December 1940, but it was the Navy group that most actively sought information touching on radar. This group of 22, the largest naval mission ever sent abroad, had Commander Yoji Ito handling electronic matters with two others from the Naval Technical Research Department (NTRD) accompanying him [1]. They decided against the Trans-Siberian Railway used by the Army and chose a sea route through the Panama Canal. The separate travel arrangements illustrate the serious rivalry of the two services. The naval delegation left Yokohama on 16 January 1941 aboard the *Asaka Maru*, the same day they learned that American armed guards would board all foreign flag ships during passage of the Canal. By 6 February the *Asaka Maru* received assurances from the United States that this would cause no affront to the prestige of the Imperial Navy and dropped plans for a voyage around one of the capes. Indeed the passage of the Canal proved to be quite friendly

with the senior officers accepting a dinner invitation ashore from the Commanding Officer of the Canal Zone. They departed Port of Cristobal 9 February and arrived in Berlin on the 24th by way of Portugal [2].

Ito and a few others immediately met with the military attachés in Berlin and left to see the points of naval interest from the French campaign, boarding 13 new Packard sedans at the Düsseldorf railway station, which they noted was severely damaged by a recent visit of the Royal Air Force. The first sight of radar that Ito gained was British, not German, the remains of GL mark 1s and MRUs displayed in the wreckage at Dunkirk. At the submarine base of Lorient Admiral Dönitz greeted the delegation, which proceeded with their inspection after a reception. It was then that Ito saw a Würzburg; it took no effort on his part to ascertain that it was a gun-laying radar, and he was suitably impressed. To obtain a closer look at the Würzburg took a bit of persuading and was limited to half an hour for a few, including Ito and Rear Admiral Naosaburo Irifune, head of the Navy's Gunnery School. Attempts to obtain details came to nothing, as Göring had declared the Würzburg the most secret of Germany's weapons; not even their formal ally, Italy, had been given such information [3]. Ito noticed a cage-shaped antenna on a pole that he took to be for a very-high-frequency directed beam. It was probably a Freya, as they were being installed along the coast at that time, but his inquiries received no answer [4].

The delegation toured Germany for several weeks with numerous meetings and exchanges of information, but this was not an 'Axis Tizard Mission', the very open exchange of secrets between the British and Americans that took place in late 1940¹. Ito did not learn many details of German radar, but neither did he let out anything about his magnetron. Given the continued bad performance of German torpedoes, one must assume that they told them nothing about their own designs. One suspects that the Germans did not expect to be taught anything by the Japanese, which may have restrained their probing.

While the Naval delegation was in Germany, alarming intelligence began to accumulate, both to the delegation and in Tokyo, about British and American radar. This was more often than not inaccurate in the direction of exaggerating the capabilities, but this only added to the rising concern that Japan was being left behind in the knowledge of what was finally realized to be an important new weapon.

While the delegation was in Germany the Axis suffered two serious naval defeats at the hands of the Royal Navy, both resulting from British radar superiority. During the night of 27/28 March 1941 Italy lost three cruisers and two destroyers in the night action off Cape Matapan². Rumor of this filtered to Tokyo from the Italian Naval Attaché in Washington in the form of a report that British ships could deliver accurate blind fire at night

¹ See Chapter 4.2 (pp 159–66).

² See Chapter 5.1 (pp 208–9).

without searchlights. As a consequence of this report Commander Iwao Arisaka, an ordnance officer then the Naval Inspector resident in New York City, was ordered to investigate discretely any radar capability that the US Navy might have. His report, based on what evidence is not clear, came back with exaggeration that matched the Italian: American battleships, carriers and cruisers all had antennas on their foremasts suspected of being this new method of night vision. Inasmuch as the Japanese considered themselves to be masters of naval night fighting, this was serious [5].

This was followed by news reports—attended by rumors of radar’s involvement—of the sinking of the German battleship *Bismarck* on 27 May³, which led to instructions to the Naval Attaché in London, Commander Ryo Hamazaki, to look into the matter. He came up with precious little about what radar had to do with the sinking of the *Bismarck* but did send a description of what must have been a GL mark II that he saw set up with an AA battery in Hyde Park [6].

Part of the delegation to Germany had planned to leave in June, leaving Ito and the others to remain a little longer to extract what more they could, but the news of the radar capabilities of Japan’s prospective enemies brought a peremptory order on 19 June for all to return immediately. If information gained about radar had been meager, the overall results of the mission were considered to be extremely valuable for the details of industrial processes, submarines, high-speed torpedo boats and methods for manufacturing artificial rubber.

The delegation returned home in two different groups. The first, which included Ito, departed Rome on 15 August in Italian aircraft for Recife, Brazil by way of Villa Cisneros in western Sahara. German aircraft took them from Recife to Rio de Janeiro, whence they boarded a Japanese steamer for Yokohama. The remainder went through Switzerland and Vichy France to Spain where passage on a Spanish ship to Rio was arranged, thence by freighter to Japan [7]. Although the Army’s interest in radar did not equal the Navy’s, one officer of its delegation, Lieutenant Colonel Kinji Satake, remained in Germany and became well instructed about radar and the Würzburg in particular after Japan entered the war.

