SRH-025

BATTLE OF THE ATLANTIC

VOLUME IV

VOLUME IV

TECHNICAL INTELLIGENCE FROM ALLIED C.I.

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CHAPTER I

GERMAN SEARCH RECEIVERS AND RADAR

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GERMAN SEARCH RECEIVERS AND RADAR

1.
Summary

In the German Navy's fight to preserve the "invisibility" of the U/B, it's chief enemy in direct combat through most of the war proved to be Allied airborne radar. At the beginning of the war the U-boats had been able to range far at sea, often to intercept convoys without fear of advance detection by aircraft, and to sink their prey and get away before any defensive force could be effectively brought to bear against them. The equipping of aircraft engaged in A/S operations with radar began early in 1941 and gradually initiated a contest between Allied radar and German countermeasures which became very acute by 1943. Among the counter-devices upon which the Germans pinned their hopes were search receivers designed to intercept radar transmissions and thus inform U/B's in advance when they were in danger of attack by a radar equipped A/C. Several different models of the GSR were developed, with varying degrees of success. The first model, though poorly constructed and primitive, served its purpose. When the Allies resorted to centimeter wave-length radar, however, the tables were turned and a long period of desperate searching for the cause of Allied successes followed. For many months the German effort to determine that cause failed completely The first step taken was to improve the GSR models currently in use.

When that failed to produce results the U-boat Command turned to investigation of the possibility that infra-red detectors were being used by the Allies. In the summer of 1943 the German Navy became obsessed with the idea that the enemy was profiting by detection of radiations from the GSR. New models were developed to eliminate radiation, this at a great loss of valuable time. It was not until September 1943, after the Germans had discovered that Allied A/C were using centimeter radar, that U-boats were equipped with GSR capable of dealing with all wavelengths in use by the Allies. Even this search receiver was inadequate, owing to its very short warning range and the fact that it never had a permanent aerial. Since the introduction of Schnorchel early in 1944 did not eliminate the possibility of detection by radar, it was necessary to fit the Schnorchel mast with an aerial, which, however, was incapable of receiving centimeter wavelength transmissions at distances of more than 1,000 meters. German radar, under development and in use concurrently with GSR, took a definite second place in the opinion of U-boat commanding officers. Confidence in its capabilities was expressed from time to time by Command, but fear that Allied A/C were equipped with search receivers caused the commanders to neglect its use until the spring of 1944. Thereafter radar became more popular with the commanders and proved of value as a warning against A/C and as an occasional aid in convoy shadowing, firing and navigation.

Introduction of Allied Radar and the first German Search Receiver.

The use by Allied aircraft of ASV radar, operating on meter wave lengths, was instituted early in 1941 and soon proved its value in increased sinkings of U-boats, including not only those in the vicinity of convoys, but also those in other areas. Mounting Allied successes, together with the appearance of aircraft so frequently as to eliminate the possibility that their presence was due to visual sighting, aroused the Germans to the fact that some locating device was being used against them. They were not backward in technical matters and were quite aware of the possibilities of meter wave length radar. Aided by the capture of an ASV Mark II in the spring of 1942, they concluded that radar was the cause of the U-boat's troubles and set about finding a means to counteract its effect. The answer to their problem, proved by tests in the summer of 1942, rested upon the fact that transmissions of a radar set could be received by means of a simple aerial and receiver; hence a U-boat could discover the presence in its vicinity of a user of radar and submerge before it could be successfully located. A makeshift search receiver, manufactured by the firm of Metox in Paris and designated the R600, was hastily put into production and supplied to U-boats, starting in September 1942. The R600 was designed to cover a range of 60 to 265 centimeters, including harmonics, and probably had a maximum effective detection range of

about 6 miles. Hurriedly contrived as it was, it showed the varied and serious weaknesses which might have been expected under the circumstances. Its generally poor structure, particularly its primitive aerial, resulted in frequent breakdowns; its usefulness was limited by its inability to distinguish between radar and non-radar disturbances, its inability to take a bearing, and its inability to receive short transmissions. In addition, the set was a source of powerful radiations when in operation, a matter which was dismissed as of little consequence at the time, but which was later to be remembered, and exaggerated in the mind of the German technical expert to a significance out of all keeping with common sense, this at great cost to the U-boat. Despite all its weaknesses, however, the Metox set was operationally successful for some time. It was improved in some respects as time went on, mainly in the substitution of a fixed basket aerial ("Runddipol") for the old cross type, addition of a second oscillator, and installation of a "Magic Eye" mechanism; but it remained the only standard U-boat search receiver for more than 6 months. U-boat radio traffic for November and December 1942, the first read here, abounded in reports of "Ortung", i.e. "radar", and plainly showed the success of the German counter-device. That radar had been successfully counteracted for the moment was also shown by the general picture in the Atlantic war, for Allied shipping losses had continued high in the latter part of 1942 despite improved convoy arrangements. The U-boat still

maintained its decisive advantage.

3.
The Introduction of Centimeter Radar.

In February and March 1943 a new refinement in the war of detection in the form of ASV Mark III, a set operating on centimeter wavelengths, was introduced on Allied aircraft. The R600, with its 60 centimeter lower limit, was quite unable to detect transmissions on the new very short wavelengths, and the result was a gradual increase in the number of sightings of U-boats and attacks against them, accompanied by an increase in the proportion of attacks carried out without prior appreciation by the U-boat that radar was being used. In his message 1631 of 30 May, 1943 for instance, Kentrat (U-196) reported that he had been flown at twice during the hours of darkness by A/C "without radar"; and in his message 1019 of 26 September, Schroeteler (U-667) reported: "So far 5 attacks at slight distance without any radar Cruising at night is impossible, since there is no time for outmaneuvering." A more correct interpretation was recorded by Hartenstein (U-156), who reported in his 0105 of 7 March 1943: "A new kind of radar. Metox is useless. Very accurate attacks without searchlight." The deteriorating situation quite naturally became evident to the Germans before many months had passed, but they were totally unaware of the cause of it, and contrived counter-measures, most of which were aimed at the wrong objective.

4.

The "Magic Eye"

The first attempt to solve the new detection problem centered about improvements to already existing search receiver sets, the Metox R600 and the Grandin, a receiver which covered the same frequencies as the former. It was first assumed that Allied radar transmissions were now producing headphone vibrations outside the range of audibility. Working on this hypothesis, a visual tuning indicator of the "Magic Eye" type was introduced into the improved Metox R600A, a development mentioned in enigma traffic in message 2105 of 10 March, 1943. By the rarest good fortune, it happened that naval aircraft in the Mediterranean area were using supersonic modulation at the time, and the success of the "Magic Eye" in detecting these particular aircraft evidently led the German technical experts to believe, for as long a period as a couple of months, that they had solved the problem. Evidence for this appeared in messages 1217 and 1304 of 23 May in which it was indirectly stated that the "Magic Eye" indicated inaudible impulse frequencies and that outfitting of U/B's would continue. But the continued Allied successes, representing the worst situation for U-boats since the beginning of the war, could not permit continued reliance on the "Magic Eye".

5.

Measures against Infra-red Detection and Short-timed Radar.

The next line of attack taken by the technical authorities

was in the field of counter-measures for infra-red detection. The suspicion that infra-red detection might be the secret of the new Allied success was based upon reports from U-boats at sea mentioning a dull red glow emanating from attacking aircraft. The German technical staff turned its attention with characteristic singleness of purpose to the discovery of a means of counteracting the suspected bogey. Infra-red detectors were carried by some U-boats for experimental purposes, but difficulties in operation of the device precluded formation of any definite conclusions from the lack of successful experiments with it, and the Germans wasted the whole summer of 1943 clinging tenaciously to their suspicion that infra-red was the cause of their trouble. U-boats were covered with a special paint calculated to absorb infra-red rays and other precautions were taken, yet sinkings by Allied aircraft continued. Simultaneous research directed toward developing means of detecting the suspected use of short-timed radar as an anti-interception technique also produced no visible results in a decrease in U-boat sinkings.

6.
The Germans take Stock.

After several months of failure by the Germans to find the cause of their misfortunes, it was apparent that the U-boat Command and its skippers had lost faith in their search receiver. In the Bay of Biscay U-boats began to spend the nights under water,

preferring to take a chance on visual sighting of an enemy during daylight for the period of time necessary for ventilating and charging the batteries. In July 1943 the Director of the Naval Communications Division, German Naval War Staff, admitted in a long communication concerning the search receiver service that the "invisibility" of the U-boat was gone, that the element of surprise in U-boat attacks had been eliminated by new Allied location methods which had so far proved inaccessible to interception. The Director outlined plans for overcoming the German deficiency, including increased use of radar itself by naval and coastal defense forces. Taking note of the many serious mistakes made in the past, he announced extensive changes in organization and procedure aimed at strengthening radar and radar interception research and practices, and stated that the Commander-in-Chief of the Navy had promised his special support toward attaining that end, as indeed Admiral Doenitz had promised U-boats in May.

7.
The Radiation Specter

For some reason, the fact that search receiver radiations were capable of being detected at a distance of several miles suddenly began to plague the Germans in the summer of 1943. No new technical knowledge was concerned in their appreciation of that fact, for they had known of that possibility when the search receiver was first introduced and had discounted its importance as a threat

to the U-boat. The Allies had also investigated the practicability of using search receiver radiations for homing purposes and had abandoned the idea because of the difficult operating conditions aboard aircraft. But now the Germans, still searching for the cause of Allied detection successes, fastened upon this specter as the object of their feverish activity during the next several months. Tests on the Metox receiver showed that it produced very powerful radiations, and in the middle of August use of both Metox and Grandin was prohibited because of the fear of benefit to the enemy. (PSRE 0410/15). To make sure that the prohibition was observed, it was ordered that the Commanding Officer should remove an essential part of the set, keep it under lock and key, and enter that action in the war log. (PSRE 2022/17). The Metox was replaced by a new GSR called Wanz G1 or Nagenuk, details of which were passed to OP-20-S in a memorandum of 6 October 1943. This set, designed for frequencies between 120 and 150 centimeters, was originally produced for the specific purpose of detecting suspected short-timed radar transmissions, but by chance produced radiations only about one twenty-fifth as powerful as those emitted by the M600. Hence it was looked upon as a complete answer to the need of the moment. It was also an improvement over the old M600 in other ways, for scanning with the visual indicator was automatic, and only after a transmission had been picked up was manual scanning for sound reception necessary. In addition, the set had a greater range

(about 30 miles for an aircraft at about 1,000 feet altitude, 60 miles at 6,500 feet), and greater sensitivity. Yet, in spite of all these improvements, especially the greatly reduced radiation, sinkings continued. The German mind was still not convinced that radiation was not its great enemy. On 5 November 1943 messages were sent instructing U-boats not to use their Wanz G1 because freedom from radiation had not been established. (2049). Instead they were to be supplied with either Wanz G2 or Borkum search receivers. As further insurance against radiation ordinary radio programs were to be received by U-boats east of 15 W. while submerged, using VL/F.

8.
The first non-radiating
Receivers.

The Wanz G2 was a later version of the G1, as its name implies. Covering the same frequency range, it had the advantage of practical elimination of radiation, though at considerable cost in warning range (only about 37 miles with aircraft at 6,500 feet altitude). Another of the stop-gap devices, it was subject to frequent breakdowns, but all its imperfections were accepted in favor of the release from fear of detection through radiation. The Borkum set, designed to receive all signals in the 75 to 300 centimeter band without tuning, had been first introduced in the summer of 1943. Outside the band mentioned its sensitivity

decreased, but it is possible that it gave some indication even of 10 centimeter transmissions. An emergency installation, its efficiency was considerably below that of the Wanz G2 (about one-fourth, according to 0246/16/6/44) and was used in practice chiefly when the latter was out of order. The Borkum, too, produced radiations below evaluable magnitude, so the Germans had at long last conquered their imaginary enemy. The real enemies still remained.

9.
Discovery of the Use of Centimeter Wavelength Radar.

In some way the U-boat Command became aware by September 1943 that centimeter wavelength radar was in use against them, a discovery which should have led to the speedy solution of the radar problem. Actually the search receiver developed for use against the newly recognised threat at first defeated its own purpose because of its lack of sensitivity. The Naxos set was designed for the 8 to 12 centimeter band, in which receiving would have been difficult enough with an excellent set. The Naxos was far from excellent. It was very delicate, therefore subject to continual breakdowns. A particular weakness was the antenna, which was subject to frequent breakage because of the use of porcelain rods in its construction, and which had to be mounted each time the U-boat surfaced and taken down again before submerging. The disadvantage of this was strikingly

illustrated in the case of U-625, whose captain was lost at sea because of difficulties which developed in removing the antenna in time for a crash-dive to avoid an attacking aircraft. (0532/4 January 1944). The warning range of the set with its original antenna was pitifully small, so small as to render it almost useless, but every effort was made to increase its efficiency, particularly by improvement of the antenna. The first improvement of this nature was the introduction in early February of the Fliege, a reflector antenna giving approximate bearings and operating in the 8 to 12 centimeter range. Use of this antenna greatly increased the range of Naxos against 10-centimeter radar, making it an effective detection device. In addition the Fliege was used separately with some success for aiming anti-aircraft guns in advance of appearance of the target. Another antenna, the Muecke, was put into operational use in May 1944 as a complement to Fliege to cover wavelengths from 2 to 4 centimeters, for it had been discovered through capture of a crashed aircraft that 3-centimeter radar was in use by the Allies. Also a directional antenna, the Muecke covered approximately the same warning range as the Fliege. These two antennae were later incorporated into a single frame called "Tunis", and the Naxos set continued in use against centimeter wavelength radar until the end of the war. On the radar question as a whole very extensive experimental work was done in the spring of 1944. In February and April, respectively, U-406 and U-473 left port fully equipped to

investigate every type of Allied radar. Both boats were sunk, but others carried on constant investigation of Allied frequencies. "Feldwache", a combination of several different sets, was used for experimental searching of all wave bands from 320 cm. down to 5 cm. A summary of results of experiences presented as a Current Order on the use of Tunis (0602/22 June 1944) indicated that the Naxos-Tunis combination would remain the chief instrument for search receiving, but that experimentation would meanwhile continue.

10.
Schnorchel and GSR

While the introduction of Schnorchel in 1944 proved a blessing to the U-boats, it did not eliminate entirely their susceptibility to location by radar when the Schnorchel was extended, although the radar target was considerably smaller than that of the whole U-boat. It was therefore necessary to devise a means of search receiving for the Schnorcheling U/B. This was brought about by including a drum type aerial, called the Schnorchel round dipole, in the Schnorchel mast. The round dipole was capable of receiving radar transmissions on meter wavelengths, but according to message 2003/10 of July 1944, it could only register Fliege range radar at the short distance of 1,000 meters. The Germans apparently believed it practically impossible for a Schnorchel to be picked up by centimeter radar because of its rubber camouflage protection and

considered search reception over the round dipole adequate protection from meter wavelength radar. At the end of the war they were trying to develop a permanent centimeter aerial for the Schnorchel mast. That they had not succeeded was shown by a reply from Germany to Soerabaja's inquiry concerning the installation of such an aerial. Berlin replied:

> "At present there is still no gear available for observing centimeter radar during Schnorchel cruise." (FPB 86, 3 April 1945).

Type XXI U-boats were to have carried such aerials.

11.
German U-boat Radar

It was known from the first two months of U-boat traffic read here that at least some U-boats were fitted with radar and that its wavelength was 80 cm. There was no indication that U-boats made any real use of radar. References in traffic were very few until the summer of 1943, when U/boat Command started a campaign to persuade U-boat captains that their own radar should be used for A/C detection in lieu of the forbidden GSR. Among the significant developments in the radar picture, easily followed by reading of German traffic, was the continuing question of U-boat radar's merit relative to the GSR. There was great reluctance to use radar because of the fear that Allied A/C were fitted with search receivers. Owing to the fact that GSR ranges were greater than those of radar,

it was not surprising that the U-boats preferred to rely on GSR for warning against enemy aircraft, especially in view of the radiation scare of 1943. There appeared to be a split between Command on the one hand and the operating U-boats on the other as to the advisibility of using the radar sets provided. This was chiefly illustrated by the periodic appearance of instructional messages from Comsubs emphasizing that the German radar was an effective instrument and should be used. Occasionally there was a direct reprimand for failure to use radar under circumstances favorable to its use. In June 1943, for instance, there were two messages (2343/5 and 1252/25) which directed that radar should be used as much as possible, one of them stating:

> "Our own radar sets are well suited to establish the presence of airplanes independently of their use of radar, for example during surface cruise in the Bay of Biscay. Planes are contacted at altitudes of 500 meters and more at a distance of 10 kilometers at the least. For the time being, enemy search reception of our radar is not to be presumed."

