~~TOP SECRET CANOE~~ REF ID:A65650

~~SECURITY INFORMATION~~

Office Memorandum • UNITED STATES GOVERNMENT

TO : RADM WENGER (Vice Director, NSA)

DATE: Op-322Y/rdw
SSO/Y-137
1 APR 1953

FROM : CAPT ROEDER (Op-322Y)

SUBJECT: OEG Report #68; forwarding of

Encl: (1) Dir., OEG Report ser (LO)2271-52, undated
(2) OEG Report #68

1. Enclosures (1) and (2) are forwarded herewith for information and retention.

Respectfully,

B. F. Roeder

B. F. ROEDER

~~TOP SECRET CANOE~~
~~SECURITY INFORMATION~~
~~TOP SECRET~~ ~~CANOE~~

Page 1 of 1 Page
Copy 1 of 2 copies

~~TOP SECRET~~

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON 25, D.C.

~~SECURITY INFORMATION~~

~~TOP SECRET~~ (LO)2271-52

MEMORANDUM

From: Director, Operations Evaluation Group
To: Op-03D
Via: Op-322Y

Subj: Forwarding of Enclosure (1), Operations Evaluation Group Report 68, ~~TOP SECRET CANOE.~~

Encl: (1) OEG Report 68: Evaluation of the Role of Decryption Intelligence in the Operational Phase of the Battle of the Atlantic.

1. The attached report, prepared at the request of Op-03D and Op-322Y, should be viewed as an example of the kind of information which can be obtained by an extensive study of the data extracted from the decryptions by both the Germans and the Allies of radio communications pertaining to the operations of the German submarines against Allied shipping. This study has established a number of conclusions of wide general interest to all those concerned with the Radio War, and with the conduct of anti-submarine operations.

2. No effort is made here to recapitulate the findings of this study on the use of decryption intelligence to our own forces and to convoy safety, since these subjects are covered in the summary of the report, Part 5. These findings warrant careful reconsideration of the conclusions reached in other studies in which the efforts of decryption intelligence were not taken into account.

3. Distribution of the attached report to all properly cleared staff agencies concerned with anti-submarine warfare and submarine operations is recommended.

JACINTO STEINHARDT,

Director, Operations Evaluation Group.

PRNC-NSS-346

~~TOP SECRET~~

~~TOP SECRET CANOE~~

OPERATIONS EVALUATION GROUP

REPORT 68

EVALUATION OF THE ROLE OF DECRYPTION INTELLIGENCE IN THE OPERATIONAL PHASE OF THE BATTLE OF THE ATLANTIC

TABLE OF CONTENTS

BIBLIOGRAPHY

I. SOURCES

A) German

(a) X-B Berichte. Weekly reports of the German decryption service (X-B Dienst). Captured at end of war. Extend from 1939 through April 1944. Complete record of all German Naval intelligence. The decryptions deal almost entirely with convoy movements. (Secret).

(b) The War Diary of Befehlshaber der Unterseeboote (BdU), (Commander of Submarines). From 1939 through December 1944. (Confidential).

B) Allied

(c) Files by date of Decrypted Messages read by Op-20-3-GI(A). (Top Secret Ultra).

(d) Daily U-Boat Estimate. COMINCH daily charts with U-Boat and convoy positions plotted. (Secret).

II. REFERENCES

(e) Account of U/B War from December 1942 - May 1945. Compiled by Op-20-3-GI(A), dated 29 October 1945. (Top Secret Ultra).

A very comprehensive, thorough, extremely interesting account of the task accomplished by the group during World War II. It is in five volumes, as follows:

✓ Vol. I - Allied Communications Intelligence and the Battle of the Atlantic. A summary.

Vol. II - U-Boat Operations. This is in five parts, four dealing with successive periods in the Battle of the Atlantic, and the fifth with blockade runners and German Naval Operations in the Far East and Indian Ocean. The role of decryption intelligence is described throughout each period, chiefly by means of case histories of particular convoys. There is a very comprehensive collection of these case histories covering the US-UK, US-Gibraltar, and UK-Gibraltar convoys of certain periods.