By summer of 1941 the reports from abroad had begun to alarm key members of the Naval General Staff (Kaigun Kansei Hombu) and caused the issuance of an order on 2 August for the expenditure of ¥11 million (\$4.4 million) on radar. Rear Admiral Kiyoyasu Sasaki, head of the Electrical Engineering Research Department (Denki Kenkyu Bu), was quite eager to get started and called a meeting of his entire staff. Commander Chuji Hashimoto was placed temporarily in charge until Ito returned, and he consulted closely with Ito’s staff. Industrial support was added from NHK Japan Broadcasting Corporation’s Technical Research Laboratory, specifically and importantly by Kenjiro Takayanagi, who had developed

³ See Chapter 3.3 (pp 124–9).

Japan's television, and NEC (Nihon Denki). Most of the design elements needed for a meter-wave apparatus were at hand among these groups, and assembling them into a lashed-up pulse-modulated 4.2 m set of 5 kW proved remarkably easy.

A 3 m refined prototype was set up on the grounds of the Naval Mine School on the Miura Peninsula by 8 September. At this time they had no data on the reflectivity of aircraft nor any idea as to the best polarization to use, but they were soon able to detect a medium-sized bomber at 97 km and a flight of three at 145 km.

From this prototype the mark 1 model 1 (Ichi-go Ichi-gata) was contracted to three firms for immediate production: NEC for transmitters, Japan Victor (Nihon Victor) for receivers and Fuji Electrical Apparatus Manufacturing Co. (Fuji Denki Seizo) for antennas. The first industrially produced radar was placed in November 1941 at the Katsu-ura Lighthouse, where it was used throughout the war [8].

The Army relied primarily upon NEC and Toshiba for its radar, the key developmental elements of which were the NEC Ikuta Research Office Branch (Ikuta Kenkyu Bunsho) and the Toshiba Research Institute (Toshiba Kenkyusho) [9]. The Doppler interference between widely spaced transmitters and receivers, such as had been observed at the US Naval Research Laboratory, in the Watt's Daventry experiment, by David in France and by Oshchepkov in Russia, had not escaped Japanese observation, and the Japanese Army put this equipment, designated as type A, operating on 4 to 7.5 m, to use in China in 1941. The longest such link was from Formosa to Shanghai, a distance of 650 km [10]. In June 1942 NEC and Toshiba each began developing 1.5 m searchlight radars, designated Tachi-1 and Tachi-2 respectively. Both proved too fragile for field service and only about 25 of each were manufactured, although Tachi-2 proved a financial success to the manufacturer at ¥200 000 (\$80 000) each [11]. The Army's air-warning radar was the 4 m type B, soon designated as Tachi-6. It used a broadcast transmitter reminiscent of CH but with some degree of electronically adjustable direction and had up to four separately directional receivers [12].

Trustworthy information about Allied radar came with the first Japanese conquests. A report by the military commander in Singapore described what were thought to be electronic weapons captured from the British, which led to a delegation that included Masatsugu Kobayashi of NEC and Shigenori Hamada of Toshiba flying to inspect [13]. At Singapore they obtained a GL mark II and a searchlight control radar (SLC), which startled them in its use of Yagi antennas. This antenna, named for their own illustrious high-frequency expert, had been used extensively in America, Great Britain, Germany and Russia for experimental work and a few final designs, but it had found very little use in Japan. Along with the SLC came a nice extra. A Corporal Newmann had made—in violation of draconian orders to the contrary—a complete set of notes that the Japanese had typed

in English and duplicated in a 22-page booklet [14]. In the Philippines they obtained an SCR-270 and 268.

The British SLC had impressed Hamada with its compact simplicity and its similarity to the design already employed in Tachi-1 and 2, and he had its improvements copied into Tachi-4. It had a single Yagi for the transmitter and four Yagis positioned about it for the receiver and connected through a rotating capacitor that generated a conical scan, a technique already used in Tachi-1 and 2. It also worked on 1.5 m and had trailer-mounted antennas that could be pointed in azimuth and elevation as had the two predecessors.

Kobayashi allowed Masanori Morita to make the improved copy of the GL mark II called Tachi-3 that had dominated his thoughts since he had learned of the British set [15]. Transmitter and receiver were mounted separately about 30 m apart over underground shelters that rotated in azimuth. The radiation pattern of the transmitter could be adjusted in elevation by altering the phase between pairs of dipoles. The receiver had five dipoles in a horizontal array, four forming a diamond that yielded lobe-switching for azimuth and elevation with the fifth used for determining range. Both Tachi-3 and 4 became widely used sets for searchlight and somewhat limited gun-laying use.

The Navy successfully developed its own version of SCR-268 as mark 4 model 2 and placed it in operation at the important base of Rabaul in 1943. It was widely used and one of the most produced Japanese radars, 2000 units having been manufactured. As the war progressed the nomenclature of Japanese radar becomes more confused, although generally with regard to equipment that was never deployed.

With Japan's entrance into the war against two of Germany's three principal enemies a change in attitude prevailed in Berlin—specifically Japan could have the Würzburg secrets. To obtain the details and an operating set the new and very large submarine I-30 was dispatched on a long, adventurous voyage to France with 120 men on board and arrived at the growing U-boat base of Lorient on 8 August 1942 to a rousing welcome. I-30 departed on 22 August with all that could be desired for building Japanese copies of the now famous gun-laying radar and arrived at the Penang Naval Base on the Malay Peninsula on 10 October. After refueling she continued this remarkable voyage only to strike a British mine seven days out of Penang. The sample Würzburg was damaged beyond repair and the drawings became a soggy mass. In summer 1943 Colonel Satake and a Telefunken engineer, Heinrich Foders, made a harrowing voyage on an Italian submarine to bring Würzburg capability to Japan; unfortunately, important components and data were on an accompanying submarine that was sunk [16]. The Navy re-engineered it as mark 2 model 3, and the Army produced its own version independently as Tachi-24, illustrating the fundamental problem the nation had in apportioning scarce resources. Neither advanced beyond prototypes completed in April 1945 nor affected the war

in any consequential manner [17].