A slight shift in sentiment on the latter point was demonstrated in PSRE 0257/9 September, in which, while use of radar was still stated to be the only means for locating the enemy under certain conditions, it was pointed out that

> "it is necessary to be prepared at all times for enemy search receiving activity".

A memorandum to Cominch sent on 22 October 1943 recorded the fact that German radar seemed destined to occupy a role secondary to GSR,

an opinion which was borne out by future developments. Nevertheless, Comsubs continued to exhort his boats to use radar, and provided them with improved sets to make its use more effective. The original set supplied, the Gema, had been a cumbersome, unsatisfactory set operating on 80 centimeters. As technical development progressed, improvements were made to the Gema and a new set, the Hohentwiel, operating on 50-55 centimeters, was introduced. Both the improved Gema and the Hohentwiel represented advances both in ease of operation and in increased effective range. There were continual reports of sets out of order, however, leading to a statement by Comsubs that failures were often due to insufficient tending and lack of training (1840/1 Apr. 1944). Meanwhile the effort of Command to popularize the use of radar had continued, with three separate messages devoted to the subject in February alone (2141/4, 1752/16 and 1622 ff.). There were indications in March that the reluctance of U-boat commanders had been overcome to some extent, for several instances of successful use of radar were reported. As time went on that reluctance was further broken down, with many reports of A/C successfully detected by radar before they were able to attack. There was also increased use of radar for locating and shadowing of surface vessels. In addition, examples were recorded of U/B's using radar as the means of aiming at both attacking A/C (1947/16 Oct. 1944) and surface targets (0308/15 Dec. 1944). It was also pointed out that Hohentwiel could be successfully used as a navigation aid in hazy weather. (0018/5 Dec. 1944).

CHAPTER II

ANTI-DETECTION DEVICES

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ANTI-DETECTION DEVICES

1.
Summary

A clear-cut illustration of the value of Communications Intelligence is offered by the story of "Aphrodite", a radar decoy balloon first used in the middle of 1943. The device was first mentioned on 17 April in Baltic Naval traffic which was read by the British and reported by them to the Atlantic Section. With a few details given in the original message and two other messages sent in June, it was possible for the Atlantic Section to inform Cominch of the nature and description of the device before it was put into operational use. "Aphrodite" consisted of a hydrogen balloon to which were attached metal strips tuned to known British and American radar frequencies. They were released to lead searchers off on a wild goose chase and thus allow a U/B to escape detection. The device proved very successful at times, even leading, in connection with the T-5 acoustic torpedo, to several sinkings of Allied craft. During the invasion, "Aphrodites" were released in large numbers to deceive searching aircraft while U-boats not provided with Schnorchel surfaced for charging in the Bay of Biscay. Another device with the same object as "Aphrodite" was "Thetis", a dummy buoy to which metal dipoles were attached, designed to give the same radar reflection as a U/B. All significant details of this device were given in the message which announced its impending use in January 1944.

Traffic indicated that it was used to simulate patrol lines and for protection of non-Schnorchel U-boats during the invasion. "Bold", a device which produced noises and bubbles when discharged into the water, was used against vessels searching with asdic or hydrophones.

2.

Introduction of "Aphrodite"

The first mention of "Aphrodite" to come to the attention of the Atlantic Section was in a British routine report on communications matters, issued under date 1 May 1943. Speaking of a radio circuit guarded by the British, it was stated that at 0115/17 April Communications Experiment Trial Command sent the following to the depot ship "Wilhelm Bauer" for Captain Giessler:

> "Communications Equipment Trial Command tests today without result. No 'Aphrodite' signals established. Propose on 17/4 first experimental series from 1300 with 'A.S.V.' aircraft due to arrive at midday. For each series have ready 2 to 3 free and 2 to 3 captive. Characteristics of U-boat: swastika flag forward, morse lamp flashes on closing."

To this the British added the following notes:

> "1. Giessler had long been connected with R.D.F.
> 2. Nothing known of 'Aphrodite'".

Nothing more was heard of "Aphrodite" until June, when two messages on all U-boat circuits mentioned the device. One of these, 1552/12, was addressed to "boats with 'Aphrodite II' " and stated:

> "Hydrogen tanks not dangerous even if hit. At worst gases will blow off without exploding."

The other message, 1203/15, stated:

> "Beginning at once the use of "Aphrodite" according to instructions is authorized."

3.
RI Action on the Information at Hand.

With the arrival of the June messages quoted in the preceding paragraph, a conclusion as to the nature of "Aphrodite", based entirely upon the earlier British report and a knowledge of the place occupied by Aphrodite in Greek mythology, was formulated. Thus it was that on 23 June 1943 the Atlantic Section was able to send information in a memorandum to Cominch giving an accurate theory as to the nature and use of the device. The memorandum stated:

> "It is believed that 'Aphrodite' refers to deception equipment of submarines in combatting A/C radar. The assumption as to its working is as follows: When a surfaced submarine obtains via Metox any indication of radar, a hydrogen balloon is released by the submarine. To the balloon are attached metal strips of various lengths tuned to known British and American radar frequencies. The submarine steams off into the wind while the balloon passes off to leeward, drawing the hunter off on a wild goose chase."

Later, incontrovertible evidence demonstrated that the above theory was in fact correct.

Of great importance was the fact that by means of Communication Intelligence Cominch knew of the existence of "Aphrodite" before it was put into operational use.

4.
"Aphrodite" Successes.

In July the U-boat Command, apparently impatient because

it had received no reports on the performance of "Aphrodite," directed U/B's to make experimental use of it, since there was little possibility of tactical use, and various reports were sent in answer to that order. A possible, but not confirmed, tactical use may have occurred on 21 July, when an Allied report cited a disappearing radar contact in 15.45 N - 72.50 W; but the first tactical use acknowledged by the U/B Command was in September and October, when several successful deceptions were claimed and an obvious campaign to instill confidence in the device was carried on by the U/B Command. It must be remembered that for the previous several months the U/B had existed under the heavy shadow of fear of radar and almost complete inability to detect or combat it. "Aphrodite" was a hope, and in the German struggle against surprise attack from the air, was worthy of every consideration and trial. Whatever comfort it could supply to the demoralized U/B arm was sadly needed.

Actually, after the long dearth of U/B successes, there was some occasion for rejoicing in the reports of "Aphrodite" successes. Aside from the general feeling of satisfaction resulting from any aid to avoidance of aircraft, a few reports of extremely advantageous use in offensive action must have been very encouraging. U-68, for instance sank the Free French escorted freighter "Fort le Vaux" on 30 November 1943 "after successful use of 'Aphrodite'"; and, most striking of all, at the end of December, Petersen(U-541) used "Aphrodite'

in conjunction with the very effective acoustic torpedo "Zaunkoenig" to sink "three destroyers" in one attack. It is small wonder that the captain of U-541 thought that "Aphrodite" was "first-rate!", and that thereafter Command urged upon all U-boats the advantage of "the skillful release of 'Aphrodite' along with the use of 'Zaunkoenig'".

From the beginning of 1944 on, reports on "Aphrodite" showed no unanimity of opinion among U-boat captains as to its effectiveness in various instances and in differing situations. The high tide of its use seemed to have passed, and it assumed the position of a rather routine, not especially exciting, countermeasure, though it was apparent that the U-boat Command considered it a successful device on the whole. One significant reference during January directed Group Borkum to "infest the area with numerous 'Aphrodites'; when attacking convoy, use 'Aphrodite' to loosen up the defenses". Other references during the first months of 1944 showed that it was being used for the purpose of testing German radar sets, and that its range for deception covered not only meter length radar, but also frequencies around 10 centimeters.

5.

"Aphrodite" and the Invasion.

One further episode of importance in the "Aphrodite" story

occurred in connection with the difficult situation for U-boats in the Bay of Biscay during and after the Allied invasion of France. In the midst of the unprecedented danger from aircraft, U-boats caught in the danger area without Schnorchel were sometimes forced to surface in order to charge their batteries and ventilate the boat. In such cases a "forest of Aphrodites" was successfully used to protect the boat from detection and attack during the period of emergency. In several messages read during June, emphasis was on the large number of "Aphrodites" being used and the difficulty of supplying replacements through the French ports, a difficulty which persisted throughout the remainder of the time the ports were in use by U-boats. As time went on, reports on use of "Aphrodite" became more and more infrequent, and by the advent of 1945 they were almost non-existent. Boats leaving port continued to carry the device, however, so it was clear that it was still considered an effective counter-measure under certain conditions, even though the addition of Schnorchel had revolutionized the whole problem of U-boat attack and defense.

6.
"Thetis"

Message 1642/11 January 1944 on all U-boat circuits introduced a new German anti-radar device to Allied Communications Intelligence, and through the usual channels to Cominch. The translation of the message read:

"To interfere with enemy radar activity, dummy buoys of type 'Thetis 2C' will be put out in Bay of Biscay as far as about 12 W. beginning 11 January. Description: A thin wooden upright 5 meters long, on a float. Weighted underneath with a 5-meter steel tube. Thin metal dipoles on the wooden mast, can be seen only from very short distances. Effect: Buoy gives same reflection as U-boat."

In this one short message the most significant details about "Thetis" and its purpose were given. Until July 1944 messages reporting the setting out of "Thetis" buoys occurred in considerable number, with positions in the Mediterranean and in the Atlantic as far as 31 W. Thereafter the number of references in traffic decreased, with final mention in message 1641 (Grey) of 15 August to French U-boat flotillas, in which it was ordered, concerning cargoes to be carried by U-boats escaping from French ports:

"Relegate transfer of 'Thetis' to last place. They are too unwieldy. Use space for important things such as 'Aphrodite', power cable, valves and 'Bolde'."

thus the relative unimportance of "Thetis" was finally announced.

The one significant detail not revealed in the original message about 'Thetis' came to light in three almost simultaneously transmitted messages of 19 March, all directing the addressee to set out their remaining "Thetis" at 15-mile intervals, the object presumably being to simulate patrol lines. This type of mass use continued through July, including general use for protection of non-Schnorchel U-boats during the invasion.

7.

"BOLD".

A counter-device less frequently mentioned in U-boat traffic than "Aphrodite" was the "Bold", a cartridge containing pellets of a chemical composition which produced noises and bubbles when discharged into the water. Their purpose was to confuse A/S search by vessels using asdic or hydrophones. The device was first mentioned in enigma traffic when Buelow (U-404) requested a rendezvous with another U-boat so that he might take aboard some "Bold" (1925/28 January 1943). That Comsubs attached importance to the device was indicated by the fact that he granted the request as well as by a more direct statement in message 1531 of 24 April. Reminding commanding officers of the use of "Bold" when taking evasive action, he said: "The 'Bold' technique has been used in recent times almost invariably with success." Only a limited amount of material about "Bold" appeared in enigma traffic, but the information at hand from all sources was correlated and presented to Cominch in a memorandum of 30 July 1943, and was sufficient to indicate the nature and tactical possibilities of "Bold". The instructions pamphlet taken from the U-505 and translated by the Atlantic Section proved helpful in elucidating several messages sent to U/B's during the winter of 1944-1945 concerning the more effective use of "Bold" in "Total Underwater Warfare".

CHAPTER III

SCHNORCHEL

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5. Schnorchel and Radio.

The Testing Period, January-May 1944.

That the Germans had not devoted all of their time and effort to alleviation of the radiation condition of their search receivers during the latter months of 1943 was clearly shown at the beginning of 1944, when Schnorchel was first used by U/B's operating in the Atlantic and consequently became known to the Atlantic Section through various references in radio traffic. The first such reference, in January, gave no indication as to what the device might be, except that it was of a mechanical nature and had some connection with the diesel engines, but the British had seen the term in their reading of Baltic traffic and were able to supply the opinion that it was a cover-name for "an internal combustion system of propulsion which can be used by a submerged U/B." Later information from traffic, prisoners of war, and captured documents provided extensive knowledge of the device. It was found to consist of two trunks, one for air intake, the other for diesel exhaust, encased side by side. A valve arrangement prevented entry of water, and an oil pressure system was used to raise the Schnorchel from its horizontal resting position on the deck to its vertical operating position.

The first several months of 1944 were used in gaining information on the performance of Schnorchel in practical use, and Command sent orders at various times requiring U/B's to make reports on their findings in this regard. In addition, Command was apparently worried over a possible tendency of Schnorchel

SCHNORCHEL

1.
Summary

Schnorchel, an extensible trunk which allowed charging of batteries as well as diesel propulsion and U/B ventilation while submerged, was first used by U/B's in January 1944. The first few months of use were devoted to experimentation under operational conditions. During the invasion, Schnorchel was used to the limit of its capacity and allowed operation by U/B's against invasion traffic at a time when air coverage was so effective as to necessitate the recall to port of all U/B's not equipped with Schnorchel. The device was considered of such importance that its installation was designated the chief task of U-Boats in port in August 1944. Although Schnorchel was not immune to detection by radar, it was much less susceptible than a surfaced U/B and permitted boats to operate close to coastal traffic concentrations with little fear of detection for weeks at a time. Unquestionably, Schnorchel was the most effective counter-device developed by the Germans in the Battle of the Atlantic. While a half-way measure in the development of a true underwater boat, Schnorchel did make possible a dangerous approximation of the "total underwater warfare" which the Germans were trying to perfect on blueprints and in the shipbuilding yards.

U/B's to feel too safe with their new protection, for several times during February and March, warnings were sent that Schnorchel was not secure from location by radar. Replies to requests for information on the practical performance of Schnorchel were evaluated and used as the basis for Current Order 20, broadcast in 2200 and 2259/31 May, which indicated that several U/B's had used Schnorchel with success for submerged cruises lasting several days; that charging of batteries could be accomplished by use of Schnorchel for four to five hours daily; that certain U/B's tended to smoke up during Schnorchel cruising; that Schnorchel could be located by radar only at distances considerably shorter than those at which a surfaced U/B could be located; and that it was necessary to interrupt schnorcheling approximately every twenty minutes in order to make a hydrophone sweep.

3.

Schnorchel and the Invasion.

The Allied invasion of France on June 6 brought the Germans not only the opportunity, but also the necessity of using Schnorchel tothe limit of its capacity. On June 6 in message 1150, the operational area for Schnorchel U/B's as previously ordered was changed and they were disposed about the southern coast of England and in the English Channel to interfere as much as possible with passage of traffic between England and France. More than that, within a week, U/B's in the Bay of Biscay not fitted with Schnorchel were ordered to put into port (2302/12), for it had become apparent that the U/B which was forced to surface in order to charge its

batteries in the Biscay area could not survive. The relative safety of the Schnorchel U/B, on the other hand, could only lead to the conclusion that boats not already fitted should receive the equipment as soon as possible; consequently, the summer and early fall of 1944 were devoted with great energy to its installation in the hard-pressed ports of western France. For boats which were already fitted, the main activity during the summer was, of course, a concerted attempt to prevent the movement of Allied ships in the Channel area. Fortunately, there was little success in this effort, owing in part, perhaps, to the fact that there was still considerable hesitation in using Schnorchel with the boldness later evidenced by some captains. Aside from the directly operational objective, boats also concentrated on shortening the time required for charging batteries during Schnorchel operation. The continued confidence of Command in Schnorchel was evidenced in August in an order directing that completion of equipment with Schnorchel should be considered the main task of U/B's in port, and that boats without Schnorchel should not leave port unless the port was directly threatened (2058/7 Grey).

4.

Schnorchel and Radar.

On the basis of accumulated experiences, message 1333/10 of September 1944 gave an estimate of the effectiveness of Schnorchel as a means of avoiding radar, advising U/B's that if the Schnorchel was extended only the normal amount, one-half meter above the surface,

the impression on a radar receiver would be only about 30 percent that of a fully surfaced U/B. In addition it was claimed that Schnorchel could not be located accurately enough by radar to permit good placement of bombs. Again the general satisfaction of Command was expressed in an Experience Message in the characteristic style of Admiral Doenitz, signed personally by him (1551/17 October). It stated in part:

> "the experiences of many captains have shown that Schnorchel permits cruising without great detours. The Schnorchel allows the U/B to remain in sea areas close to the coast in spite of very strong patrol and to achieve successes there. ....I require the captains to make the most energetic use possible of the singular capacity offered by Schnorchel and to become master of the enemy defense. Go right up to the sources of enemy traffic and attack there...."