Vol. III - German Naval Communication Intelligence and Compromise of Allied Ciphers.

This volume contains a very interesting account of the manner in which Op-20-3-GI(A) proved that the Allied messages were being read by the Germans.

Vol. IV - Technical Intelligence from Allied C. I.

Describes the contribution of Allied decryption intelligence concerning German U-Boat material and armament.

Vol. V - The German Naval Grid and Its Cipher. Very interesting description of techniques used in decoding the German grid cipher.

(f) G.C. and C.S. Naval History. ~~Top Secret Ultra.~~

This is a compendious account of the work of the British Naval Intelligence Office, in 24 volumes. A very excellent history of the U-Boat war is presented in Volume XVIII, "The Battle of the Atlantic."

(g) ORG Secret Memorandum No. 18: Frequency of attacks on Convoys in Relation to U-Boat Predictions, 18 November 1942.

(h) ORG Secret Memorandum No. 25: A Probability Study of COMINCH Daily Submarine Estimates, 27 February 1943.

(i) OEG Confidential Report No. 51: Antisubmarine Warfare in World War II, 1946.

(j) OEG Confidential Report No. 56: Search and Screening, 1946

(k) G.C. and C.S. Naval Sigint, Vol. VII. - The German Navy's Use of Special Intelligence and Reactions to Allied Use. ~~Top Secret Ultra.~~

Covers the subject in narrative form from 1938 to the end of the war. Contains some case histories of specific applications of German decryptions of Allied RI. In addition to the weekly X-B reports, the author had available the captured daily files of German decrypts.

~~SECURITY INFORMATION~~ PREFACE

This report contains the findings of research carried out with the general objective of determining in what manner and to what extent the availability of intelligence derived from the decryption of intercepted radio messages affected the conduct of the U-Boat war against North Atlantic convoys on the part of both belligerents. The specific purpose of the research can be most clearly stated by giving the circumstances connected with the genesis of the project.

During World War II the Antisubmarine Operations Research Group (ASWORG) was organized for the purpose primarily of analyzing operational data as they were assembled in the course of the war against the German submarines, in order to provide information that would be of assistance in adapting strategy and tactics so as to utilize the available A/S forces with maximum effectiveness. In the course of this work, ASWORG found it necessary to devise measures of effectiveness for the various aspects of the A/S operations--as an example, in dealing with the detection of the enemy, subjects of study by ASWORG included the construction of systematic search plans for surface vessels and aircraft; the evaluation of the means of detection--visual, radar, sonar; studies of the most profitable areas of search, etc. At the end of the war, the most important results of the various studies carried out by ASWORG were assembled and published in two comprehensive reports: reference (i) dealing chiefly with the several aspects of the war against the U-Boats from a statistical viewpoint; and reference (j) presenting a complete and coherent theory of search and screening operations developed on the basis of the operational data assembled during the war.

To be effectual, operations research requires as complete operational data, both own and enemy's, as possible. The results of intelligence in general were, of course, made available to ASWORG. Certain aspects of intelligence itself pertaining to the antisubmarine effort were subjected to analysis by the Group. For example, reference (g) contains an investigation of the relationship between attacks on convoys and the predicted positions of U-Boats shown in the COMINCH daily submarine estimate, thus providing a means of estimating the accuracy of U-Boat tracking. Reference (h) is a further study of the accuracy of the COMINCH daily submarine estimate; in this paper, the displacements of evaluated submarine contacts from the nearest plotted submarine on the chart last issued before the time of contact served as a basis for the analysis.