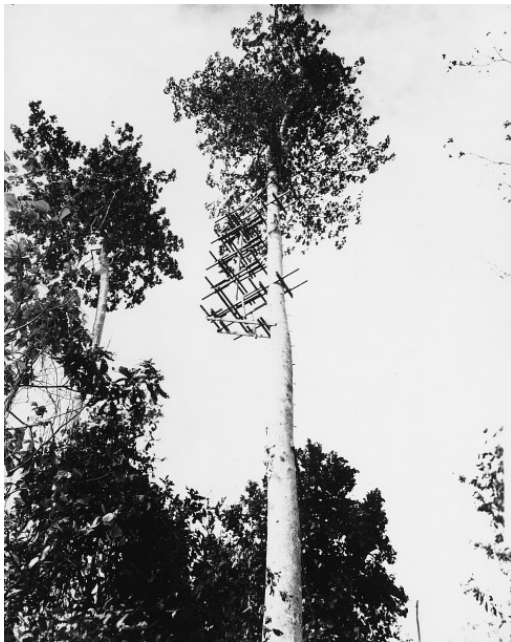
GEMA also sent an engineer, Dr Emil Brinker, to Japan by a submarine that landed in December 1943 with details about Freya, including anti-jamming circuits. The Japanese considered their own air-warning equipment adequate and were not interested in Freya, so Brinker spent his time developing radar test equipment. Although an expert in IFF, he was not allowed to enter Japanese radar research because his security clearance was only for work on a Freya [18].

By the end of the war Japan's radar had been completely outclassed by the Allies. This came about from having resources unequal to the task and a military divided from beginning to end as to radar's relative importance in the disputes about allocations. Until dramatic examples were presented in the late war years of the great power of this new method of waging war, this attitude held back Japanese radar. There were high levels in the government that appreciated the military need for scientific and technical research, so Prime Minister Fumimaro Konoe established the Cabinet Board of Technology (Gijutsuin) to organize such efforts and appointed Viscount Kyoshiro Inoue, Professor at Tokyo Imperial University and Minister of Railways, as president of the Board on 31 January 1942, but the Board was severely hampered by contemptible annual budgets and ignored by the feuding Army and Navy. Its effect on the course of the war is difficult to find [19].

Shigeru Nakajima headed research at Japan Radio, which conducted Japan's research in magnetrons, and saw his staff shrink from 800 at the beginning of the war to half that number at the end [20]. Technical specialists were simply drafted into the Army. It was a startling comparison to the huge growths of similar American, British and, after an initial pause, German groups.

Nevertheless, much was accomplished. Fielding an industrially produced 3 m air warning set in November 1941 in a program begun in August is rivaled in speed only by the South African production of the JB and the Australian of the LW/AW⁴. As we shall see, the Japanese 10 cm equipment was at sea only months behind the British and weeks behind the Americans. Yet the value of their sets was limited by retaining only the A-scope, the most primitive indicator, the display of signal size against range, something that immeasurably reduced the effectiveness of this equipment and that so remained until the end. Only 100 IFF sets were manufactured [21].

⁴ See Chapter 5.2 (p 221).



Japanese Army 4 m Tachi-6 air-warning radar transmitter. This used a broadcast transmission with a vertical dipole array configured to produce radiation lobes covering the region from which attack was expected. Three or four directional receivers completed the station. This design was the Army's standard air-warning radar. This well camouflaged antenna was captured on Noemfoor Island, Dutch New Guinea in July 1944. National Archives photograph 111-SC 267148.

CHAPTER 5

YEARS OF ALLIED DESPAIR AND HOPE

5.1. THE CHANNEL, 1942

5.1.1. *The dash of the warships*

Students of comparative naval theory had assembled for them toward the end of 1941 at Brest a conundrum worthy of their best analytical minds, and because the solution was more than just an exercise for the faculty of some war college it engaged an increasingly large circle of thinkers, who in turn activated an ever increasing array of military force. In March the battle cruisers *Scharnhorst* and *Gneisenau* had ended a successful cruise of commerce raiding and went to Brest to prepare for their next sortie. Initially Raeder planned to have them join with the *Bismarck* and *Prinz Eugen* in a progressive advancement of the technique, but problems with their boilers could not be resolved in time for the action, and a change in the fortunes of war had brought the *Prinz Eugen* fleeing to Brest without having sunk a single merchantman and having left the *Bismarck* resting on the ocean floor.

Thus one naval theory, the value of warships for commerce raiding, had just lost a degree of credibility, although its proponents were by no means inclined to admit a general failure of doctrine. The presence of three large-gun warships in Brest brought into play another naval theory, one guarded by the sacred writings of Alfred Thayer Mahan: the value of a fleet-in-being. So would the matter have remained a generation earlier, but by 1942 there was another theory with which the contending admirals had to deal, one that came from the pen of Billy Mitchell, a prophet as highly honored by airmen as Mahan by seamen. Succinctly put, it stated that surface ships, however well armed and armored, could be destroyed with comparative ease by land-based heavy bombers. As so oft in affairs of abstract thought, the situation at Brest by the end of 1941 was concluded with little regard for theory.