This note of confidence and exhortation was prevalent in communications of Command concerning Schnorchel at the end of 1944, and a new Current Order giving instructions on procedure in operational areas gave considerable attention to the use of Schnorchel in "total underwater warfare." In addition a separate new edition of the old Schnorchel Current Order went into great detail on all aspects of Schnorchel operation. During this period there were scattered references to the apparently satisfactory rubber covering and anti-radar mats with which the Schnorchel had been provided. A final estimate of the value of Schnorchel, far from inaccurate, occurred in a weekly news summary of Cominch (1831/27 January 1945), in which it was stated:

"The war at sea has entered a completely new stage through use of the Schnorchel, which makes it possible for U/B's to remain under water for weeks at a time. The more adroit the U/B's can become in use of Schnorchel against the enemy, the greater their successes will be."

5.

Schnorchel and Radio.

Along with the decided advantages brought by Schnorchel, the operational U/B received certain disadvantages quite apart from the question of the crew's comfort during a 70-day submerged cruise. Dampness became a problem, harming certain of the more delicate apparatus. Radio gear was particularly affected. At the same time that the efficiency of standard radio equipment was being reduced, the Schnorchel U/B was trying to develop the radio communications system of the U/B of the future, but like Schnorchel itself only a half-way measure was tried. Communications experiments with the Schnorchel round dipole failed to relieve the U/B from the necessity for surfacing to transmit.

CHAPTER IV

ARMAMENT
(TORPEDOES AND A/A GUNS)

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ARMAMENT
(TORPEDOES AND A/A GUNS)

1.
Summary.

ULTRA sources contributed information of value not only in following technical progress in matters of armament, but in showing the potential striking power and duration of cruise of operating U/B's. In the field of torpedoes, the most important developments were the "curly" (FAT) torpedo, which increased the probability of a hit by traversing the immediate area of a convoy several times, and the "gnat" (T-V or "Zaunkoenig"), a torpedo which homed accoustically after an initial straight run. Both types met with considerable success, and the "gnat" accounted for the sinking of many Allied destroyers before noise-makers were devised to lure it from its intended prey. Developments in A/A armament were clearly indicated in enigma traffic. Armament was greatly increased on U/B's in the first months of 1943, and during that year there were concurrent experiments with 20 mm. quadruple mounts and 37 mm. automatic guns, with inclusion of both types on a special A/A U/B. Failure of the Flak-Boat led to reversion to the principle of greater A/A protection for all boats at a cost in crash-diving speed. Outfitting with 37 mm. guns was undertaken on a large scale in December 1943, but the weapon never reached the effectiveness hoped for by Command.

2.
Information on Torpedoes Available in Enigma Traffic.

Among developments in the field of weapons which could be followed with great advantage by the reading of enemy traffic, the most important were probably concerned with the U/B's chief weapon, the torpedo, upon the development of which the technical staffs of the German Navy expended considerable effort and ingenuity. Data available from ULTRA sources included more than one type of information of value. There were, for instance, frequent reports from U/B's at sea giving the number of torpedoes of different types on hand. These reports, along with other pertinent information, were an indication of the potential striking power of the U/B concerned, and thus aided in determining how long the boat was likely to operate before returning to port. Another type of information furnished, especially from the reading of administrative traffic which began with the breakdown of German landlines in June 1944, concerned the problem of supply of torpedoes to U/B bases as well as to departing U/B's. In addition there were extensive orders and reports which gave valuable clues as to the character of new types of torpedoes and torpedo parts and their effectiveness.

3.
Standard Torpedoes

Torpedoes at the disposal of U/B commanding officers were of three basic types: air, electric and electric-acoustic. The capabilities of the air and electric types were further increased

by use of improved pistols and fuses as well as by introduction of a "curly" mechanism, which increased the probability of a hit by directing the torpedo back and forth several times over the area being traversed by a convoy or ship. The standard 21-inch air torpedo, generally carrying an impact pistol, had three settings: 44 knots to 6,500 yards, 40 knots to 8,700 yards, and 30 knots to 15,300 yards. It made a visible track, so was usually used in night attacks. Because it required less attention than the electric torpedo, it was generally used by U/B's carrying out long patrols. The standard 21-inch electric torpedo had only one setting allowing for a speed of 30 knots to possibly 7,000 yards if the battery was pre-heated. Owing to the fact that it showed no track, it was a more popular type for general use.

4.

"Curly" Torpedoes.

The first FAT (Feder-Apparat-Torpedo) were introduced aboard U/B's late in 1942, as evidenced by a message to Dietrichs in January 1943 (1326/1) in which he was required to "report in detail on FAT and pistol." An order sent the middle of the same month (1902/15) gave a hint as to the nature of FAT when it cautioned U/B's that overestimation was to be preferred to underestimation, since as a result of underestimation "the entire FAT falls short and the torpedo changes course before reaching the target," whereas "an overestimated FAT distance utilizes at least the preliminary run of the torpedo and consequently affords the

same chances of success as does the normal straight shot." A flurry of short-signal reports during February and March giving notice of intention to attack with FAT indicated that the device was receiving adequate trial in the field, and there were several reports giving firing data for successful shots. Such reports continued to be sent throughout the course of the war. In December 1943 (1058/28 and continuations), in a long Current Order, it was pointed out that the FAT torpedo, as well as the newer electric-acoustic T-V, was valuable for firing under the current difficult conditions which prevented U/B's from approaching their targets to favorable distances and from favorable directions. It was indicated that these torpedoes were especially suitable for "blind" firing by hydrophone data. Meanwhile, continued experimentation had produced not only improved models of the FAT, but also a new refinement on the same principle, LUT, a torpedo which could be fired effectively in a "curly" pattern independent of the target angle. Its line of advance when "curlying" could be pre-set to any angle from its straight run and its mean speed of advance along its "curlying" direction could be pre-set at will from 5 to 19 knots. The LUT was not used extensively until the middle of 1944, when Comsubs stated that a destroyer and two large freighters had been sunk by LUT spread shots (2333/6 July). Most reports of the period, however, were concerned with tube runners caused by failure of the LUT adjuster to disengage, and this trouble continued at least until the beginning of November, after which little was heard of LUT.

5.
The Electric-Acoustic T-V.

The most spectacular torpedo developed by the Germans, because of its appeal to the imagination as well as the impact of its sudden initial success, was the T-V, called the "Zaunkoenig" ("wren") by the Germans and the "gnat" by the British. That Consubs was relying heavily upon this new torpedo to restore to the U/B its former advantage in the Battle of the Atlantic was evidenced by a series of messages during September 1943, all sent in Offizier settings for purposes of security. The first reference (1128/2) called upon all U/B's equipped with Zaunkoenig to make use of every opportunity to bring their "sharp weapon" into play and to act upon the principle that "offense is the best defense." Decimation of the convoy's escort was stated to be their main goal. The great importance of secrecy with regard to the new weapon was emphasized not only by the use of Offizier settings in the first messages concerning it, but by the fact that the contents of the messages, in so far as they could be made known to the crew at all, were to be withheld until shortly before the beginning of the first operation (1226/13). Moreover, in reports on shots with "Zaunkoenig," the target angle was to be disguised by use of an additive and comments on enemy speed were to be given in code-words. It was expressly directed that details of firing and the limits of effectiveness of the torpedo should be kept secret from the crew (1422/21). Continuation of this secrecy into 1944

was demonstrated by instructions to U/B's enroute to the Far East to sink their "Zaunkoenige" and keep them absolutely secret from the Japanese (1024/4 April 1944). It was not until the end of May that Admiral Doenitz was ready to supply the Japanese with general information* and even in June an order was given that while the Japanese at Penang were to be allowed to inspect the torpedo itself, they were under no circumstances to be permitted to see the instructions for its use (2119/19 June). The implication even then was that the inspection was to be allowed because it could no longer be avoided. Fortunately for the Allies, all the German secrecy was to no avail, for RI had made the nature of the torpedo available even before it was actually used for the first time by Group LEUTHEN in mid-September 1943.

The T-V was a 21-inch torpedo which could be fired either on the surface or down to a depth of about 100 feet at a speed of about 24 knots up to 6,000 yards. The torpedo's most important attribute was its ability to home accoustically to the propeller noise of a target after an initial straight run. The immediate widespread use of the T-V can be appreciated from the fact that after the initial report of a tube runner by Maeder on 15 September (0029) there followed within ten days fifteen separate reports on the firing of T-V's. Almost half of the reports claimed indications of success, and it was significant that the successes were generally registered against escorting vessels rather than freighters. In a message of 12 October (1555) Comsubs enthusiastically claimed further successes, including five destroyers and

*The Japanese Naval Attache in Berlin had already gotten wind of the thing.

three freighters sunk and one destroyer probably sunk, all between the second and tenth of October. In message 1847/25 November, while admonishing U/B commanders to utilize all opportunities for firing T-V's, the elation of Comsubs was expressed in the statement that the T-V "has fundamentally altered the U/B-destroyer relationship in favor of the U/B. In this torpedo the U/B has not only a good defense, but a strong attacking weapon as well." The large number of sinkings which continued to be reported bore out this opinion, and the Japanese Naval Attache in Berlin reported on 29 January 1945 (JNA #914) that the rate of hits of acoustic torpedoes since they were first put into use was 49 percent. When the French U/B bases were evacuated in the middle of 1944, the "Zaunkoenig" was so highly valued that the removal of T-V torpedoes and testing facilities from the bases was considered a paramount task. The latter half of 1944, however, showed a diminishing effectiveness of the T-V owing to success of noise-makers used by Allied ships as well as the generally more difficult operating conditions for U/B's, both clearly indicated in enigma traffic.

6.

A/A Armament Prior to December 1943.
Quadruple Mounts and Flak-Boats.

As the struggle between the U/B and its enemy, the airplane, progressed, it became necessary to provide the boats not only with means of avoiding aircraft but of waging battle with them when they could not be avoided. In the first half of 1943 A/A armament aboard U/B's was increased so that the typical 500-

tonner was carrying an 88 mm. gun forward, a 20 mm. on the bandstand, and two machine guns on the bridge, with one or two additional 20 mm. guns on a temporary platform below and abaft the bandstand. When the effect of this increase in armament proved negligible with existing tactics, the next step was a change in tactics whereby U/B's remained on the surface and fought it out when surprised by aircraft. This change in procedure caught the airplanes unprepared and achieved a temporary success reflected in traffic by eighteen occasions during the month of July alone in which U/B commanders reported that the enemy had been "warded off." Nonetheless, a large number of U/B's were sunk by A/C in July, and the success of the new policy dwindled in August and September when planes were reported driven off only six times altogether. A few boats had been equipped between May and September with 20 mm quadruple guns, for accommodation of which the bridge was permanently enlarged. On some of the 500-ton boats these guns were mounted on the lower platform, abaft the bridge, with one or two smaller 20 mm. installations on the bandstand. The 88 mm. gun forward was generally removed from these boats.

Manseck (U-758) was among the first U/B's to be equipped with a 20 mm. quadruple mount, and his first engagement with it occurred on 8 and 9 June 1943 when he was attacked by four A/C from the USS BOGUE. The attacking aircraft, confused by the enlarged bridge, believed they were dealing with a 1600-ton supply submarine. Manseck, though badly damaged, managed to drive off

his four assailants. One of them was hit in the engine but all returned to the USS BOGUE. Manseck's report on the engagement stated:

> "Eight carrier planes warded off; one shot down, four damaged." (0527/9).

Comsubs was delighted. He replied:

> "Well done. Long live your quadruple." (1257/9),

and announced a few days later that other U/B's were to be equipped with the new weapon.

There was little indication of the effectiveness of the 20 mm. quadruple mount from enigma traffic, but there was only a moderate increase in the number of planes hit or brought down in the last months of 1943. Enigma traffic did reveal the fragility of the weapon, however, with no less than seventeen U/B's reporting their quadruple mounts out of order in October alone. Of great importance was the fact that the increased armament had also increased the crash-diving time of the U/B's by probably a quarter of a minute. Such an increase was quite unacceptable, and experiments with a special A/A U/B, or Flak-Boat, were instituted in May 1943, when one such boat was sent out. By November there were five of them actively operating. Conversion of a 500-tonner to a Flak-Boat consisted of enlarging the superstructure and increasing the fire power. The 88 mm. gun forward was replaced by a 20 mm. quadruple mount, with a second quadruple mount on the greatly extended bridge, and below it a 37 mm. gun on a platform. Conversion took from 11 to 13 weeks in most cases. The Flak-Boat was apparently

envisioned as a floating fortress, capable of defending itself and other U/B's on the surface. Indeed, these boats were assigned as escorts in the Bay of Biscay and as protectors for refueling operations. A case in point was that of Brauel (U-256), a Flak-Boat assigned to protect Barber (U-220) in a refueling operation at the end of October 1943. Both boats were attacked by A/C on the 28th. Barber was sunk, but Brauel must have submerged even before ascertaining that fact, for his only report on the incident three days later merely stated that he had not seen Barber since the attack. In protecting either themselves or other vessels, the boats were conspicuously unsuccessful, and the whole record pointed to the conclusion that the Flak-Boat was a failure, with its one positive contribution being its service as a preliminary testing ground for the automatic 37 mm. gun. Even that service turned out to be of limited value in view of the necessity for long-continued experimentation even after the 37 mm. was fitted on other boats.

7.
The 37 mm. Automatic A/A Gun.

The failure of the Flak-Boat led to reversion to the original approach, namely an increase in the armament of all U/B's at the expense of quick crash-diving by fitting them with the 37 mm. gun. A memorandum sent to Cominch in December 1943 summarizing the above facts concerning A/A armament pointed out that this reversion to the original approach showed the same

trend as other developments of the period, namely, a transformation of the U/B from an offensive weapon to a defensive one. In support of this statement it was possible to bring to witness a statement made by Comsubs in a long message of 13 November (1903 and continuations) in which he said as consolation to his commanders that enemy forces engaged by U/B's "cannot be put into action against the homeland. Therefore, you are protecting your home even in battles which seem to you at the time unsuccessful." In the same message, Comsubs hailed the new hope of the U/B, stating:

> "In the fight against the main enemy, the opponents' air arm, the automatic 37 mm. gun will bring further easing.... It is expected that from the beginning of December on, all U/B's departing from Western France will be equipped with this excellent weapon and that from the middle of December on, all home U/B's will be so equipped. In addition to the 37 mm. gun, U/B's will be equipped with the most modern mine ammunition, the effect of which amounts to that of the 20 mm. many times multipled, and one hit of which generally will bring a plane down."

Unfortunately for the Germans, "this excellent weapon" was constructed and installed with such rapidity that the usual thorough tests were omitted, as acknowledged in 1034/5 January 1944. Even so, there was hopeful confidence in the weapon from the first, even to the extent of ordering U/B's equipped with 37 mm. guns to charge their batteries in the daytime in the Bay of Biscay (2238/6 January). This order was rescinded about a week later owing to decreased A/C activity at night rather than to any success or failure of the 37 mm. The continued confidence of Comsubs was demonstrated when, in planning an approaching convoy operation by a group of U/B's, he ordered that all the U/B's whose 37 mm.

guns were in order should remain on the surface if the operation extended into the daylight hours so that the mass of U/B's could "shatter and scatter" the enemy's defenses (2236/17 February). This test of the effectiveness of the 37 mm. did not take place as the group operation failed completely and offered no opportunity for attack. In recapitulating the failure, Comsubs betrayed some misgivings about his new weapon when he said:

> "A continuation of the operation by day was not possible, since, with only a few U/B's in the vicinity of the convoy, the battle with the A/C defenses could not be taken up; especially since there were carrier-borne A/C with the convoy. This attempt will be made as soon as more U/B's are with a convoy and we can rely better on the 37 mm." (0207/20 February).

In actual fact, the reports of mechanical trouble with the 37 mm. gun far outweighed reports of successes in the first months of 1944, but the equipping of U/B's, including those operating in the Arctic area, continued. The continuing confidence of the U/B Command was further expressed in an Arctic Order (0420/17 May) which stated:

> "With the equipment of U/B's with the 37 mm. a first-rate weapon is given to the boats. It will pierce any armor of carrier or land based A/C or flying boats, and often makes it possible for U/B's to remain on the surface and to advance. In all situations, take advantage of the power of this weapon."