The intelligence derived by means of the decryption of German radio communications, however, was for security reasons not specifically identified as such in the data made available to ASWORG. The question eventually arose whether the inability on the part of the operations analysts to take into account the factor of special intelligence had resulted in inaccuracies in the determination of certain parameters still of current importance in operations research. As examples of such parameters can be cited the theoretical sweeprate of submarines, which had been determined from operational data provided by our own submarines operating in the Pacific (reference (i)); force requirements for sighting submarines by aircraft (reference (j), p. 98) were computed without being able to distinguish between cases in which decryption intelligence located the target submarine accurately, and those cases where the searchers were restricted to using the results of probability considerations only. It has been possible, in the course of the present investigation, to determine the operational sweeprate of the German U-Boats, when they operated without the aid of operationally useful decryption intelligence, and the effect such intelligence had on their performance. Moreover, data which make possible a comparison of sweeprates of aircraft carriers on submarine targets, as these are affected by decryption intelligence are presented.

It should be stressed that this report is in no sense a comprehensive evaluation of the part played by decryption intelligence in the war against the U-Boats. It is concerned only with the particular effect which decryption intelligence had on the capability of the U-Boats to contact and attack convoys, and on the capability of the allies to counter these operations of the U-Boats defensively and offensively. Other aspects of decryption intelligence, such as its technical applications to new weapons, search equipment, countermeasures to these, etc., are not dealt with.

Attention is confined to the convoys that traversed the North Atlantic between the United States - Canada and the United Kingdom - the eastbound HX and SC, and the westbound ON(S) convoys. The period considered is from July 1942 to March 1944. From the viewpoint of this study, this overall interval can conveniently be divided into four periods:

Period I. From 1 July 1942 to 31 December 1942. During this time the Germans were reading the Allied convoy traffic with some success. The Allies were not reading the German traffic. (Part 2)

Period II. From 1 January 1943 to 31 May 1943. The Allies began reading the German traffic in late December 1942, and read it sporadically throughout this period. The Germans read the Allied traffic, also sporadically, but more successfully than in the previous period. (Part 2)

Period III. From 1 June 1943 to 15 September 1943. During this period the U-Boats did not operate against the North Atlantic convoys. The Allies took the offensive and killed a large number of U-Boats. The Allies changed the naval convoy cipher in June, and the Germans were deprived of decryption intelligence. The Allies read the German traffic less successfully than in the previous period, but effectively exploited whatever intelligence became available. (Part 4)

Period IV. From 16 September 1943 to 31 March 1944. During this period the Germans succeeded in reading only an unimportant part of the Allied convoy communications. The results were of little use to them, and in early December the source dried up. The Allies, on the other hand, read the German traffic completely and currently. (Part 2)

The conclusions of the report are based on the following items:

(a) A case history of each of the HX, SC, ON and ONS convoys, during Periods I, II, and IV, with respect to the German intelligence on each, the use, if any, to which this was put by the German ComSubs, as evidenced by the BdU War Diary (Ref (b)), contacts and attacks by the U-Boats.

(b) A case history of all the Atlantic U-Boats in Period III, with respect to specific Allied decryption intelligence on each, and Allied action against them. In addition, the history of the German U-Boat refuelling fleet is summarized with special reference to the contribution of decryption intelligence.

(c) A categorized tabulation of all radio communications pertaining to the North Atlantic U-Boat-convoy war, that were decrypted by the Allies from 1 March 1943 to 31 March 1944.