A fleet-in-being is one harbored safely behind coast defense guns, mine fields, breakwaters, nets, booms and torpedo boats, and by 1941 it

was one also guarded by components of air power. By its mere existence it is a threat to an enemy who wishes to travel the adjacent waters. This requires that forces must be at sea or in the air to prevent it from departing unexpectedly. The presence of these ships at Brest meant that convoys would have to have battleship escorts as well as the lighter vessels for defense against submarines; three heavy ships at Brest skewed completely the dispositions of the entire Royal Navy.

Brest lay within easy striking range of British heavy bombers, and although the RAF had never placed the abolition of warships as part of their mission, as had their sister service across the ocean, they were assumed to be capable of sinking ships with bombs. Almost automatically Bomber Command reluctantly found itself expected to destroy the ships at Brest—reluctantly, because its avowed mission was to win the war alone by destroying Germany, and every digression from this was resisted. This in turn required the Luftwaffe to defend the ships with large numbers of fighters and AA guns at a time when these resources were much needed on the Russian front and for defending the Reich against ever growing air attacks. So the three ships became a distracting evil for the Kriegsmarine, the Royal Navy, Bomber Command and the Luftwaffe.

Into this tangle of conflicting theories stepped Hitler. He had decided that the British would soon invade Norway in order to secure the northern route to Murmansk and Archangel and to rid themselves of some troublesome U-boat bases, which he rightly saw as a greater threat to his enemy than surface ships. This meant that these three ships had to be posted to Norway to aid in its defense, and if the experts were of the opinion that it was impossible—because of radar among other things—to return to Germany by the old northern route, then they must return through the English Channel. This brought on a naval chorus crying that it could not be done and that another Atlantic sortie was the better use of the ships. Hitler disregarded all this and ordered them to proceed through the Channel, threatening to remove the heavy guns for coast defense and pay off the ships, if the admirals could not bring themselves to the task. This certainly fixed the attention of the naval staffs, who, on examining the matter in detail, began to realize that ocean raiding was probably finished and that a dash up the channel might not be as foolhardy as their first reactions had given voice [1].

On the English side of the Channel, naval thought began coming to similar conclusions, for although little damage had been done by the thousands of bombs dropped where the ships were thought to be, eventually they would be destroyed or at least damaged beyond the repair capabilities of Brest. A dash up the Channel was the only way of saving the ships. That they were worth saving was a thought as natural to British minds as to those of the Kriegsmarine. Only Hitler seemed to have realized that events had reduced them to three nuisances.

Thus two sides began to plan for the dash up the Channel that be-

gan in the evening darkness of 11 February 1942, ten months after the two battle cruisers had taken refuge at Brest. The Germans produced an extremely detailed plan that provided for scheduling the ships' movement to the minute, for sweeping mines from the route, for using radar for navigation, for jamming the British radar, for preparing a vast cover of fighter planes and for central control of all these activities. The British plan consisted of alerting high-level commanders that the ships were expected to attempt the passage. There were separate commanders for the Fleet, Fleet Air Arm, Army Coast Defense, Coastal Command and Bomber Command units, all of whom had responsibilities in combating the vessels, and no direct communication links between them. Secrecy allowed no planning at the command levels where the details of a response would have to be carried out, and the news of the breakout caught them by surprise. It was assumed that the Germans would elect to pass the Straits of Dover at night, which meant they would have to depart Brest during daylight, which the Germans inconveniently and prudently decided not to do.

Radar featured prominently for both sides in this action. Gen Martini personally supervised this aspect on the German side. The Kriegsmarine insisted on complete radio silence to include the ships' radar. This prevented them from using their Seetakt sets to obtain their positions from prominent land features or radar beacons. Given that the antenna arrangements of the Seetakt allowed almost no back-leakage of radiation and that their direct beams could hardly have been received on the English side until near Dover, this was probably an unnecessary and not very helpful restriction, but the squadron was able to navigate successfully nevertheless. As a substitute the shore stations were to locate the ships, which had IFF, and radio their positions to them [2]. In practice this proved difficult, owing to the inherently poor directional accuracy of the shore-based Seetakt sets and an unreliable IFF performance that made distinguishing between the ships difficult [3]. On top of this, communication failures at times failed to get the information assembled and transferred [4], so the navigation officers had to pay close attention to their fathometers and the depths indicated on the charts. There were also a series of marker boats at various points.

The British radar of which Martini was aware was the 1.5 m CD/CHL sets all along the coast. No shore-based radar would be able to observe the squadron except in the vicinity of the Dover Straits, so Martini set up 1.5 m jamming devices there, starting with very little interference but increasing it slightly from day to day until the level was thought adequate to mask reflections from the ships. This tactic did not fool Lieutenant Colonel B E Wallace, who quickly called attention to it but was ignored. In desperation he went to R V Jones, Head of Scientific Intelligence, and implored to be taken seriously. Jones had a top officer from the Telecommunications Research Establishment on the spot the next day—just in time for the passage of the ships [5].

Unknown to Martini, however, there were new 10 cm NT 271 coast defense sets (also called CD mark IV) installed on the southern coast. These were essentially the same as the Navy type 271 but with a 2 m paraboloid. Four that were within range of the squadron's path were located at Ventnor, Beachy Head, Fairlight and Dover. A fire had put the Ventnor station out of operation the night before, and it may have been out of range anyway, but the others worked just as intended. During mid-morning of 12 February 1942 the Beachy Head and Fairlight stations reported a force of large vessels at the far side of the Strait moving much faster than a normal convoy. These two reports then began winding their way to the Dover Coast Defence Operations Room. At the same time aircraft observed the ships visually but made no report until after landing, as strict radio silence prevailed, and their report also began its way toward Dover. Well over an hour later, Dover observed the ships with their own NT 271. It was their first news of the affair, as word of the other sightings had still not arrived [6].