Yet, in contrast to this expression of enthusiasm, Comsubs was impelled to warn Atlantic U/B's in message 2201/10 June not to become overconfident in their A/A and search receivers and thus jeopardize the safety of the ship.

The A/A armament of U/B's continued to be the subject of many reports throughout the remainder of the war. After the Allied invasion of France, there was the usual preoccupation with difficult supply for U/B's based in France. Most of the other messages dealt with mechanical difficulties, with a few indicating definitely that the 37 mm. was still an object of experiment. In this connection, Raabe (U-246) was told in November (0911/7) that experiences with the new 37 mm. gun were very important, and messages similar in content were sent as late as January 1945.

CHAPTER V

GERMAN-JAPANESE EXCHANGE OF INFORMATION

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GERMAN-JAPANESE EXCHANGE OF INFORMATION

1.
Summary

Traffic of the Japanese Naval Attache in Berlin was of especial value to NI because it gave full details on technical matters under investigation by the German Navy, and also gave an insight into the future broad policy of the Naval High Command. A very large amount of information was furnished on all sorts of technical matters, including U/B's, aircraft, weapons, radar, radar defense, and the extent of Axis knowledge of Allied weapons, devices and procedures. Of particular value to the Atlantic Section was the data on the new type XXI, XXIII, and XXVI U/B's, with which the Germans hoped to regain their former power on the high seas. With the early knowledge of the main feature of the new types, their higher underwater speed, and subsequent fuller details, it was possible to appreciate the proportions of the anticipated new German measures. Of no less importance was the ability of NI to follow closely the progress in construction of the new type boats.

2.
The special Significance of Berlin-Tokyo Traffic.

Traffic between the Japanese Naval Attache in Berlin

and his superiors supplied certain unique contributions to the general picture which were not available in the administrative and operational traffic of the German Navy. Whereas the technical material sent in U/B traffic was being passed to people who already had a knowledge of the subject discussed through possession of handbooks and other aids, hence presumed a prior knowledge of most details, the Japanese were in much the same position as their enemies in that they had no such extensive prior knowledge. Therefore, when a new device or measure was reported to Tokyo by the JNA, full details had to be given and were thus made available to the Allies through decryption. The information to be gained from JNA and diplomatic traffic was also valuable because, in addition to its full discussion of technical matters, it provided an insight into the line of major policy adopted by the German Navy after the U/B was driven from the North Atlantic in the spring of 1943. The type XXI U/B, which was to be the mainspring of that policy, will be discussed at some length in following paragraphs. The selection of new type U/B's as a prime example of the value of JNA traffic should not, however, lead to disregard of the importance of other information furnished. Of direct Naval interest were details of midget, transport and mine-laying U/B's; new torpedoes, including the turbine torpedo still under development

at the time of the German surrender; and location and anti-location devices. Of a more general interest were the details of radar and radar defense; jet-propelled and other aircraft; V-weapons and many other types of enemy weapons; and the extent of enemy knowledge of Allied weapons, devices and procedures.

3.
Allied interest in the effort toward Total Underwater Warfare.

It was apparent to the Allies as well as to the Germans that, after the utter defeat to which the U-boat had been subjected in the spring of 1943, the German Navy would be forced to turn to the skill of its technical departments even more urgently than before. The situation demanded quick, effective and revolutionary measures, and it was a matter of supreme importance for the Allies to find out what those measures were to be in order to plan counter-measures before any large measure of success could be achieved by the enemy. The introduction of the Zaunkoenig and the Schnorchel has already been discussed in other chapters. They were part of the general plan to restore to the U-boat its old power. It was known, however, that other plans were also in the making. On 6 March 1944 the Japanese Naval Attache reported to Tokyo:

> "Although German submarines were amazingly effective at first the enemy now has invented new defensive weapons and in addition devised great counter-measures which have brought about a continued decrease in the damage inflicted by submarines. Consequently the

German Navy has determined to improve the submarine and we believe they are making plans for the future, but judging from what we know now, we do not expect any great activity from new type submarines before autumn."

The direction of German thought, as was to be expected in view of past developments, and as was indicated by the introduction of Schnorchel, was toward severing the tie which bound the U-boat to the surface and made discovery by radar possible. Schnorchel was a step in that direction, but only a step, and it was feared by the Allies that exhaustive research might lead to a U-boat which would not need to go to the surface or even near the surface during the entire period of a cruise. It was thus a great relief to be able to learn from reports of the JNA that while new type U-boats were indeed to be introduced, their chief advantage over older types provided with Schnorchel would be in their increased underwater speed.

4.
First details of the new type U-boats.

On 28 December 1943 (in a message not read until June of 1944), the Japanese Naval Attache in Berlin sent to Tokyo a description of two new types of U-boat, details of which had not yet been officially released to him by the German Navy. The information represented the report of Naval Inspector Tomonaga, who had been permitted to view plans and charts at the shipyard

and to catch a glimpse of part of one of the vessels. The Attache himself had first viewed the plans the preceding August at the Deschimag Shipyard, and his observations, added to those of the Inspector, provided specifications and other information sufficient to indicate the trend in U-boat construction for the remainder of the war. As was later confirmed by official information, it appeared that the chief feature of the new U-boats would be their increased underwater speed, which would be made possible by large-capacity batteries. Two new types were described, the large type XXI, designed for long-range operations; and a small type designed for coastal operations. The small U-boat was referred to as type XVII B but later evidence pointed to the conclusion that the U-boat under construction was actually the type XXIII, concerning which a large amount of information was later gained from Attache traffic. As to the state of construction of the new boats, the Attache considered that large numbers were already in the construction stage, would be completed from about May 1944 on, and should begin combat activity in about August or September. (#479 of 28/12 1943).

5.
Speeds

Since the increased underwater speed of the new type U-boats was to be their chief advantage over older types, a dispatch in which pertinent figures were given, JMA #316 of 13/8/1944,

was of more than passing interest. The speeds and ranges quoted were as follows:

Type XXI (6 battery compartments)		Type XXIII	
at 3 knots	450 miles	at 2 knots	250 miles
6 "	285 "	4 "	175 "
8 "	165 "	6 "	113 "
11 "	110 "	8 "	70 "
14 "	45 "	10 "	43 "
Top	24 "	Top	22 "

According to JNA #420 of 12/9/1944, the tested top speed for type XXI was about 16 knots, and it was hoped that this could be increased to 17 or 18 knots. Also of significance was the type XXI's lowest submerged speed on electric motors, 0.5 - 1 knot, at which the motor was said to be noiseless as the result of reduction by rubber belts. For type XXIII the tested top speed was 12.5 - 13 knots. It can be seen from the above table that use of the higher underwater speeds would be severely limited by the short ranges at which such speed could be maintained before exhaustion of the batteries.

6.
Delay in completion of the new type U-boats.

The Japanese anxiety over the condition of German striking power led to continual inquiries as to when the new type U-boats would be ready for combat. The serious construction difficulties due to Allied bombings and other factors were reflected in repeated

postponements in estimates of that date. By the reading of Japanese messages it was possible for RI to keep informed of construction developments. On 26 July 1944, Ambassador Oshima reported concerning the type XXI boat:

> "At present it is in process of construction and its effect will first be felt from about September; and by November or December it is said that greater results will be effected by its use in great quantity." (#756).

Again, on 12 August (#621), Doenitz was quoted as saying that the new offensive U-boat warfare would begin "at one swoop" after a considerable number of the new U-boats had been completed, therefore in the winter of 1944-45. But on 3 December (#753) the Naval Attache wrote with regard to combat use of new type U-boats:

> "Although the German submarine fleet and the ministry of military supplies are making feverish preparations, there will probably be no results until about March of next year."

Even in March 1945, the best that could be reported concerning type XXI boats was that they would be ready on a large scale in May or June (#301 of 7/3). Actually, only four of the type XXIII's made war cruises, while the only type XXI to leave port for an operational cruise was U-2511 (Schnee) which was outbound on the day of surrender.

CHAPTER VI

FUEL

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1. Summary
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3. The use of Fuel in Operation.
4. Fuel Reports as an Aid to RI.

FUEL

1.
Summary

Fuel reports sent by U/B's at sea were of significance in the planning both of U/B operations by Comsubs and of A/S operations by the Allies. The amount of fuel which a U/B had on hand was usually appended to any other report which it made. The mass of data on fuel resulting from such frequent reports provided an ample basis for various assumptions with regard to U/B operations. Moreover, the same information provided a basis for identification of the type of a given U/B and for determination of fuel capacities and consumptions, day's runs, and prescribed speeds. There were occasions when knowledge gained from fuel reports aided in the decipherment of disguised grid positions.

2.
Availability of Information on Fuel.

Fuel reports sent by U/B's at sea had a double significance. For Comsubs in his conduct of the U/B war they were essential in disposition of the U/B's and in the planning of operations. For the Allies, the reading of fuel reports was of equal importance in the conduct of the A/S war. The vital nature of these reports is evidenced by the fact that U/B's were generally required to append

a statement of the amount of fuel on hand to every transmission which was otherwise necessary, i.e. position, movement, contact, and success reports, as well as specific requests for provisioning. The number of such reports received by the U/B Command varied, of course according to the number of U/B's at sea and the extent of their activity. For example, in March, 1943, when U/B anti-convoy operations reached their peak, 179 U/B's were at sea, and Command received a total of 325 fuel reports, an average of 10.5 per day. The maximum number on any one day was 33, the minimum 2.

3.

The use of Fuel in Operation.

One of the cardinal principles in U/B operation was the economical use of fuel in the patrol line and during any cruising which was not directly operational; but once contact was made with a convoy, U/B's operated with a total disregard for fuel, only reserving an amount absolutely necessary for their own safety. When U/B's had sufficient fuel and were not engaged in a convoy operation, they normally sent routine fuel reports along with position reports. When the supply decreased to the amount required for the homeward cruise, they might request provisioning if the prospects of success in the attack area seemed promising, or simply advise Comsubs that they were returning. A convoy sighting, however, nullified all immediate plans, and the contacting

U/B shadowed to the limit of its fuel or until other U/B's could be brought to the scene. Whenever possible, the movements of U/B tankers were coordinated with those of the attacking force to lessen the chance of losing the convoy. In some few cases in which no U/B tanker was available, an outgoing U/B refueled those at sea, or U/B's engaged in an attack themselves transferred fuel in order to permit continued operation or return.

4.

Fuel Reports as an Aid to RI

The abundance of information regarding the fuel status of U/B's was also of inestimable value to RI activity. In February 1944 Comsubs confirmed estimates of fuel consumption which had previously been made here on the basis of the daily fuel reports, revealing that for type VII-C boats in anti-convoy groups Command counted on a maximum daily consumption of up to 2 cbm. if no operation was going on; for type IX-C, up to 3 cbm. under the same conditions. From the amounts reported, the Atlantic Section was able to identify or confirm the types of new U/B's as they reported from sea. The daily reports also permitted an evaluation of cruising speeds in terms of a day's run and the identification of these speeds with those ordered by Comsubs--maximum, economical, cruising, etc. With a knowledge of the type of U/B operating in a given area and an approximate idea of its fuel capacity, it was

possible to estimate the extent of its future operations and to plot a rough course. Furthermore, it was possible to reduce enciphered positions to a specific area with the aid of knowledge of the fuel capacities and consumptions of the U/B's concerned.

CHAPTER VII.

U-BOAT NAVIGATION.

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4. Navigation for "Total Underwater Warfare".

U-BOAT NAVIGATION

1.
Summary.

The most important new development in navigation during the war was the use of German air force Elektra-sonnen for U/B navigation. The use of beamed signals from these transmitters enabled U/B's to fix their position by employing only an ordinary radio receiver. A great deal of attention was given by Comsubs to amassing information on the adequacy of navigation by this means. The results of experiments were not directly available to RI because they were included in the written communications reports of the U/B's, but there were several instances in which successful navigation by Elektra-sonne was claimed. It was found that this method was available to U/B's making long submerged cruises, as Elektra-sonne signals could be received over the Schnorchel round dipole.

An experimental program to determine the possibilities of D/F'ing VL/F transmitters for navigational purposes was also carried out, but no significant results were recorded in radio traffic.

The concept of "Total Underwater Warfare" brought about increased emphasis on all methods of navigation which could be substituted for the taking of astronomical fixes. Navigation in

coastal waters was a matter of particular concern because of costly accidents to U/B's due to faulty navigation. Accurate dead reckoning, terrestrial navigation, and utilization of lines of soundings were recommended for their reliability; but the exercise of appropriate caution was urged as the basic principle in coastal navigation.

2.

G.A.F. Elektra-sonnen.

The most important development of the U/B war in the field of navigation was the utilization of German Air Force Elektra-sonnen. The experimental observation of Elektra-sonnen as an aid to U/B navigation was begun by boats in the Bay of Biscay in April 1943 and later extended to other more distant areas of the Atlantic. The Elektra-sonnen in use by U/B's at various times were located in Norway, Holland, France, Spain and the Danzig area. Ranges of the beacons varied, the longest range cited in traffic being that of Sonne 6, up to 1300 miles. The advantage of navigation by Elektra-sonnen lay in the fact that in addition to the opportunity for D/F'ing offered by an ordinary radio beacon, their transmission of beamed signals, turning gradually past definite sectors, made possible the fixing of a definite direction line by use of an ordinary radio receiver. Accurate bearings could be obtained by a process of

counting or timing dots and dashes of the beamed signals and plotting the result on charts especially prepared for Elektra-sonne navigation. Full details of this procedure were given in an operating manual found aboard the captured U-505 in June 1944.

As was usual with newly introduced procedures and equipment, the U/B Command experienced considerable difficulty in assembling necessary information from practical experience because of inadequate reports from U/B's. There was no evidence in 1943 that any satisfactory amount of information had been reported, and as time went on the demand for greater use of Elektra-sonne grew more insistent. On 22 March 1944 encouragement was offered in a message from Comsubs in which he stated:

> "Recent experiences have shown that after repeated practice in navigating by Elektra-sonne very good results were obtained. Work with it as often as possible, particularly in the North Atlantic." (1653/22).

A few days later the U/B's were told:

> "Navigation by Elektra-sonne has not been tested fully enough in the past. U/B's have used the sonnen almost exclusively just for taking bearings and thus have yielded insufficient results. The advantage of the sonnen is that positions may be ascertained without D/F set." (1850/31/3/44).

The long submerged periods which resulted from increasingly extensive use of Schnorchel late in 1944 accentuated the importance of any aid to underwater navigation, and use of Elektra-sonnen

for this purpose was advised in experience message 181 (1917/6/11/44) in the following terms:

> "The commanding officers still devote too little attention to navigation by Elektra-sonne. Good navigation is possible even when submerged. There have been many favorable experiences. For practice you should navigate by Elektra-sonne all the time, even if there is another fix available. There is thus a means of comparison. The commanding officer will have to justify failure to use Elektra-sonnen."

Submerged U/B's were able to hear Elektra-sonne signals over the Schnorchel round dipole, while transmissions could be heard over the D/F loop if it was out of the water.

The extent to which navigation by Elektra-sonne had been developed by the closing months of the war was indicated by a message stating:

> "One U/B returning from mid-Atlantic had a correction from estimated position of only 2 nautical miles on entering port after a 4 weeks' passage without taking position by star sights. Navigation by Elektra-sonnen only. In addition a running fix outside the port of destination was taken from Sonne 8." (1819/31/1/45).

3.

D/F'ing of VL/F Shore Transmitters.

On 21 January 1944 (1520/21 ff.) an experimental program to determine the possibilities of long-range D/F'ing of VL/F transmitters for navigational purposes was announced. Bearings were to be taken as frequently as possible on specified transmitters on both sides of the Atlantic with a view to determining

the maximum range for sufficiently accurate bearings and the possibility of taking cross-bearings on American and European transmitters in the middle of the Atlantic. Comparison was to be made with dead reckoning or astronomical fixes, and full details, with evaluation exclusively by the U/B commander, to be included in the boat's communication report. Because of the fact that all data were to be handed in after returning to port, it was impossible to determine by BI what the results of the experiments were. The only indication was a statement in a situation report on the Minch area that approximate bearings had been obtained on the Rugby VL/F transmitter. (1927/27/12/44).