INTRODUCTION

The U-Boat-convoy war had certain peculiar aspects which posed special problems for Intelligence. On the part of the Germans, there was the fact that unless they could prevent the Allies from shipping enough material they could not prevent an invasion which would divide and strain their land forces beyond the breaking point. To accomplish this mission, they had available enough submarines to be able to keep from at least 40-60 at sea at all times after Pearl Harbor and over 100 for the 9 months from October 1942 to June 1943. The great majority of these, however, were the small 500-T type VII C. They had a long transit from even the French ports to the most promising operating areas; as a result the average time spent on patrol was only from 16 to 20 days, unless they could be refuelled at their stations, in which case they could remain for as much as 32 - 36 days. Good intelligence on convoy movements would aid in effecting economy in their use, in that it would make it possible to vector the boats on to targets known to be in a certain locality, instead of requiring them to devote much of their possible effort to reconnaissance. Moreover the German Submarine Command was convinced that more sinkings would result if a promising contact were exploited by a large number of attacking U-Boats, rather than distributing the boats among several possible simultaneous contacts; hence from their viewpoint good intelligence was required to aid in disposing the boats in such a way as to attain this end. Since aircraft reconnaissance was available to the Germans only to a very limited extent, and hardly at all with regard to UK-US convoys, the decryption of Allied radio communications, containing information on sailing routes, rendezvous with escorts, and sometimes current positions, was their best source of intelligence on convoy shipping. With the exception of several periods of comparatively short duration, the Germans read the convoy code partially but fairly consistently for nearly 1½ years after the entry of the United States into the war. From June 1943 on, however, they were able to read practically nothing except some messages which gave stragglers' routes and early rendezvous points, and the submarine command suspected many of these to be deceptive. Even this scanty source dried up in December 1943, when the Allies began to avoid giving definite locations, using reference points instead. This situation did not improve, up to the end of the war. (The extent and use by the Germans of Special intelligence is discussed in parts 2 and 3 of this report.)

The Allies on their part handled their intelligence problem in the U-Boat war by evaluating all the information of U-Boat movements that came in from every possible source in order to plot the probable locations of as many U-Boats as possible, thus providing a guide for the evasive routing or diverting of convoys and for the vectoring of task groups or other forces for the specific mission of hunting down the submarines. A very important source of intelligence was provided by the heavy radio traffic carried on by the Germans, necessitated by the firm control that the submarine command kept on the boats in order to carry out his group operations effectively. The German radio communications were exploited by the Allies in three ways:

(1) By Direction Finding (D/F), a method of locating a transmitter by obtaining simultaneous bearings on a transmission at several stations by means of directional antennae, and noting the area of intersection of the bearing lines. This method was used very extensively and effectively.

(2) By identifying the transmitter by means of the characteristics of the intercepted transmission. Two techniques for this purpose were used:

(a) TINA, a method of identifying a radio operator by his sending characteristics. It consisted of making a tape recording of each transmission and taking mathematical measurements of each dot, dash, and space.

(b) Radio Finger Printing (RFP), a method of identifying the radio transmitting station. This consisted of taking high speed photographs of the electrical characteristics of a transmission, which made possible an analysis of the transmitter's power supply.

(3) By obtaining the content of a radioed communication by decrypting it.

Decrypted messages were of great strategic value, in giving the operating areas of the U-Boats even when sightings or attacks had not occurred, supplementing and checking D/F fixes, calibrating the accuracy of the D/F network, establishing the strength of the packs, and providing information on equipment and armament and basic tactics. In some cases the information in the messages could also be used tactically -- either to divert a convoy, or to vector a hunter-killer group onto a concentration of U-Boats.

This report deals particularly with the part played in the operational aspects of the Battle of the Atlantic by decryption intelligence (3), as distinct from (1) and (2), or intelligence obtained in other ways.

NOTE: Throughout the report, the commander of the German submarines (Befehlshaber der Unterseeboote) is referred to by the initials of his German title - BdU.

~~SECURITY INFORMATION~~ HISTORICAL SURVEY

From 1940 on the Germans had used some of their comparatively few U-Boats to attack UK-US convoys, but immediately after Pearl Harbor deemphasized this phase in order to exploit the opportunities offered by unescorted, independent U. S. coastal shipping, with practically no air defense and negligible surface combat ships to make it hazardous. The results during the first months of 1942 were disastrous for the Allies. By late spring, however, the campaign began to lose its effectiveness, and BdU renewed the attacks against the North Atlantic convoys. He was handicapped in this campaign by the lack of sufficient U-Boats until toward the end of the year; but by December he was able to operate, on the average, 35 U-Boats in the area traversed by the convoys, and the number rose to 70 by March 1943. The number of convoyed ships sunk became formidable. The landing of the Allies in Africa in November 1942 diverted BdU's attention somewhat from the North Atlantic, and from December 1942 on he placed U-Boat groups of fairly large size--up to 15 boats--west of Gibraltar to intercept convoys between that point and the United States and Caribbean.