The most important radar sighting was the one that was not made. Patrols had been set up for Coastal Command in three regions in the vicinity of Brest by Hudson bombers equipped with ASV mark II. These planes had been watching the harbor for seven months and their procedures had become slack. The patrols did not overlap and equipment failures were not allowed to disturb routine. ASV mark II was capable of spotting surfaced submarines, and a capital ship would have been the largest target the operators had ever encountered, but they were not there. In a maddening series of equipment failures—both in aircraft and in radar—the German ships passed the patrol regions when they were not covered [7].

Martini made no provision for jamming these sets, which is strange given the demand that there must be no discovery during the dark part of the passage [8]. It is especially puzzling because British ASV capability had been known since the preceding May [9], yet the detailed plans saw no problem in the possibility that air surveillance might have radar. One can only conclude that this was another of the many examples of something kept secret from those who needed to know.

The feeble attempts to sink the escaping ships concern this account only peripherally. All attacks were made piecemeal. Some were marked by great courage enhanced by knowledge of the small chance of either success or survival. The heavy guns at Dover, which initiated British action, seemed impressive until one inquired about their rates of fire and ability to follow moving targets; none of their 33 rounds hit. Motor torpedo boats failed to penetrate the protective cover of the German destroyers and E-boats to a range that would have allowed hope of a successful launch. Next came the pathetic attack of six Swordfish torpedo bombers, all of which were shot down. Had they been able to attack as planned at night, the specialty in which they excelled, the result might have been otherwise, but they attacked during the day with one-tenth the fighter cover intended and suffered the fate of all torpedo bombers that had to face an overwhelming

fighter and AA defense. A flotilla of six 20-year-old destroyers went straight after the big ships accompanied by Beaufort torpedo bombers properly escorted by Spitfires. In the waning daylight and bad weather the mixture of destroyers and aircraft from both sides gave generous examples of mistaken identity with fights between enemies at times appearing to be the exception, because visual IFF had problems as severe as radar IFF. Bomber Command's high-level attacks at the end of the day seldom found the target, let alone hit it.

As night closed the squadron had to thread its way—not too successfully—through mine fields. This would have been an excellent time to use Seetakt with radar beacons on shore to navigate, but strict radio silence was still enforced. The two battle cruisers were damaged by encounters with three mines. The *Gneisenau* received a blast followed by subsequent bombing from which she was never to recover; the *Scharnhorst* went on to meet a futile but heroic end in the waters off northern Norway; the *Prinz Eugen* served in the Baltic and ended her career as a test ship for an atomic bomb at Bikini Atoll.

The removal of the fleet-in-being from Brest greatly simplified the Royal Navy's arduous Atlantic duties, so Britain emerged from this in a better position strategically but having suffered a major defeat psychologically. It happened at the time of the sinking of the *Prince of Wales* and the *Repulse* and the loss of Singapore. The reaction of the public and the lower levels of military command was one of fury, as it was seen to be incompetence of the kind demonstrated at Pearl Harbor. The Prime Minister's investigation found everything in order, and no senior officers were disciplined or replaced. Disparaging remarks in the report about the capabilities of radar triggered an extensive response in Watson-Watt's memoirs [10].

5.1.2. *The Channel Convoys*

Despite its proximity to the enemy, the Channel was an important supply line for both sides. Britain's western harbors could not handle all of the island's cargo, and distributing it inland strained an already overloaded rail network. This meant shipping had to face the dangers of attacks by German torpedo boats, long-range guns and aircraft. The coin had two sides, of course; transport shortages required the Germans to make use of their own convoys bound to and from the French and Lowland ports. Each side kept its ships close to a friendly shore, but neither shore was friendly around Dover and Calais.

The Germans had set up long-range guns shortly after occupying that part of the coast, and on 11 November 1940 scientists at His Majesty's Signal School were informed that a convoy had been subjected to accurate gunfire at night. Suspicion of radar brought N E Davis, an experienced Marconi television engineer, to the scene with a receiver capable of a wide range of wavelength. (Unknown to the Navy, technicians from TRE had

observed the Seetakt radiation the month before and identified its origin as radar [11].) Davis quickly determined the radiative characteristics of Seetakt, providing the certain evidence of the existence of German radar. He then set out to provide a jammer.

Using a high-power decimeter-wave triode Davis built an oscillator tunable with Lecher wires over the Seetakt frequency band. Restrictions on the form of jamming modulation came from fear that an effective noise might be used against CH, forcing him to use a sinusoidal form. By February 1941 he had six experimental jammers in the Dover–Folkstone area, which greatly reduced the accuracy of the gunfire. It was the beginning the ‘radio war’ at Dover.

The experimental sets were replaced by engineered versions, the Navy type 91, which had large waveguides fitted to flared apertures fed with wide-band dipoles. The presence of Würzburgs, which could be used for coast watching, was known by then, so the frequency range was extended to encompass them as well. The Germans countered by altering frequency, and so it went. As the radio war expanded an inter-service organization was set up to collect relevant intelligence. Secrecy deemed it be called the Noise Investigation Bureau [12].