4.
Navigation for "Total Underwater Warfare".

The attempt at "Total Underwater Warfare", which was foremost in the plans of the U/B Command at the end of 1944, brought with it considerable concern over improvement of navigation during long submerged periods. One group of a series of "General Rules for Total Underwater War" directed U/B's to

> "Avoid surfacing for astronomical fix as far as possible. Keep scrupulously exact dead reckoning, allowing for current. Use of sounding apparatus, Elektra-sonnen and radio beacons makes a thoroughly

> exact determination of position possible, according to available experiences. Make use of every possibility for determining positions by landmarks when near our own and enemy coasts." (2040/16/11/44).

The "available experiences" presumably included some which had been mentioned earlier in the same month. Speaking of accurate fixes which could be obtained from lines of soundings taken by repeated crossing of prominent depth demarcations in various directions, Comsubs had reported:

> "Foerster (U-480), coming from the Atlantic after an 18-day cruise without fix, made an exact determination of position by this procedure and without any further navigational aid reached the escort pick-up point. Von Friedeburg (U-155) made his way in from Iceland passage guided by the Elektra-sonne equisignal zone beam, then reached the escort pick-up point without difficulty by means of soundings." (2239/2/11/44).

A new aid to sounding in the form of sonic telegraphy was also recommended on the basis of experiences of Schimmelpfennig (U-1004), who measured depths of over 1000 meters by sending out sounds by S/T and timing the interval before the return of the echo. (2005/3/11/44). That there was need for particular attention to the problems of navigation in coastal waters was evidenced by two messages of 24 December 1944, which placed great emphasis on caution in such waters. One of the messages called attention to collisions between U/B's and other German vessels resulting from lack of navigational practice. (1908/24/12/44).

The other summed up the desired navigational policy as follows:

> "Since astronomical reckonings are not to be carried out in enemy coastal regions, the greatest value and extreme care must be put on very plentiful terrestrial navigation, painstaking dead reckoning with consideration of current according to current atlas, and utilization of soundings (line of soundings). As a basic principle, if position cannot be obtained beyond doubt, always assume that the U/B is in as unfavorable a position as possible, and act with appropriate caution in waters dangerous for navigation."
> (1156/1445/24/12/44).

CHAPTER VIII

U-BOAT COMMUNICATIONS AND USN C.I.
(Intercept; H/F D/F)

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U-BOAT COMMUNICATIONS AND USN C.I.
(Intercept; H/F D/F)

1.
Summary

Communication between U/B's and their bases was carried out by H/F radio, with repetition on VL/F to insure reception. Either the "Broadcast" or "I" method was used by control to deliver traffic to U/B's. The large number of circuits, designed to serve all areas in which U/B's were operating, consisted of regular U/B circuits, convoy circuits, and special circuits. In addition to this system for communication between control and its boats, medium frequencies were used for cooperation of U/B's with each other, with surface vessels, and with aircraft, mainly for homing purposes.

The chief concern of the German communications service was to maintain contact between Command and the U/B's without offering too good an opportunity for D/F'ing and traffic interception by the Allies. Proper regard for radio discipline was in evidence in traffic at all times, but became more pronounced as unfavorable conditions for the U/B, particularly at R/V's and in group operations, became more acute; and the summer and fall of 1943 brought the campaign of Comsubs against D/F to a new height. During that period, restriction and supervision of the use of radio became stricter than ever. Restrictions were placed on the use of certain receiving sets, and Comsubs demanded employment of off-frequencies of the Norddeich service even more insistently

than before. Also the off-frequency procedure already in effect was completely revised with a view to increasing both efficiency of operation and difficulty of interception. This stage of development of the off-frequency procedure offered little difficulty to the Allied D/F organization, but a later refinement introduced in January 1945 was quite effective in combatting interception.

The summer of 1944 brought the most important development in German communications in the form of "Kurier" experiments.. "Kurier" was a system of high-speed automatic "flash" transmissions involving the use of special sending and receiving equipment. During several periods of experimentation, no "Kurier" signal was ever D/F'd, and if the system could have been brought into operational use, the Allied D/F organization would have been rendered helpless until counter-equipment could have been devised.

American efforts to intercept German Naval circuits were made as early as 1935, and by the time the United States entered the war almost 100 percent coverage was obtainable. H/F D/F'ing of U/B transmissions was begun in January 1941 by shore stations and was extended to shipboard stations the next year. The D/F organization was much improved during the course of the war through liaison with the British, an increase in the number of stations, and better operating technique. The "tip-off" system was used to advantage for alerting all D/F stations simultaneously. Op-20-G cooperated fully in the establishment of shipboard H/F D/F stations, in training personnel to man them, and

in keeping the forces afloat abreast of all the latest trends in U/B communication procedure. TINA and RFP were used extensively in conjunction with H/F D/F for the identification of transmitters.

2.
Operating Procedure.

German U/B's maintained contact with and received orders from their home bases by high frequency radio communications, but to insure that U/B's received all traffic, an elaborate VL/F repetition service was in operation over which practically all U/B traffic was repeated.

The control stations on the U/B circuits delivered traffic to U/B's by either the "Broadcast" or "I" method. The same H/F circuits were used for both shore-ship and ship-shore traffic. The control stations observed fixed silent periods on all circuits for the reception of U/B transmissions. In addition to these fixed silent periods, the shore stations normally observed a five-second pause at the end of each fortieth group in long transmissions in order to permit U/B's with traffic of higher precedence to break in. Thus a U/B could transmit during silent periods, during the five-second pauses, or at any time when control signified that the circuit was clear by use of $\overline{VA}$. Neither external address nor call sign was used by U/B's. Control acknowledged a U/B transmission by repeating the message and inserting a serial number in the heading.

3.

U/B Circuits.

Communications were carried out on a large number of frequencies which were divided into circuits and selected so as to be suitable for any sea area in which the U/B's were operating. Several of these circuits were known as "Convoy circuits," and were used by U/B's while making group attacks on convoys. The following is a list of the circuits used. It is to be noted that the name of the circuit in most cases indicates the general area in which the circuit was used.

(a) Regular U/B Circuits:

Coastal
Ireland
America 1, A & B
America 2, C & D
America 3, E & F
Africa 1, A & B
Africa 2, C & D
Africa 3, E & F
Arctic
Mediterranean
Aegean
Penang

(b) Convoy Circuits:

Diana
Hubertus
Wotan

(c) Other Circuits used by U/B's:

Bruno 3 (Norddeich)
Anton (Kootwijk)

All of the circuits in list (a) were used at one time or another during the war. Certain circuits were dropped or put into effect depending upon the dispostion of the U/B's at sea.

The Coastal circuit was normally used by boats operating in the Channel and Biscay areas. Ireland was used for the eastern North Atlantic. The America and Africa circuits consisted of three separate circuits each in which two channels or frequencies were generally keyed simultaneously. Each of these two could be disconnected and operated as a separate circuit if necessary. America 1 was generally used in the same area as Ireland circuit. America 2 served the western Atlantic north of a line from about the Azores to Key West. America 3 served the Middle Atlantic, Caribbean and South American coastal areas. The Africa circuits, of which never more than two were employed at one time, served the southern East Atlantic and the Indian Ocean.

All of the above circuits were controlled from Lorient, Paris, Bernau (Berlin), or Wilhelmshaven, depending on the progress of the war.

The Arctic circuit, which was controlled from Northern Norway, served U/B's operating off Northern Norway and on the Murmansk routes. The Mediterranean circuit, controlled from Toulon, served U/B's in the Western Mediterranean, while the Aegean circuit, controlled from Salamis, served the Eastern Mediterranean. Penang acted as control for the circuit of that name and served the Indian Ocean area, supplementing the Africa service.

Of the three convoy circuits in list (b), either Diana or Hubertus was always in effect; at times both were employed simultaneously. Wotan was in force only once and for only a

short period during the latter part of the war. The purpose of these special circuits was to separate communications with U/B operating groups from the traffic with other U/B's in the area which were not members of the group. Normally U/B's guarded the area circuits until contact with a convoy was contemplated or made, then shifted to guard the designated convoy circuit. When operations were broken off, the U/B's returned to the area circuit.

In the event that communications with home stations were broken off because of ionospheric disturbances or for other reasons, provisions were made for U/B's operating as a group to maintain contact with each other by means of what was known as a "Group Circuit." The procedure was for all boats concerned to shift to a predetermined frequency, appoint one boat as control, and continue operations until conditions permitted a return to the assigned circuit.

Other circuits available for use of U/B's were Bruno 3, designated Series Norddeich by the Allies, and Anton, otherwise known as Series Kootwijk. Bruno 3 consisted of four frequencies keyed simultaneously. The frequencies were chosen from the various wave bands to permit world-wide coverage both day and night. While this circuit was used mostly by U/B's, it could also be used by surface craft. In fact, it was on one of the Bruno 3 frequencies that the ill-fated "BISMARCK" transmitted her last message. Far East surface blockade-runners were known to guard this circuit while outside of Japanese-controlled territory. Off-frequency

operation was also carried out by U/B's in connection with this series.

Circuit Anton normally consisted of four frequencies keyed together and was intended for the use of boats in the Eastern North Atlantic and Northern Norway. This circuit was available to both U/B's and surface craft. A system providing for off-frequency operation in connection with Anton was in effect but apparently seldom, if ever, used.

4.
Use of Medium Frequencies.

Medium frequencies were used by U/B's for homing purposes and sometimes for general communication in home waters. Three types of homing on M/F were noted: homing for convoy attack, sometimes in cooperation with A/C; homing for rendezvous; and homing to port. In homing for convoy attack, the U/B which first made contact on a convoy was ordered by control to send beacon signals to lead other U/B's to the convoy. Homing for rendezvous, usually for the purpose of supplying provisions and fuel, was accomplished by having the supply boat transmit beacon signals on M/F. Such signals were ordinarily sent only during bad weather when precise navigation was not possible. In homing to port, the beacon signal was sent by the escort vessel or by regular shore beacon transmitters.

5.
Use of VL/F.

High-powered very low frequency transmitters were used

extensively by the Germans to augment the regular U/B transmissions on H/F. All traffic carried on the regular U/B series was repeated on VL/F to enable reception while submerged or when ionospheric conditions prevented reception on H/F. Practically every known high-powered VL/F transmitter in occupied Europe was employed for this purpose at one time or another. What was estimated to be one of the most powerful VL/F transmitters in the world, called "Goliath" by the Germans, appeared on the air late in 1943. This transmitter, having a power believed to be nearly 1000 kilowatts, was capable of being shifted in frequency and had a range from 15 to 25 kcs. One U/B reported a signal strength of 5 from the Caribbean while submerged at 60 feet.

6.
Norddeich Off-frequency Operation
(Standing War Orders 217 and 218).

A method of transmitting by U/B's to defeat the Allied H/F D/F organization was brought into operation in October 1943. This system was used in conjunction with the Norddeich (DAN) transmitters. Briefly the system was as follows: Norddeich sent on four frequencies in four different wave bands simultaneously. Each wave band had ten different "off-frequencies" above and below the basic frequency available for use. Norddeich selected one off-frequency for each wave band in use and informed the U/B of the chosen frequencies by inserting several indicating letters in the call sign idling strip. The U/B desiring to use this

system listened to determine the valid frequencies and then transmitted on the off-frequency in the wave band best heard. The above system, which offered little hindrance to H/F D/F operations, was continued until January 1945. At that time a more complicated system was inaugurated and continued in use until a few days before the end of the war. The latter system provided for using any one of 336 kcs above or below each basic frequency. Further, the system of indicating valid off-frequencies was changed to compose three four-letter groups which were encoded on a special table. Otherwise it was essentially the same as the former system. This new system proved difficult for the H/F D/F organization because a very exact frequency calibration was required to detect each transmission. Only mediocre success was experienced in D/F'ing such transmissions.

A set of four "check" transmitters were operated in conjunction with the Norddeich series for assisting U/B's to select the proper wave band in which to transmit. The transmitters were of the same power as the regular U/B transmitters. Therefore a U/B, after listening to all four, could select the wave band best heard, and could transmit with a good chance of being heard in Germany.

7.
"Kurier."

A system of high-speed automatic "flash" transmission known by the covername "Kurier" was first introduced on an experimental basis in August 1944. This equipment consisted of a separate unit

designed to be attached to a radio transmitter. The unit could be set up by a series of levers to reproduce dots, dashes, and spaces, and was capable of sending about ten letters of encoded text at a speed of approximately 600 words per minute. Nothing is known of the receiving equipment, but presumably an automatic recorder of high sensitivity was required. Obviously this system was designed as a counter-measure against D/F. Further security was obtained in the use of frequencies, in that deviation from a given basic frequency of as much as 200 kcs plus or minus was provided for. In no case were Kurier transmissions ever D/F'd, and it is significant that if this sytem had been brought into effective operational use, the Allied D/F organization would have been rendered helpless until counter-equipment could have been devised.

8.
U.S. Intercept Operations.

First efforts to intercept German Naval circuits were made by Op-20-G early in 1938 from the East Coast of the United States. The results obtained were very poor, mainly because German operations at that time were confined to the Baltic and North Sea areas, with resulting poor signal strength. In October 1938, an intercept team consisting of four men was established in the flagship of Squadron 40-T, then operating in European waters. Results were excellent and this team remained in operation until the squadron returned to the U.S. in September 1940. At the

outbreak of World War II, all German U/B circuits were known and were being intercepted by Op-20-G. Interception was undertaken on a full scale by shore intercept stations on the U.S. East Coast thereafter. This work was done at Cheltenham, Md., until January 1943 and was then transferred to Chatham, Mass., where a major intercept station was placed in operation. Practically 100 percent intercept coverage was obtained until all but the final weeks of the war. Information relating to German communications procedure obtained by radio intelligence methods was compiled and published by Op-20-G in a document known as R.I.P.42 early in 1941. The information contained in this publication was greatly enlarged upon when subsequent liaison with the British was effected.

9.
H/F D/F Operations Ashore.

First attempts to take bearings on U/B transmissions were begun in January 1941. At this time there were only seven H/F D/F stations in operation in the Atlantic area and bearings were taken independently. However, through liaison with the British, added D/F stations, and improved operating technique, the D/F organization was fairly efficient by the time of U.S. entry into the war. Improvements were rapid thereafter, and at the war's end, fixes were being made with bearings furnished by more than forty U.S., British, and Canadian stations. Three U.S. nets, the East Coast, Caribbean, and South American, were in operation, each with plotting facilities to serve the Sea

Frontier Commands as required. Centralized and interlocked control by both land-line and radio was maintained, making it possible to alert or "tip-off" all D/F stations. The use of the "tip-off" system was gradually expanded to a point at which, in addition to our own stations, it was utilized by all Canadian stations, outlying British stations, and all U.S. vessels engaged in convoy escort or ASW operations. The "tip-off" frequencies were controlled by San Juan, sending simultaneously on four frequencies which were selected to cover the entire Atlantic. "Tip-offs" from U.S. East Coast stations on land-lines were relayed by radio to San Juan by Jupiter. The "Tip-off" system helped greatly in increasing the efficiency of the H/F D/F nets and proved particularly helpful to H/F D/F equipped ships at sea.

10.
H/F D/F Operations Afloat.

Every possible assistance was rendered by Op-20-G in furthering the shipboard H/F D/F program as an additional ASW weapon. Two technicians from Op-20-G were sent to England in 1942 to gather information relating to the operation and maintenance of this equipment. These two men assisted in establishing an H/F D/F school for the training of shipboard operators in December 1943. The school was subsequently administered by BuPers. Constant liaison with the school and forces afloat was maintained by Op-20-G personnel to insure that all concerned were in possession of the latest trends in U/B communication procedure. Such liaison

was in the nature of exchange visits by RI and D/F officers both ashore and afloat, letters, and dispatches. It is considered that this assistance was of great value to the forces afloat. A special publication dealing with German U/B communication procedure, designed primarily for Atlantic Fleet vessels engaged in convoy escort and anti-submarine warfare, was published on 1 July 1943. This publication, CSP 1774 Series, was particularly valuable to H/F D/F equipped vessels in detecting U/B transmissions at sea.

11.
TINA and REP.

Both TINA and REP were extensively utilized in conjunction with H/F D/F in attempting to identify individual U/B's. TINA, the purpose of which was to identify a radio operator by his sending characteristics, consisted of making a tape recording of each U/B transmission and taking mathematical measurements of each dot, dash, and space. REP was a method of transmitter identification in which high-speed photographs were taken of a transmission, making possible an analysis of the transmitter's power supply.