In the North Atlantic, BdU maintained a fairly constant strategic pattern. By the end of 1941 he knew the general rhythm of the eastbound HX and SC and the westbound ON convoys he also knew the general routes they followed. In acquiring this knowledge he had been aided greatly by the decryptions of radio communications from Allied shore stations. Hence, lacking specific intelligence on a given convoy, he was able to make a fair estimate of its probable position on a given date; easily within 500-600 miles in a generally north-and-south direction, and within one day's run--say 150-200 miles--along the great circle. If he had a pack of, say, ten boats spaced 15 miles apart, they could sweep out the probable area in about 2 days if the weather permitted them to proceed at standard cruising speed. Given fair visibility, there was a good chance that they would sight the convoy. If the area was one where convoys from opposite directions passed each other the probability of a contact was increased. The German Special Intelligence Service (X-B) had computed these areas of probable greatest convoy density, and, in general, throughout the convoy war, BdU had from two to six U-Boat groups patrolling these areas. They were disposed roughly in three lines, and the packs were shifted along these lines as intelligence (or the lack of it) suggested. In the east, the boats were deployed in segments of a line running south from Iceland to the 50° parallel, somewhere near the 25° meridian. The packs on this line were intended to intercept ON (west-bound convoys), chase them across the Atlantic to about

45° W, (the eastern limit of aircraft patrol), refuel, and then take up patrol as a western pack. In the west, a line was established in a nearly east-west direction from north of Newfoundland to the Flemish Cap. A third line extended from the south-east tip of Greenland in a south-easterly direction to the 40° parallel. The pack on this line could be used against both east-bound and west-bound convoys, as occasion suggested. In addition, boats in transit traversed the regions not patrolled by the packs, and in several cases convoys were contacted by these transiting submarines.

It is possible that more contacts might have been obtained by spreading the U-Boats more thinly over the ocean and searching a larger area less intensively, especially when intelligence was plentiful and accurate, since the convoys were distributed more-or-less at random over the whole North Atlantic. BdU, however, aimed at getting the largest possible number of sinkings, rather than of contacts, and was convinced that in attacking convoys it was more profitable to have a large number of U-Boats concentrated on a single convoy, necessarily allowing others to pass unmolested or even undetected, than to attack a larger number of convoys with fewer boats each. Consequently, the value to him of X-B intelligence cannot always be judged by contact rates, especially since the patrol lines were long enough and dense enough to provide a high probability of contact.

This campaign was one of the most successful during the war, the average monthly shipping losses and the exchange rate of merchant ships sunk per U-Boat sunk reaching nearly their highest figures.

By the middle of May 1943, however, the U-Boat war against the North Atlantic convoys had become extremely unprofitable, as the following table shows:

	Number of Ships Sunk By U/B's	Number of U/B's Sunk	Exchange Rate M/V Sunk per U/B Sunk.
February 43	36	10	3.6
March	48	6	8.0
April	20	10	2.0
May	19	34	0.56

Of the 60 U-Boats sunk, about half (27) were sunk by surface craft, and half (30) by land-based air; carrier A/C accounted for three.

To get his boats beyond the range of land-based air, BdU withdrew them from the North Atlantic to an area southwest of the Azores, in order to intercept US-Gibraltar convoys. They were entirely unsuccessful during June and July, and BdU then dropped anti-convoy operations and concentrated on coastal shipping and independents in more distant areas--the Caribbean, off Brazil, Freetown, the Cape of Good Hope, and the Indian Ocean.