5.1.3. The Bruneval Raid

With the defeat of France the English Channel became the no-man’s land of the Second World War. As on the shell-scarred ground between the trenches of 1914–1918, patrols felt out the enemy but by boat or aircraft rather than by crawling in the mud. Lives disappeared in clashes forgotten except in the most detailed of official histories and in the memories of loved ones and survivors. Both shores saw the placement of the tangible elements of the earlier war of attrition—barbed wire, mines, machine-gun posts, trenches and boredom. And as before, on both sides radio technicians set up receivers to record any transmission the enemy might make, while others set about to decode them, after which staff officers tried to fit the information so obtained into a coherent picture of the enemy activities or plans.

A new component of this electronic warfare was the signals intelligence units that specialized in radar. The Germans had begun this before the Battle of Britain and had quickly identified the CH and CHL/CD chains. There remained for some months afterwards the general British belief, unquestioned at upper levels, that the Germans had no radar. It was a belief not shared by TRE, where radar had lost its mystique, nor the Royal Navy, nor by R V Jones, where the combined results of the Oslo Report, the interrogation of prisoners and a number of other pieces of intelligence pointed strongly toward German radar [13]. As noted earlier, both H M Signal School and TRE had observed Seetakt emission in late 1940. The same techniques had seen signals from Freya but had confused them with

emission from British equipment of similar frequencies, and their certain identification as radar had to wait until February 1941 [14].

The conclusive piece of evidence for Jones had to be a photograph, and for this he was in luck because the Air Force had had by the end of 1940 the remarkable Photographic Reconnaissance Unit under Wing Commander Geoffrey W Tuttle. This group of pilots flying unarmed and very smooth-surfaced Spitfires could sneak into and out of the most heavily guarded region to take pictures, which they then turned over to equally skillful interpreters. This capability came into being at the beginning of the war through the irrepressible efforts of F Sidney Cotton, wealthy Australian business tycoon, flier with experience in the previous war and photographic expert of the highest order. With private money he began doing his own freelance photo-reconnaissance of German military positions in January 1939. His annoying methods—the worst being that he did a much better job than the old RAF photographic units—alienated nearly all in the Air Force except Dowding, whose keen technical understanding convinced him to give Cotton two of his precious Spitfires at a time when Fighter Command needed them desperately [15].

Once the identification was certain that the emissions from Freya were radar, Jones quickly succeeded in obtaining a close-up view of one of the stations [16], which finally convinced the top levels of British command on 24 February 1941. The success of electronic intelligence by ground stations naturally called for equipping aircraft with suitable receivers, and a flight of 109 Squadron was outfitted with receivers in Wellington bombers, which gained the name of Ferret for this kind of aircraft, and began searching for emissions over a wide spectrum. By October electronic intelligence had located 27 Freya stations [17]. On 7 May they made the acquaintance of the Würzburg, observed as pulsed 50 cm transmissions from nine locations [18], but no suggestive antennas showed up on the kind of photographic coverage that had given the first hints of Freya. The information gained from the Ferrets indicated that the Würzburg had a much narrower beam than the Freya, and Jones suspected that this was superior equipment already widely deployed, possibly the cause of the unnerving speed with which searchlights were being brought to bear on bombers. The characteristics of Freya were pretty easily understood from the emissions, but this new set was surprising, and Jones wanted details. The need for a picture was obvious.

In late 1941 a careful study of a Freya station revealed an object close by and apparently associated with it, small but curious enough for Jones to insist on a close-up shot. This required two flights for success, but the second gave Jones the picture he wanted. This first view of a Würzburg disclosed two intriguing elements: the device was indeed small and located close to the beach. Could it or some of its important components be taken in a commando raid?

Jones was reluctant to recommend action that put the lives of many

men at risk to secure this information, but a consultation with W B Lewis, by then Deputy Superintendent of TRE, bolstered his belief in the value of learning the details of the Würzburg. A raid also fitted with Churchill's wishes to agitate the German shore defenses as much as possible, so the request went to Lord Louis Mountbatten, Chief of Combined Operations, who favored the operation enthusiastically and ordered preparations. A parachute company underwent the detailed training for a night landing near the village of Bruneval where the radar station was located, and crews of the landing craft that were to remove the raiders and their precious loot from the beach practiced on a similar coastline.

The raid took place on the night of 27/28 February 1942 and was an unqualified success. Its professionalism, greatly admired by the Germans, made up for the bewilderment that had marked British response to the battleship dash of two weeks earlier. The disposition of the garrison was known to the attackers from aerial photographs and the reports of French resistance agents, and it had been taken completely by surprise. The entire Würzburg was too large to be taken, but transmitter and receiver modules were easily removed and the antenna feed, which had the dipole, was sawed off. The radar man made understanding sketches and took a couple of photos until the camera's flash drew fire. They loaded the captured equipment onto a cart brought for that purpose and led a captured Würzburg operator with it onto the landing craft on which they departed. Loss of life on both sides amounted to two British and five German [19].

Four important pieces of information resulted from what was brought back. First and most important, the Würzburg was a fixed frequency set with a very narrow band over which it could be tuned. Second, it had no circuitry designed to deal with countermeasures. Third, it was an extremely well engineered piece of equipment, having modular design that made isolating faults and repairing them extremely easy. Fourth, the operator prisoner, though extremely cooperative, had poor technical competence. These last two characteristics were inversions of British procedure, which was to move prototype designs to production as fast as possible and have them operated by personnel trained almost to the level of electrical engineers.

Another benefit accrued from the raid. German radar stations became heavily entrenched, making them easy to spot from the air [20]—but also difficult to take. For whatever it was worth, the raid, combined with strict secrecy, gave rise to extravagant rumors within the Wehrmacht.