12.
Chronological Account of the
German Struggle against D/F
and Radio Interception.

An early illustration of precautions against D/F during refueling operations occurred in December 1942, when several U/B's were to be refueled by Schnoor (U-460). Comsubs warned the

boats against too frequent use of radio when approaching the provisioning point and directed that no beacon signals should be requested until several hours had passed without finding the provisioner (2158/3/12/42). In an earlier message of the same day (1056/3/12/42), the boats were ordered to report their fuel stocks after provisioning, but only after having moved 30 miles away from the provisioning point. Other traffic of the same month indicated that Atlantic U/B's were making use of the Norddeich off-frequency procedure in transmitting short signals, with acknowledgment by control on the basic frequencies.

On 4 January 1943, a new Standing War Order was issued containing an outline of points to be considered before sending any radio message (0516/4/1/43). The purpose of the order was to eliminate the transmission of unnecessary reports and to provide for transmission of necessary ones in the shortest possible form. This was merely the first step in a campaign aimed at the tightening of radio discipline, for during the first months of 1943 there were constant reminders on the subject, with emphasis on the necessity for radio silence and the danger of tuning transmitters with radiation. Repeated and emphatic instructions underlined the danger which could result from the use of radio during R/V operations and whenever groups of U/B's were in the same area, and there were many explicit reprimands for infractions. On 5 May an emphatic reiteration of the ban on tuning with radiation addressed to Arctic U/B's required that main and spare transmitter aerials be plugged in only when the situation might require quick use of

the transmitter; and that All-wave, Broadcast, and "Radione" receivers be used by boats in patrol lines only for reception of tactically important reports, owing to the danger of D/F. The increased difficulty for U/B's at refuling R/V's was reflected in Comsubs' message 2306/5 of June 1943, in which he directed Group THUTZ and Bartke (U-488) to carry out provisioning operations under radio silence and without any beacon signals unless the R/V had not taken place after searching for two days. Comparison of this order with the December 1942 order to boats refueling from Schnoor, cited above, illustrates the trend toward extreme caution which had developed in the intervening period.

A more direct indication of German appreciation of the effectiveness of the allied radio intelligence organization and a further intensification of efforts to escape D/F and radio interception became apparent from traffic of 10 August 1943. On that date Comsubs' Current Order 38 summed up the situation as follows:

> "By employing long-range reconnaissance A/C and A/C carriers the enemy is today able to operate A/C on offensive patrol on the basis of D/F bearings not only near the coast but also in all areas of the Northern and Central Atlantic. The danger of bearings being taken on U/B's when using their radio has thereby become more serious. The inaccuracy of the bearings of between 50 and 60 miles is compensated for by radar location by the aircraft."

Because of this situation U/B's were ordered to take advantage of discovery by the enemy occasioned by sightings and attacks to send their reports; to be especially careful in the use of radio when its use was necessary; after using the radio

to remain submerged for several hours when there was danger of being taken by surprise; to supervise radio operation and to tune without radiation; and to use alternative frequencies of the Norddeich service (0827 and 0845/10/8/43). A long series of messages under catchword "Konrad," starting the same date (1418/10/8/43 ff.), was devoted to a complete revision of the off-frequency procedure already in effect, to go into force on 1 September (later postponed to 1 October). Under the new procedure, deviations from the basic frequencies could be changed frequently by the control station and would never be known in advance of the hour of transmission even by the transmitting U/B. Several messages of September and October urged increased use of the alternative frequencies when giving passage reports in order to make it more difficult for the enemy to take bearings and establish the number of inward and outward bound boats.

From the middle of August to the end of November 1943, there was a renewal of preoccupation with the possibility that the Allied D/F service was profiting by receiver radiations. A message of 19/8 ordered that certain types of receivers were not to be used until investigation of that possibility had been completed, and directed that VL/F transmissions were to be received with the D/F receiver only, while the all-wave receiver was to be restricted to essential services (1922/19/8/43). On 24/10, however, Hartmann (U-441) reported a suspicion that bearings could be taken on the D/F receiver because he had been flown at shortly after

switching it on (2237/24/10/43); consequently on 5/11 a new order directed outward and inward bound boats east of 18° W, as well as boats outbound from Germany as far as Naval Square AE (Iceland Area), to receive VL/F only when submerged. H/F reception on the surface was permissible only if a boat was equipped with a "Main" receiver (2049/5/11/43). The ban on some of the other receivers was lifted on 8/12, however, presumably after satisfactory results in radiation tests (1837/8/12/43).

The emphasis on radio discipline and restriction of transmissions continued in 1944, with few significant developments in the first seven months of the year. An attempt was made to speed up the transmission of short signals and short weather reports in January, and provisional Standing War Order 254, providing for visual signals between cooperating A/C and U/B's as a means of avoiding D/F, was issued on the 30th of that month. In the spring, weather reports became so important to the German High Command that the possibility of D/F fixes had to be accepted in order to get the weather information through (1416/4/5/44). However, boats were ordered to proceed submerged for several hours and to change position constantly after sending their reports.

The summer of 1944 brought a new and potentially important development in German communications in the form of experiments with "Kurier" procedure. The experiments started on 4 August and continued, with some interruptions for correction of faulty equipment, until 28 August, when the tests were cancelled temporarily

because transmitting installations were still not reliable enough. During this period there had been a few successful transmissions, but a large number failed to be received or could not be deciphered owing to failure to attain the required fine adjustment of the transmitting installation. Another period of trial started in November 1944, was discontinued in December, and resumed in January 1945. During December tests were made in transmission of "Kurier" signals over the Schnorchel round dipole. There was no indication of the results actually obtained, but Comsubs held little hope of success because the radiation obtained through use of the Schnorchel round dipole was insufficient. At 2325 on 27 January the first operational "Kurier" signal was sent by Schumann (U-245), operating under the cover-name "Brutus", but on 2 February the use of "Kurier" procedure was discontinued and never resumed, probably because of the evacuation of Bernau, where the receiving installation was located.

One final development of importance during the last months of the war was the introduction on 25 January 1945 of a new and complicated cipher for determining valid Norddeich off-frequencies, directions for which had been given in a long series of messages between 20 and 26 November 1944. The new system was effective to a considerable extent in evading D/F, but was never used as extensively as the former "KONRAD" system, probably because of the many failures to get through to Control which were occasioned by the lack of necessary accurate tuning to proper frequencies.

APPENDIX to CHAPTER 8.

ACCURACY STUDIES OF H/F D/F FIXES.

The overall study of the accuracy of H/F D/F fixes contained in this report covers the period from April 1943 through April 1945. The following graphs and tables are included:

Table A shows the accuracy of fixes by months for all transmissions for which U-boat positions were available. The distances of the fixes from the U-boat positions are broken down into sub-divisions of (a) within 25 miles, (b) 26-50 miles, (c) 51-75 miles, and (d) 76-100 miles. The number of cases in each of these categories is expressed as a percentage of the total number of cases for the month. The figure at the top of each column gives the total number of cases for the month upon which the percentages were obtained. Inspection of this graph shows a gradual improvement in the accuracy of the fixes from April 1943 through August 1944, with the high point being reached during June, July and August of 1944. The record from August 1944 on shows considerable variation which may possibly be ascribed to the falling off in the total number of transmissions for this period. The average accuracy for this latter period (September 1944 to April 1945) is, however, on the average as good as the period from February through May 1944. In February 1944 the system was inaugurated of having the GT-A Watch Officer consult with the GI-A Watch Officer before making a final fix. During the 15 months in which this procedure was followed, suggestions for changes were

made in 21% of the fixes. Of these changes, 80% resulted in an improvement of the fix. The high accuracy observed during June, July and August 1944 may very well be ascribed to the fact that it was during this period that the invasion of France occurred, and it is believed that the rise in accuracy for the fixes is due to the large majority of U-boat transmissions being concentrated in a very small area in the vicinity of the Bay of Biscay and the English Channel.

Tables B and C give a breakdown of Table A for enigmas and short signals respectively. The accuracy of fixes on enigma transmissions is, as might be expected, slightly higher than those on short signals.

Table D shows the average and median number of miles between D/F fixes and U-boat positions. The overall average for the entire period studied is 109.4 miles for the average and 82 miles for the median. The blue line indicating the median number of miles is taken to be more significant since it tends to eliminate errors of a very high magnitude which would influence the average out of due proportion.

Table E shows the percentage of unit transmissions giving U-boat positions upon which it was possible to obtain D/F fixes. The average percentage for the entire period studied is 76.

Tables F, G and H show the various percentages of accuracy of evaluations by the D/F Watch Officer for all transmissions.

enigmas, and S/S's respectively. The significant points to be observed on these graphs are (a) that the percentage of fixes correctly evaluated (i.e. a grade of "A" was given those fixes within 25 miles of the U/B position, "B" 26-50, "V" 51-75, "L" 76-100, "U1" 101-150, and "U2" over 151 miles) is relatively low, approximately 25%, and (b) that the number of cases correctly graded or better averages approximately 85%. From this it would appear that it is exceedingly difficult for the D/F Watch Officer to give a correct evaluation within narrow limits but in general tend to be conservative in evaluations.

Table I compares the total number of D/F cases with the total number of those transmissions containing U-boat positions and those containing U-boat positions with fixes.

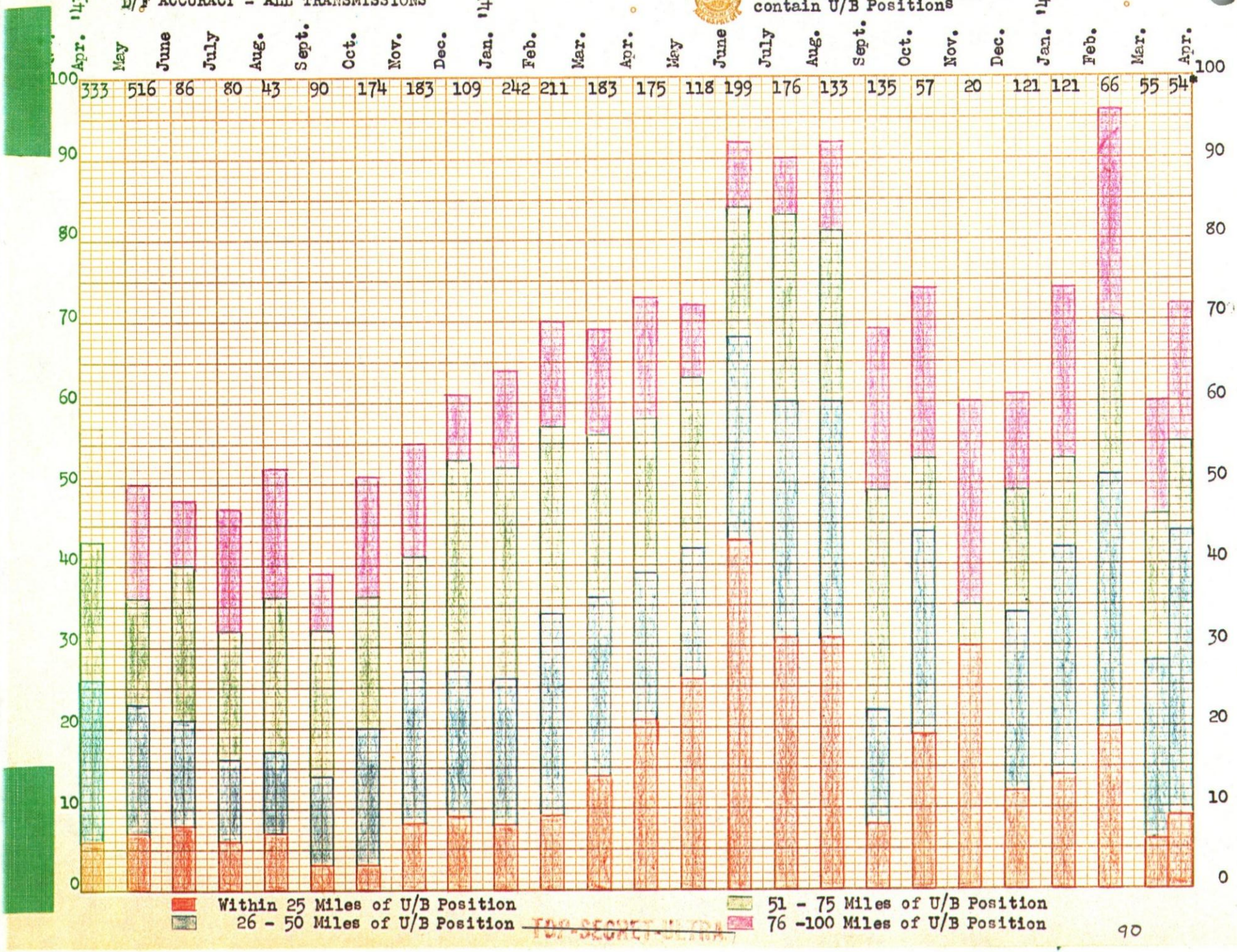
Errors in fixes may arise from a complexity of causes: Errors in bearings themselves which may be due to defects or limitations of equipment, or ionosphere conditions. Bearing errors may also be a function of time of day, frequency of transmission, distance and true bearing of the fix, geographical location of the D/F station, direction of the transmission path with respect to the earth's magnetic field, condition of "storminess" of the ionosphere, etc. Other errors may arise from garbles in transmission of bearing reports, inaccuracies in tracking charts, or inaccurate plotting of bearings on these charts. In addition to these factors there is the personal interpretation of the D/F Watch Officer

along with any mechanical or semi-mechanical procedures he may use in his attempt to establish a fix.

In view of the numerous complex causes which may affect the accuracy of fixes, this report makes no attempt to isolate the various factors. It does, however, present an objective study of the effectiveness of the end result of all the factors which go into the making of a D/F fix.