The U-Boats stationed in the Mid-Atlantic did avoid land-based A/C, since bases in the Azores were not available to the Allies until August. However, they ran into the CVE groups--BOGUE, CARD, CORE, SANTEE, CROATAN--who, during the summer of 1943, made a total of 44 attacks on German submarines, sinking 15 and damaging nine, in the area bounded by 25°N to 45°N and 20°W to 50°W.

Aside from the losses inflicted on the U-Boats in the Mid-Atlantic, the Allied antisubmarine forces gave the German submarine fleet a severe drubbing wherever they encountered them. During these three months, the Biscay offensive accounted for 31 U-Boats sunk; ten more were sunk in the Atlantic south of the area considered here and nine north of the area; six were lost in the Caribbean area and nine in the Mediterranean and the Indian Ocean. To offset the loss of these 80 U-Boats, only 86 ships were sunk by submarines all over the world.

It was doubtless the failure of the summer campaign which convinced BdU that the only region where a profitable exchange rate could be looked for was the North Atlantic. He confidently expected to meet effectively the threat of the surface escorts, which had taken such a heavy toll of U-Boats in May, by means of a new acoustic torpedo; the threat of A/S aircraft was to be countered by improved search receivers and a new quadruple-mount 20MM A/A gun. Thus, the last half of September saw the U-Boats heading again in considerable numbers for the lanes of the UK-US convoys; by October their numbers in the North Atlantic were comparable with those of the spring. This new anti-convoy campaign resulted in dismal failure; the exchange rate in October in this area was one M/V sunk per seven U/Boats sunk, and in November the U-Boats sank no ships at all in the North Atlantic, although over 30 U-Boats were concentrated there. This state of affairs continued throughout the winter. U-Boat effectiveness, as measured by the number of ships sunk from North Atlantic convoys per U-Boat-day per convoy-day was reduced to one-sixth the figure for the period from July 1942 to May 1943. In March, 1944, the last wolf-pack to operate in the North Atlantic was disbanded. The world-wide situation was very little better. The exchange rate for the period from July 1943 to the end of the war was 0.5

M/V sunk per U-Boat sunk, which was one-eighth the exchange rate during the nine-months period from October 1942 to June 1943, and only one-thirty-sixth the rate for the nine months preceding that.

The invasion of Normandy in June 1944 caused BdU to concentrate his boats in the channel. By this time it meant practical certainty of kill for a U-Boat to surface anywhere near their enemy; hence the only boats operating were those equipped with schnorchel. From this time on to the end of the war, the German submarine effort was directed against coastal shipping near the U.K. It was not successful, as the low exchange rate indicates.

2. THE EXTENT OF DECRYPTED INTELLIGENCE AVAILABLE

2.1. The Extent of Decrypted Intelligence Available to the Germans.

2.1.1. General Character of the Intelligence.

The source of information on German decryption intelligence are the "X-B Berichte", which were compiled and issued weekly by the German Radio Intelligence Service--"X-B Dienst"--and which give a complete summary of all naval intelligence from all sources. Decrypted messages of Allied origin are marked as such. These deal almost entirely with Atlantic convoys. There are practically no decryptions of messages pertaining to combatant vessels, except for surface escorts (not CVE's) of convoys. The available X-B reports run from the beginning of the war in 1939 through April 1944.

The intelligence provided by decryptions included, among other less important items, the following information:

(a) Sailing telegrams, giving the route of the convoy in detail;

(b) Diversions ordered after the convoy had left port;

(c) Rendezvous of parts of a convoy from different ports, or between the convoy and its escorts;

(d) Position, course and speed of the convoy at various stages of the passage. (The source of this is not indicated very often; occasionally it appears to derive from escort rendezvous. As a rule, radio silence was observed by convoys.)