5.1.4. The move of TRE to Malvern

If the raid had convinced the Germans to fortify their radar stations, it also made the British apprehensive about the exposed location they had selected for TRE at Swanage. The move there in the summer of 1940 from

the admittedly unsuitable quarters at Dundee must remain a puzzle to an outside observer. Fear of German air attack had caused the rapid departure from Bawdsey to Dundee, but Swanage was a terrible location after the defeat of France, yet the laboratory grew during the weeks when invasion was by no means a trifling danger. After the Bruneval raid, high command became concerned about a possible retaliation, and the knowledge that a German parachute company had been stationed near Cherbourg began to make a number of people uneasy.

Superintendent A P Rowe, who had been greatly alarmed by the position at Bawdsey, had become quite comfortable at Swanage. The laboratory had spread about the region and numbered 1000 employees. The method used to procure his cooperation was to provide rumors of German activity. The parachute company quickly grew in the telling to be 'seventeen train-loads', and the region around the laboratory was fortified. Rowe was convinced the Prime Minister had ordered the evacuation. For whatever reason, a new site was soon found in the buildings of a college at Malvern overlooking the Severn Valley in Worcestershire. With the emphasis on microwaves there was much less need for a location near the ocean. The spa town of 15 000 had to take up the addition of the 1000—soon to grow to 3000—employees and their families, and found this decidedly less pleasant than furnishing hotel space for the annual festivals of plays by Bernard Shaw that had marked the pre-war decade.

So the last and final move of TRE began on 25 May 1942 [21]. It was not the final name, however. It remains in Malvern today, although not in the college. Five more name changes have left it the Defense Research Agency.

5.1.5. The Dieppe Raid

At the first light of day on 19 August 1942 landing craft touched the beach at the channel port of Dieppe at about the time of similar landings to the east and to the west of the town. It was an action similar to others on the channel during preceding months, but this one was conducted at division strength, almost entirely by the Canadian 2nd Division with some British Commandos and a token force of American Rangers. The interrogation of an Allied officer prisoner posed a question: 'What was it? It was too big for a raid and too small for an invasion'. The answer speaks across the decades: 'When you find out, tell me'.

The first wave was met by infantry in their combat stations who delivered a withering fire, and when tanks followed—the first landed in a raid—they either fouled on the obstacles that the sappers had been unable to remove or were knocked out by antitank guns already in position. A western flank landing did better, but not even a dramatic success there could have altered the enormous measure of the disaster of the center, a disaster for Canada—of the Canadians engaged 68% became casualties—

about as great in proportion to the nation's population as the Viet Nam War was for the United States and one that left as great a psychological scar. Controversy has naturally followed Dieppe with books and magazine articles in abundance. As the years pass an uncountable number of relevant documents have been located as German files have been sorted out and Allied files released from classification. Many have been lost or were destroyed, and what remains is a great mix—thoroughly stirred by the Official Secrets Act.

For those alert to the events of the time, Dieppe is well remembered, in part as something for which rumor augmented the news reports and led to their distrust. For those who came later the name does not have the same impact, or has none at all. The work by Campbell in the general references is an invaluable aid in sorting out the confusion that lies behind the written record but is not suitable as an introduction. Although written too soon for access to important material, Robertson's book [22] presents the important facts in a gripping way.

The radar story of Dieppe is a curious one. Succinctly put, one might say that nothing happened, seemingly belying the extent of what follows, but there are occasions where 'nothing' requires a bit of explanation. There are three parts to the radar component of Dieppe: (1) the operational use of radar by British and German forces, (2) the technical intelligence gained by the raiders and (3) the effect on subsequent use of radar, specifically for the invasion.

German coast watching was the responsibility of the Kriegsmarine, which began to set up Seetakt equipment on the French coast as it became available, the first going to the batteries of heavy guns at Cap Gris Nez and Calais, and the first detected by British signals intelligence. A Seetakt had been placed at Pointe d'Ally, a few kilometers west of Dieppe, quite capable of observing the attacking flotilla. Its existence was unknown to the British, but it was removed a week before the landing, bringing British intelligence up to date. The Kriegsmarine made the change without troubling to tell the Army, telling something about interservice cooperation.

The British did know of a Luftwaffe Freya-Würzburg pair at Pourville to the west of Dieppe, the location of the Green Beach landing. Although a 2.4 m air-warning set, this Freya was capable of observing large surface craft at 30 km as a consequence of its splendid cliff location [23], more or less the capability of the Würzburg, but the Allied operations order had no provision for any kind of radar countermeasures. Air Vice-Marshal Trafford Leigh-Mallory, commander of air support, had discussed various means of jamming or deception, but the Pourville Freya was beyond the horizon of ground jammers on the English coast, so only deception was considered, such as flying aircraft to distract the operators or having motor boats tow balloons carrying dipole reflectors. Neither was done [24].

This becomes a particularly puzzling attitude because complete surprise was crucial to the operation, as there was to be no preliminary bom-

bardment. The Royal Navy refused to commit any vessel larger than a destroyer to the operation for fear of losing it to dive bombers, and Bomber Command initially refused, owing to a policy of not bombing French cities at night. When the policy was relaxed by Churchill for the occasion, the bombardment was rejected by the planners as unnecessary [25].