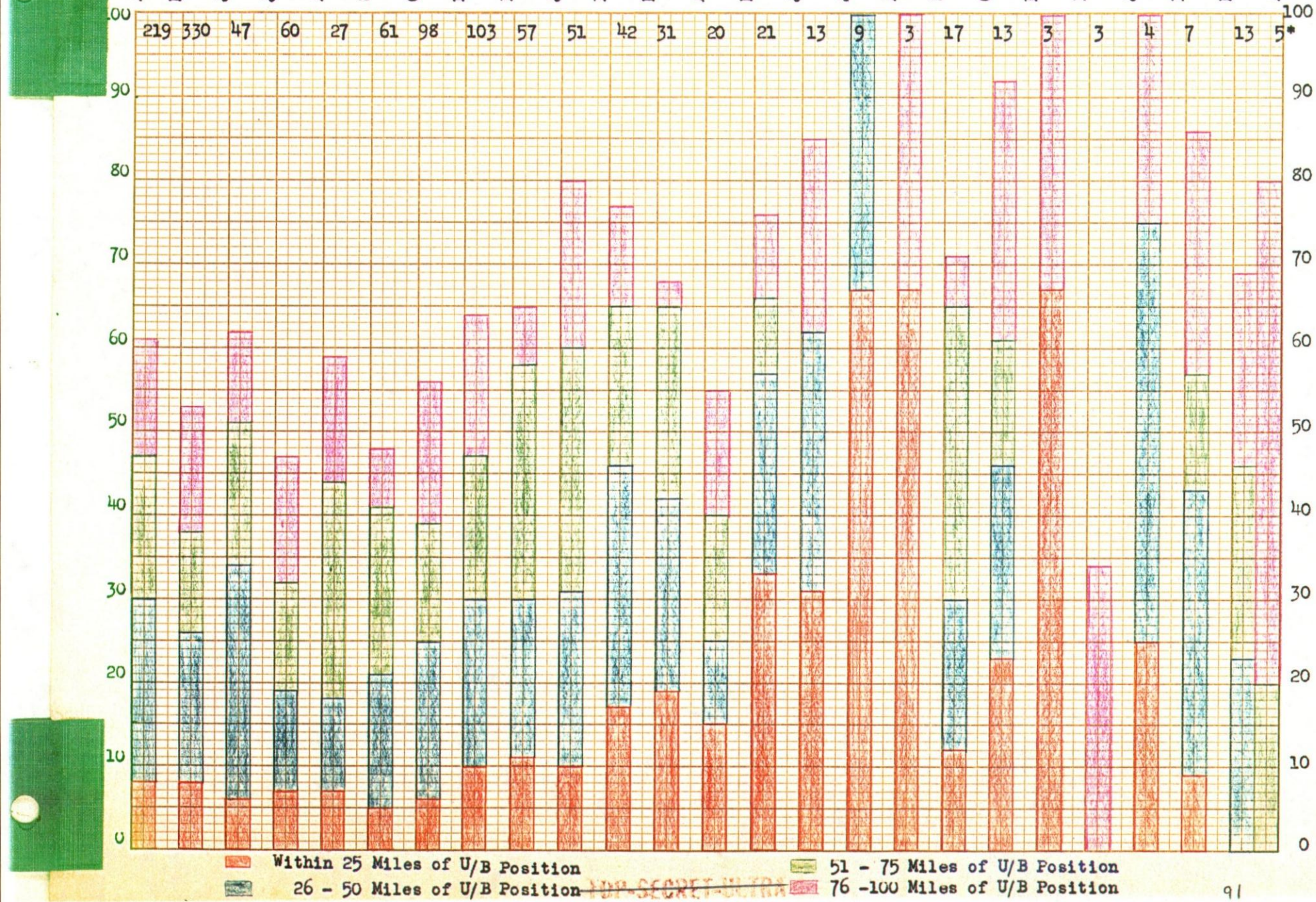
D/F ACCURACY - ALL TRANSMISSIONS

*Transmissions each month which contain U/B Positions



D/F ACCURACY - ENIGMAS

*Enigmas each month which contain U/B Positions



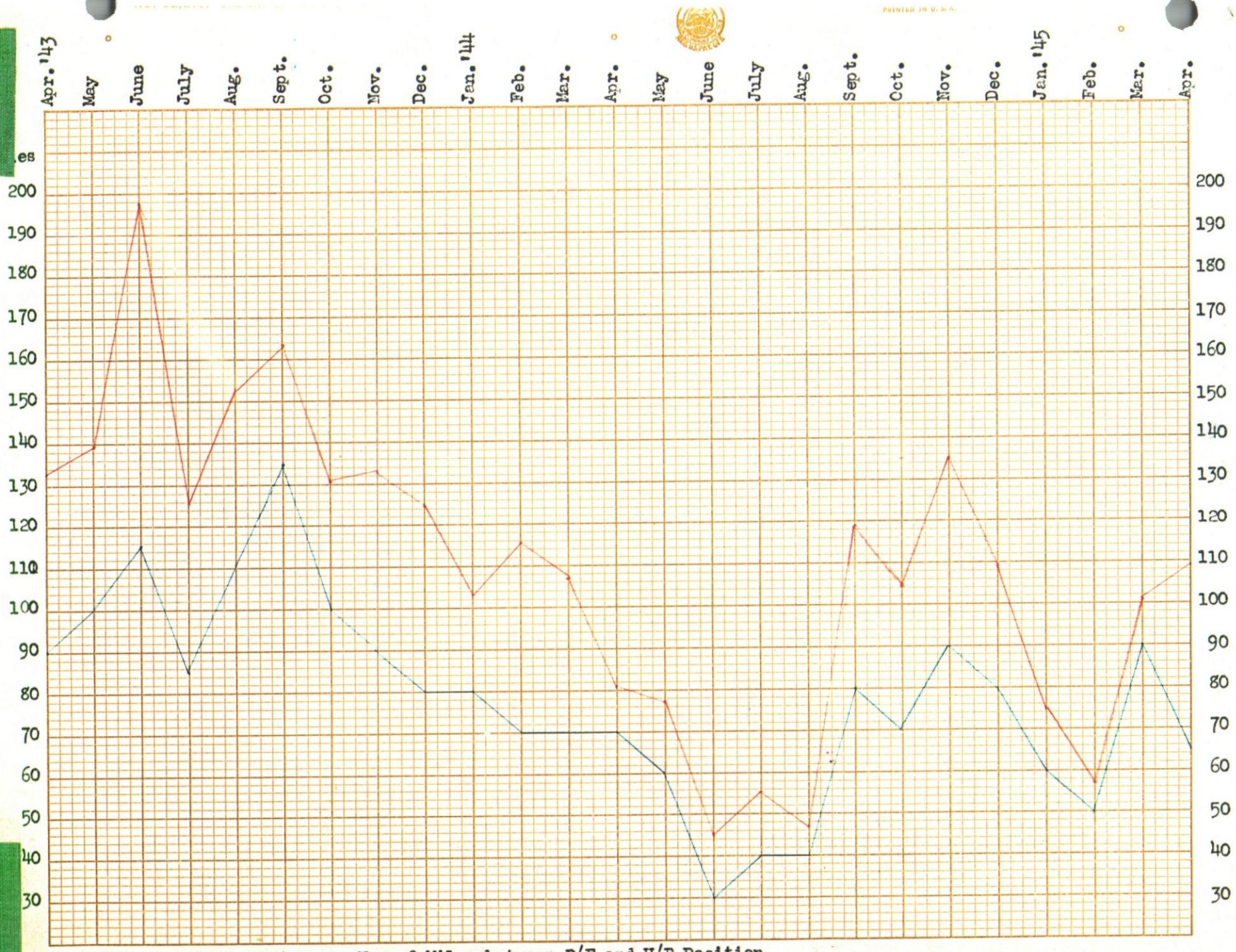
NO. 32,216. ONE DAY BY HOURS (DIVIDED INTO QUARTERS) X 100 DIVISIONS.
CODEX BOOK COMPANY, INC., NORWOOD, MASSACHUSETTS.
PRINTED IN U. S. A.

D/F ACCURACY - SHORT SIGNALS

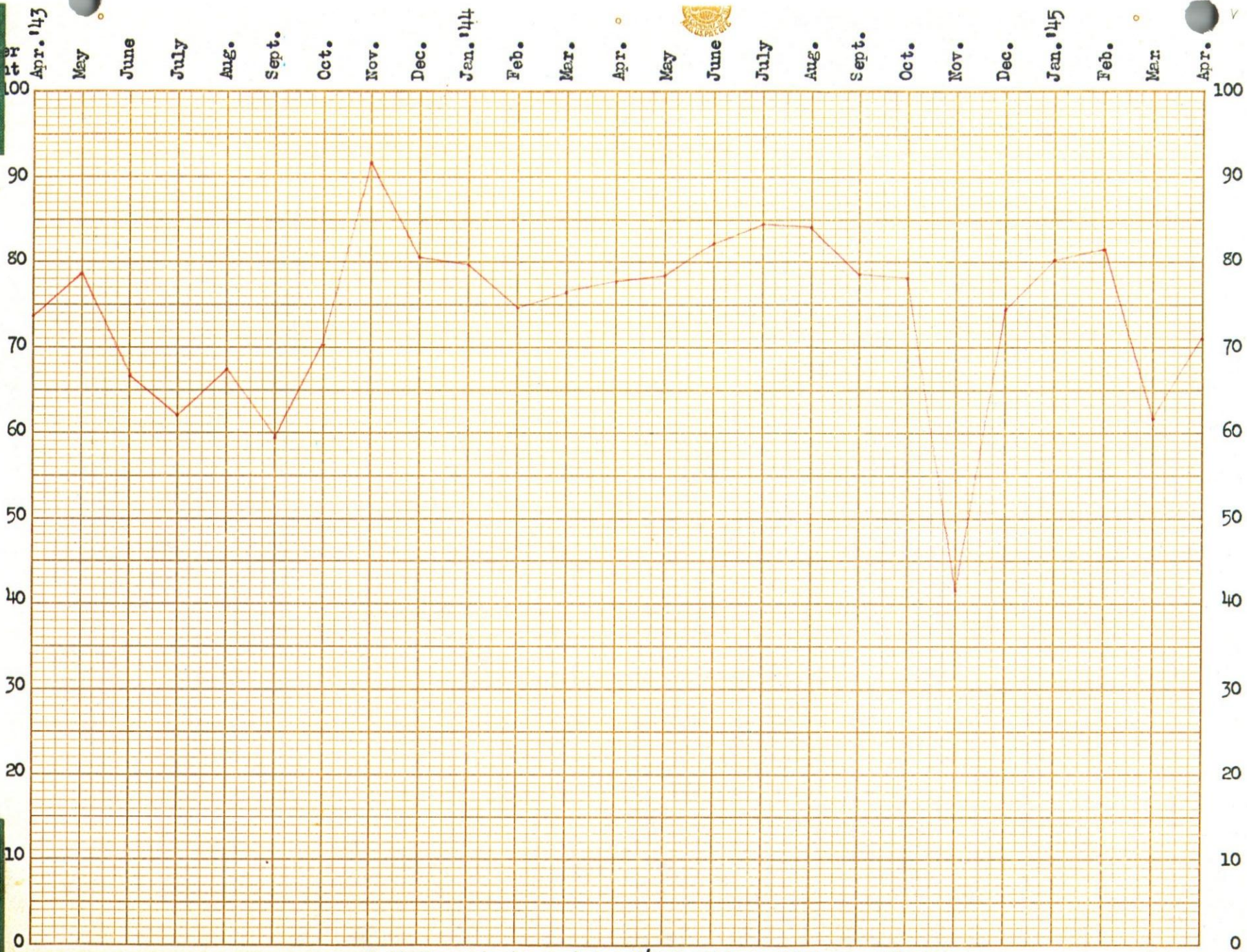
*S/S's each month which contain U/B Positions

Apr. '43	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan. '44	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan. '45	Feb.	Mar.	Apr.
114	186	39	20	16	29	76	80	52	191	169	152	155	97	186	167	130	118	44	17	118	117	59	42	49*

Within 25 Miles of U/B Position
26 - 50 Miles of U/B Position
51 - 75 Miles of U/B Position
76 -100 Miles of U/B Position

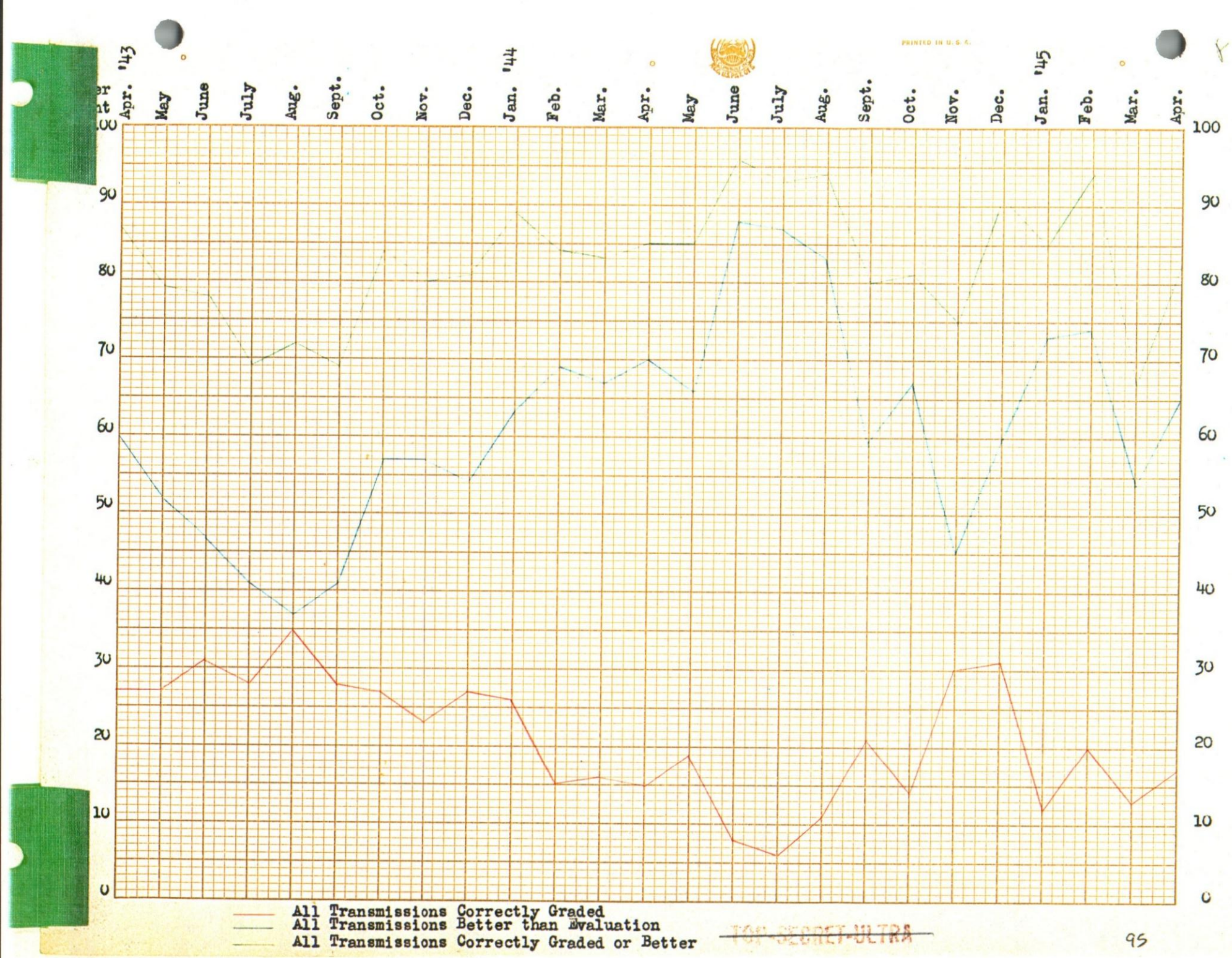


TOP SECRET-ULTRA

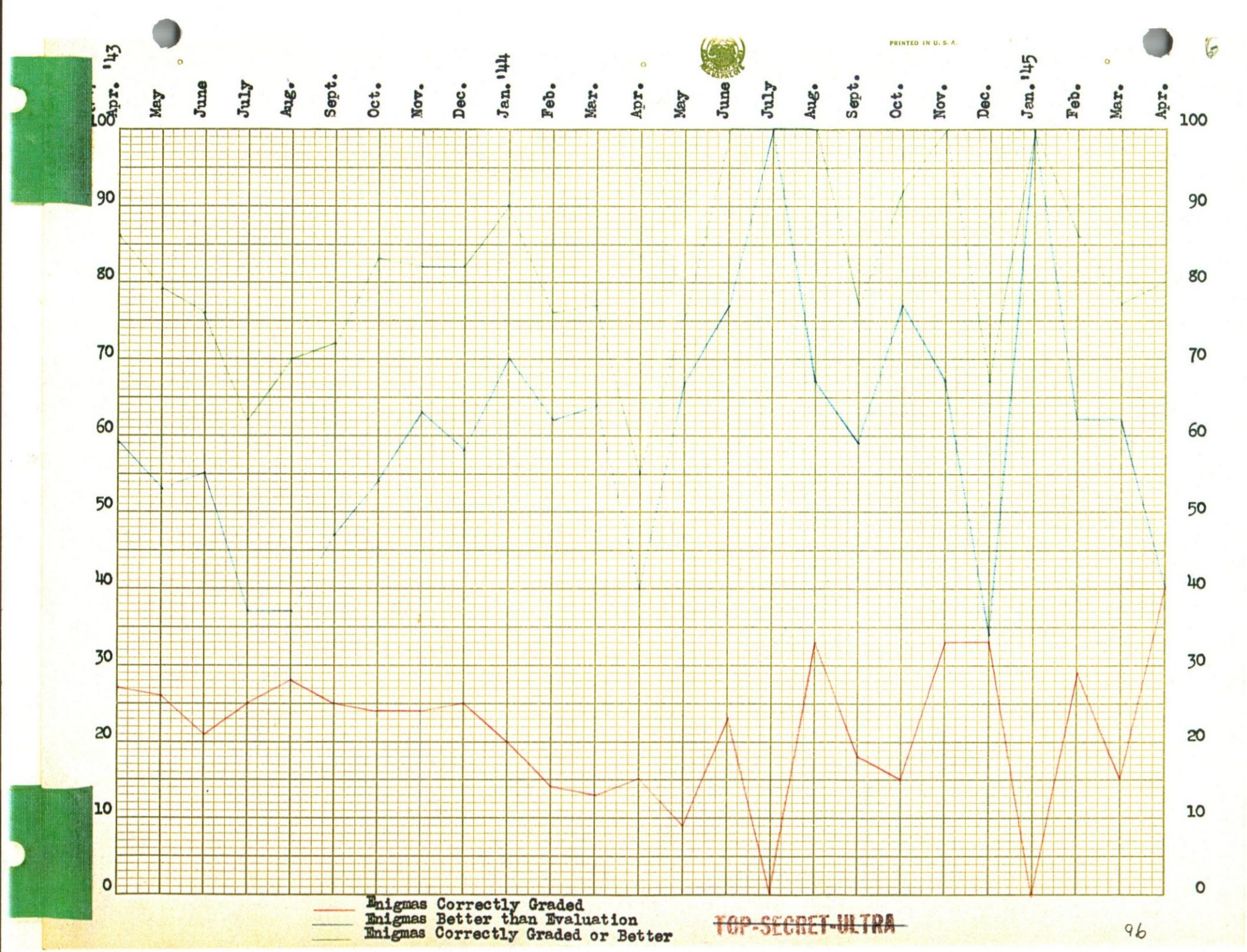


Unit Transmissions giving U/B Positions which were Fixed

~~TOP SECRET ULTRA~~



~~TOP SECRET-ULTRA~~



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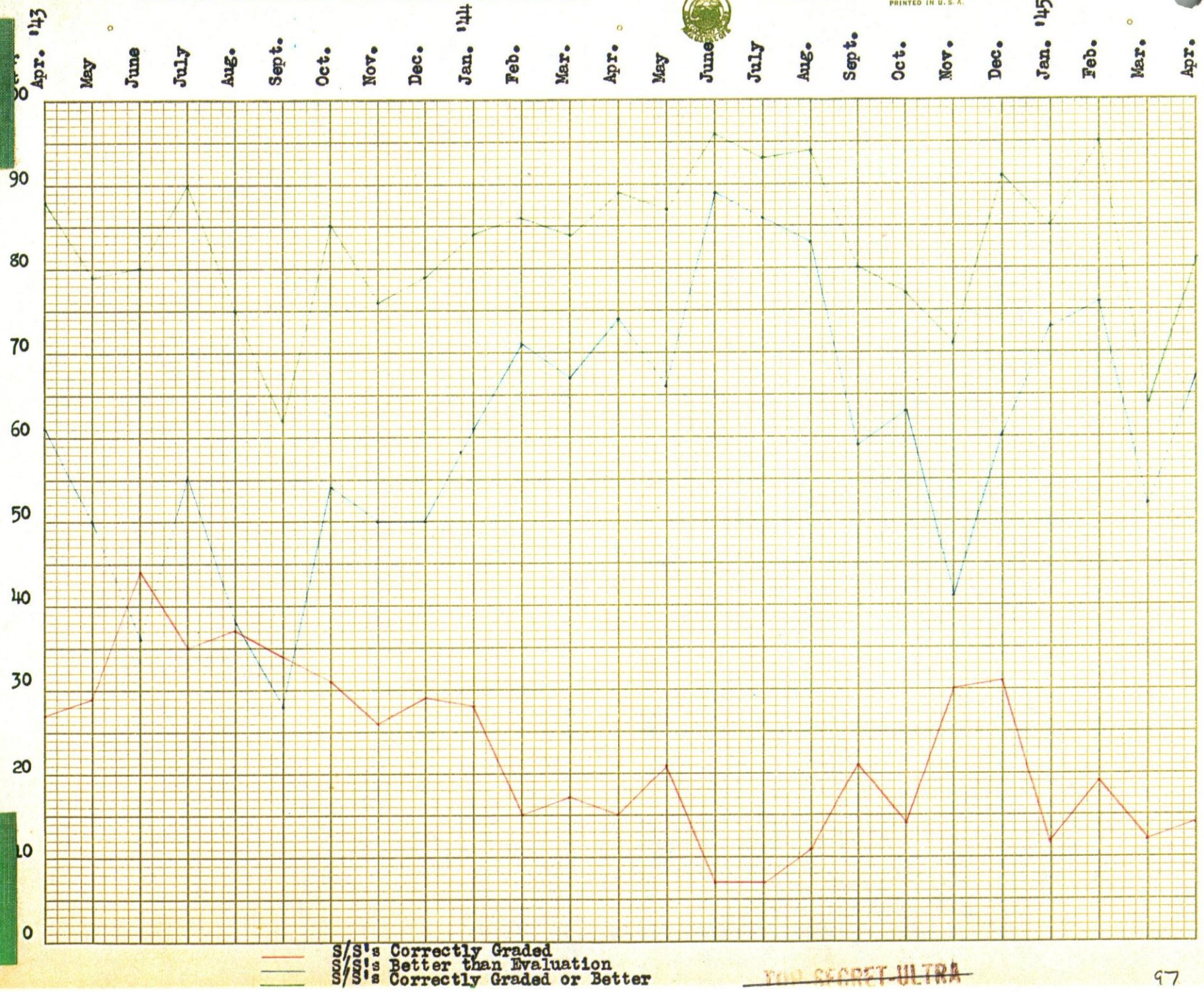

Month	Total No. D/F Cases	Total No. Transmissions Containing U/B Positions	Total No. Transmissions containing U/B Positions with Fixes
April 1943	1311	452	333
May	1383	657	516
June	490	129	86
July	465	129	80
August	220	64	43
September	381	152	90
October	590	248	174
November	612	199	183
December	419	135	109
January 1944	644	303	242
February	606	282	211
March	637	240	183
April	536	225	175
May	470	151	118
June	551	242	199
July	388	208	176
August	381	158	133
September	411	172	135
October	307	73	57
November	264	48	20
December	480	162	121
January 1945	475	151	121
February	382	81	66
March	582	89	55
April	644	76	54
	13,629	4,816	3,680

APPENDIX TO VOLUME IV

GERMAN WEATHER REPORTING ACTIVITIES

1.
Weather Reporting U-Boats
January 1944 to May 1945.

Since Europe's weather may be forecast through knowledge of weather as it moves eastward across the Atlantic, Germany has, since the beginning of the war, shown a logically keen interest in the weather conditions in the North Atlantic. This data has been gained by them from two sources: U/B's on station patrol in a small area of the North Atlantic, and meteorological stations set up in Greenland, Spitzbergen, and Franz Josef Land. Op-20-G kept COMINCH informed of all activity.

Weather reports from U/B's prior to 31 December 1943 occurred in two circumstances: appended to enigma transmissions and in short weather cipher upon order. But beginning 31 December 1943 and continuing until the end of the war, weather reporting U/B's have been stationed in assigned areas of the North Atlantic, and the coverage has been complete except for a very few days. The North Atlantic was divided into three parts: North, Central, and South. For the most part, three U/B's reported in the short-weather cipher twice daily between 0000B-0200B and 1000B-1200B. No difficulties were encountered at first except for occasional interruption of radio communication from ionospheric storms, at which time the boats would transmit on a series other than their assigned circuit. In the early summer of 1944, however, an increasing fear of being D/F'd forced the Germans to change their methods of reporting.

Fixed schedules for sending reports were abolished. Boats were ordered to "transmit irregularly in order to make it difficult for enemy D/F service to gain knowledge of the return course," and no one was to "try to get through more than three times in succession." (1616/30/8) The DAN off-frequencies became popular with the weather boats in their attempt to escape detection.

Upon failure to receive these reports, Control issued emphatic messages on the importance of regular receipt of weather data. In May, the boats were told that: "Reports are of utmost importance for the entire conduct of the war - judgment as to air situation, invasion, etc." (1416/4). After the Allied landings in France in June, weather reports were demanded with even more urgency. Additional measures were taken to insure the reception of these reports. All outbound U/B's were ordered to send short signal weather reports as passage reports, and, due to delay or absence of assigned boats, others destined for operational areas in American waters reported weather conditions while cruising through the weather-reporting area.

In December 1944, weather reporting once more assumed special importance. On 2 December, the boats were told that "weather reports are of the greatest importance for war on land and in the air" (1934/2/11); "Importance and seriousness of task demands that all means be used to get messages through." (1822/3/12). The task contemplated was the German breakthrough in Belgium on 16 December, which owed much of its initial success to the skillful use of weather cover.

> "Your recent weather reports contributed decisively to determining the beginning of our great offensive in the

west on 16/12." (1930/12/12).

In August, and from November 1944 to February 1945, experiments were conducted in the Skaggerak with a new high-speed transmitting procedure, "Kurier," which could not be D/F'd. Presumably this new method was designed with weather transmission difficulties in mind, as references to a "Kurierkurzwettertafel" (Kurier short weather table) appeared in traffic. However, other types of short signals are known to have been transmitted on "Kurier" during the trials.

Fifty-three U/B's were assigned as weather reports, and five were sunk during or prior to their performance of these duties. Hossenfelder (U-342) was sunk by Iceland-based RAF A/C on 17 April 1944, near 60 N - 30 W. HMS VINDEX was sent after Wendt (U-1276) with instructions that included Wendt's area and routine times of transmitting. Wendt was sunk 6 May 1944 in 52.30 N - 28.27 W. Task Group 22.8, having been informed of the area in which a weather boat was operating, sank Loos (U-248) on 16 January 1945 in 47.43 N - 26.37 W. Findeisen (U-877) was sunk by HMCS THOMAS on 27 December 1944, in 46.25 N - 36.36 W. Clausen (U-1226) was sunk between 23 and 31 October 1944 in the vicinity of 59.33 N - 20.24 W, before reaching his weather reporting area.

2.
German Meteorological Activity in the Arctic, 1942 - 1945.

a) Greenland Meteorological Stations.

The fact that Europe's weather originates in Greenland

caused a desperate, continuous effort on the part of the Germans to establish and maintain a meteorological station on the east coast of that island from August 1942 to October 1944:

"Holzauge" - August 1942 to June 1943
"Bassgeiger" - September 1943 to June 1944
"Edelweiss I" - September 1944 (captured before landing)
"Edelweiss II" - October 1944 (captured 3 days after landing).

Great precaution was practised during the setting up of weather stations. Each Greenland expedition set sail from Norway in the early fall with a U/B escort as far as the ice boundary, in order to reach a location "as far north as possible," and become frozen in soon afterward, thereby preventing, or at least delaying, discovery by patrol vessels, planes, or sledge patrols. Once established, a station was considered safe for the winter, although its location could be detected through bearings on transmissions or through intercepted messages concerning the station on German Naval Kootwijk Circuit. The importance attached to maintaining stations in Greenland was evidenced by the decision to send the "Goldschmied" expedition, originally destined for Franz Josef Land, to Greenland as "Edelweiss II," one month after the capture of "Edelweiss I" by the USCGC NORTHLAND. For details of each expecition, see chart following section (c). A large amount of the information was made available by P/W's and captured documents.

b) Jan Mayen H/F D/F Station.

In September 1943, the US Army decided to discontinue its aerial reconnaissance of Northeast Greenland due to "its doubtful value and winter storms." At that time there were indications that

the Germans had established another weather station on the east coast of Greenland ("Bassgeiger") despite the destruction of the previous station in May - June 1943. As a high frequency radio direction finder station was the best means of detecting enemy activity in the Arctic, such a station was set up on Jan Mayen Island (71.01 N - 08.25.30 W) by agreement with the Norwegians; it was commissioned 27 November 1943 and operated by the US Coast Guard. During the following month and a half, the equipment was checked and tested by taking bearings on known stations in the Arctic area. In October 1943, GCCS had advised by dispatch of the call signs used by the Greenland station and its ship and also of the frequencies on which the German Arctic Met Circuit transmitted. This information enabled the station to operate immediately after the equipment was put into working order and saved time which might otherwise have been wasted searching for the stations.

On 18 January 1944, Jan Mayen picked up, for the first time, transmissions from "Bassgeiger," "COBURG," and Control at Tromsoe, Norway, and took bearings on them, thus determining the location of the Greenland station and its expeditionary ship. Upon receipt of this data, air reconnaissance was planned and sledge patrols were informed of the station's existence. After several attempts were made to reach the station by land, a 7-man sledge patrol finally attacked it 22 April 1944. Although the attack itself was not successful, it led to the eventual evacuation of the station in June 1944.

No German weather station operated on Greenland after

"Bassgeiger" as both "Edelweiss" expeditions were captured before the stations were completed, but Jan Mayen kept track of "Haudegen's" transmissions from Spitzbergen.

Although traffic passed on the "Love" circuit (the circuit used by all Arctic weather stations) was intercepted by the Jan Mayen H/F D/F station, decryption was dependent upon repetition of the messages on the Kootwijk Circuit (Circuit "C") in enigma because of the expeditions' use of one-time pads. In addition, Op-20-G was dependent upon the British for complete coverage of Circuit C due to the inability of American stations to pick up all transmissions on Kootwijk frequencies. In the case of "Bassgeiger," from November 1943 until March 1944 Admiralty advised by dispatch of all developments regarding the station and its ship as they were reported to headquarters in Norway on Circuit C. Information which was not signaled was forwarded in British ZIP's.

c) Other Arctic Meteorological Stations.

While attempts were being made by the Germans to establish meteorological stations on Greenland, other stations were reporting meteorological conditions on Spitzbergen and Franz Josef Land.

Spitzbergen:	"Nussbaum"	- 1942-43 (captured by British)
	"Kreuzritter"	- 1943-44 (men returned because of illness)
	"Haudegen"	- 1944-45
Franz Josef Land:	"Schatzgraeber"	- 1943-44.

From captured documents, it was revealed that at the time of the sailing of the "Edelweiss I" expedition for Greenland in August 1944, plans were also underway to send "Haudegen" and "Goldschmied" expeditions to Spitzbergen and Franz Josef Land, respectively. However, with the capture of "Edelweiss I" the "Goldschmied" party became "Edelweiss II" thereby apparently eliminating the possibility of any meteorological operations on Franz Josef Land in the near future. This impression was confirmed when Buechler (U-387) was ordered on 10 October to proceed to Alexandraland, the southwestern portion of Franz Josef Land, to take off the two weather transmitters which had been left there for the use of future expeditions.

"Haudegen" transmissions were not heard by Jan Mayen until the end of November 1944, and bearings indicated that the station was located on northwest Spitzbergen rather than on North East Land, the northeastern island of the group, as previously planned. Presumably the change in the location of the station came as a result of the failure of both "Edelweiss" expeditions to Greenland, since advance weather information from the western Arctic was much more valuable than that from the eastern Arctic. This station continued to operate until the end of the war.

GCCS was immediately informed by dispatch of Jan Mayen's findings.

Shore Station	Location	Expeditionary Vessel	Sailing and Landing Dates	Attacks on Station	Date Destroyed	Remarks
"Holzauge" 18 men	Sabine Is. 74.6 N - 19.0 W.	KMS "HERMANN" Purchased in Denmark. Fitted out in Kiel.	Sailed from Tromsoe 22 August 1942. Landed Greenland 26 August 1942	Discovered by 3 man of Danish Patrol 12 March 1943. Raided, bombed, and strafed from air 23 May 1943.	Station - June 1943. Ship - 23 May (bombed) 1943.	CO - Lt. Ritter, P/W 8 April 1943 Physician - Dr. Sensse, P/W July'43 16 men flown to Norway (6 in May 10 in June) Supplied by plane. Considered a success as 1500 radio weather msgs transmitted to Norway.
"Bassgeiger"	Shannon Is. 75.19 N - 17.50 W.	"COBURG" (Covername "Roderick")	Sailed from Tromsoe 28 August 1943. Landed Greenland (about) 2 Sept. 1943.	By 7-man Greenland Sledge Patrol - 22 April 1944.	Station - 3 June 1944. Ship - (about) (scuttled) 21 March 1944.	CO - killed in accident. Men returned to Norway by plane. Station supplied by plane.
"Edelweiss I" 25 men (12 men - station) (16 men - ship)	(Not set up)	"KEHDINGEN" Provisioned in Kiel.	Sailed from Tromsoe (about) 24 Aug. 1944.	After a 70-mile chase by the USCGC "NORTHLAND" through moderately open lead in heavy ice, the "KEHDINGEN" was scuttled off the southern end of Koldewey Is.	Ship (scuttled) 1 September 1944.	All captured. 6 men of the weather unit had been with "Holzauge." Left Tromsoe one month earlier than planned due to erroneous report of ice conditions by "Bassgeiger." Only one of these expeditions known to have carried Radiosonde equipment.
"Edelweiss II" 32 men (12 men - station) (20 men - ship)	Little Koldewey.	"EXTERNSTEINE" Constructed at Peter Schmidt Shipyard, Rotterdam.	Sailed from Tromsoe 26 September 1944. Landed Greenland 1 October 1944.	Attacked and captured by USCG Task Force, 4 October 1944.	Station - 4 Oct. 1944. Ship - 16 Oct. 1944. (captured 10 mi. off Cape Bergen.)	"EXTERNSTEINE" sailed to US in November 1944 by American crew. No transmissions from the shore station to Tromsoe before capture.