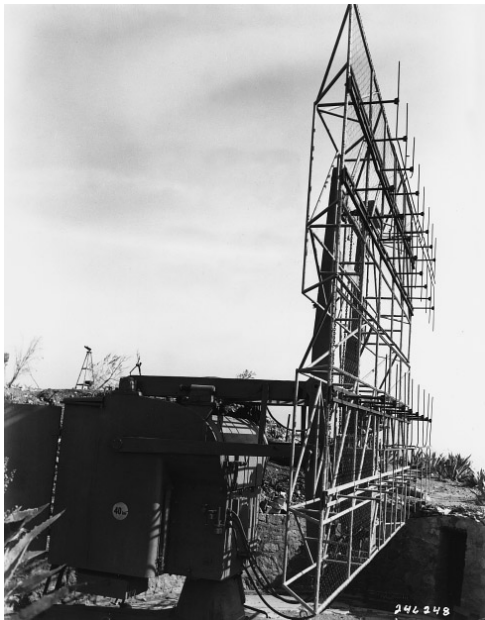
What would seem to have been an excellent capability of radar warning for the defenders was spoiled by poor interservice cooperation. The Freya stations reported air and the Seetakt stations reported surface movements, although after the Bruneval Raid local arrangements were made to have Luftwaffe stations report maritime activity to the Kriegsmarine plotting centers [26]. The Freya station, under the command of Oberleutnant Willi Weber, sighted the flotilla at 0232 hours and decided by 0330 that it was a raid of substantial size. His report to the Navy plotting center was brushed aside because they thought it was of a coastal convoy headed for Dieppe from Boulogne. Deduced from the nature of the movements Weber was sure it was not the convoy and called the 302nd Infantry Division, where he thought the warning caused the troops to go into a condition of enhanced alert. The outcome of the landing naturally reinforced in his mind the opinion that he had given the alarm [27], but the enhanced alert had had other origins. Since February Hitler had transferred his invasion fears from Norway to France with the result that all lower levels of command were thoroughly exercised. On top of that, British propaganda had been trumpeting a second front for 1942, amplified by all communists or communist sympathizers in the west. Troops went into alert positions whenever moon, tide and weather were suitable, as they were that night.

The operation did have one radar objective in putting a technician, Flight Sergeant Jack Nissenthal, ashore on the Green Beach to examine and, if possible, remove components of the Freya. Unlike the Bruneval Raid, Jones had not requested this as he considered his knowledge of Freya adequate; the task had been tacked on because the planners of every raid now wanted something about radar. Nissenthal went ashore with Company A of the South Saskatchewan Regiment, who were unable to take the well fortified radar station, but he was able to observe the movements of the antenna, which told him the set had lobe switching [28]. Some extravagant claims have been made by Nissenthal [29] and others about the accomplishments of this exploit. A big point was made and has been disputed of his having cut telephone lines out of the Freya station [30], forcing them to use radio to transmit their findings, but these stations had already used radio for this purpose to the extent that there was little more intelligence to be gleaned from listening to such transmissions [31]. However that may be, his adventures on the beach had a distinction denied any of the others, for he had had a personal guard assigned to protect him or kill him (he learned later) rather than allow his capture. This resulted from an order originally intended to apply to a TRE scientist and not altered when the assignment was given to a technician [32].

The German convoy bound for Dieppe was an unforeseen complication for the attacking fleet, as the two collided in the darkness with a resulting exchange of gunfire. This was interpreted by the Kriegsmarine to be British torpedo boats attacking the ships. British shore radar had tracked the convoy with their NT 271 equipment since 2140 hours of the 18th, even achieving remarkable long-range plots as a result of anomalous propagation [33], but this information did not reach Captain John Hughes-Hallett, the Naval Force Commander because of a communications failure [34]. Two destroyers in the force had 10 cm type 272 (a modification of the 271) radar but failed to detect the convoy [35]. The reason for this probably lies in the absence of a PPI indicator in this set [36], which made it difficult for the operators to untangle the confusion of so many ships. The resulting *melée* scarcely helped get things off to the right start for landings dependent on surprise, although the short fight actually raised no alarm. Subsequent studies show that part of the confusion arose because some officers thought plots beyond normal radar range, the result of anomalous propagation, were not trustworthy data [37].

Thus the extensive radar activities add up to very little, if somewhat more than nothing. German radar contributed nothing to warning the garrison despite the alert radar commander's report and insistence. No jamming or deception was attempted by the British despite the importance of surprise. Information about the German convoy learned from shore stations was not passed on to the responsible commander, and his own ships did not spot it. The one piece of radar intelligence that Nissenthal learned, that the Freya had lobe switching, was not deemed worth preparing a special report [38].

The small thought given to radar in preparing for Dieppe was not repeated in planning for the invasion of Normandy, somewhat less than two years later. The invasion had a detailed plan for radar at every level and used jamming and deception in the most advanced forms as well as radar in its primary mission. The debacle at Dieppe had many lessons to teach for the Normandy and Mediterranean invasions. That they had to result from such a bloody defeat does not necessarily follow.



German Seetakt (FuMG 40) surface-search radar captured at Toulon during the invasion of southern France where it was used with a coast-artillery battery. When used in this service it was referred to by British intelligence as 'Coast Watcher'. The same basic 80 cm set, known originally as DeTe-I, was used by the Kriegsmarine on ship and on shore. The pocket battleship Admiral Graf Spee received a Seetakt (60 cm version) in January 1938, the first warship to have a tactical radar. The Kriegsmarine rejected lobe switching that the manufacturer, GEMA, offered and thereby lost the capability of blind fire. National Archives photograph 111-SC 246248.