2.1.2. Estimate of the Usefulness of the Decryptions.

The promptness with which decryptions were made available to BdU is not indicated in the X-B reports, but the weekly period of compilation sets an outside limit. For the purpose of estimating the effectiveness of a given piece of useful intelligence, the item is, in general, considered to be "good", that is, to contribute potentially to the ability of the U-Boats to contact convoys, if it was included in the current week's report, or, in other words, if it was decrypted with not more than seven days' delay. However, this definition is arbitrary, since messages decrypted with more than seven days' delay might still be

exploitable tactically by BdU. (some convoys required as much as 18 days to cross the area); on the other hand, messages decrypted very promptly might be tactically less useful, if, for example, the convoy was so close to its destination that pursuit was not practicable. Hence, in particular cases, such additional considerations have been taken into account in estimating the effectiveness of the German decryption intelligence. In some cases it has been possible to check with reference (k), the authors of which had available the daily files of messages decrypted by the Germans, in addition to the weekly reports.

The arbitrary element affects very few questionable cases; its removal would affect the figures given only slightly.

2.1.3. Quantity of the Intelligence.

The contribution of the X-B service in supplying BdU with intelligence on North Atlantic convoys can be discussed most conveniently by considering separately each of the four periods already mentioned. The monthly numbers of convoys on which "good" intelligence was available appear to be fairly homogeneous during each of these periods. (See Annex 2.1) The percentage of convoys on which "good" intelligence was available for each period is:

1 July - 31 December 1942 - - - - - - - - -	37%
1 January - 31 May 1943 - - - - - - - - -	72%
1 June - 15 September 1943 - - - - - - - -	0%
16 September 1943 - 31 March 1944 - - - -	5%

The overall probability for the whole interval, including the first, second, and fourth periods but excluding the third (no operations against North Atlantic convoys were carried out during this period) is about 37%. For a detailed case-history type of description of the extent to which the X-B service supplied BdU with useful intelligence on the North Atlantic convoys, the reader is referred to Annex 2.1.

It must be emphasized that the above figures, and those in Annex 2.1, give only the extent of intelligence made available to BdU by the X-B service. The question of how much was used is dealt with in Part 3.

The contribution of the X-B service to the over-all intelligence picture of the submarine command was substantial from the beginning of the war in 1939 until the summer of 1943. Its importance was enhanced by the fact that other sources of intelligence on convoy movements were meager. The X-B reports

and the BdU War Diary indicate that radio direction finding played a very minor part in furnishing intelligence on Atlantic convoys. Reconnaissance by aircraft was possible only for short periods and at limited ranges from the European coast, owing to the unwillingness of the Air Force command to allocate long-range patrol planes to the submarine campaign.

By the time the United States entered the war, the X-B service had made it possible for the German U-Boat command to predict the probable areas of greatest density of the UK-US convoys, having obtained enough information from decryptions to establish the rhythm of sailing and the probable courses they would take. These areas were three in number:

(i) a strip northeast of Newfoundland, from 45°N-57°N, 44°W-49°W;

(ii) one just northeast of the former, stretching south from Greenland, from 49°N-59°N, 41°W-43°W;

(iii) one stretching south from between Greenland and Iceland, from 52°N-63°N, 25°W-27°W.

The value BdU placed on this analysis is indicated by the fact that for nearly two years, in every campaign against North Atlantic convoys, he placed his patrol groups chiefly in these areas, lengthening the strips to the southward when the Allies began using a southern route along the 40°N parallel in January 1943.

The contribution of the X-B service was stopped in June 1943 by a change in the cypher on the part of the Allies. By 16 September 1943 the Germans had succeeded in breaking a part of the new cypher; however, they were able to read only messages giving stragglers' routes and early rendezvous points. This information, to judge by the BdU War Diary, appears to have been of value to Com-Subs in only a few cases; in general, it may perhaps have been more confusing than helpful. On 12 December 1943 the Allies removed this last source of information by giving stragglers' routes and rendezvous points relative to certain reference points, the location of which the Germans were unable to determine. During the remainder of the submarine campaign against Atlantic convoys the U-Boats were obliged to depend on their own reconnaissance and that of the few long-range aircraft available. The Allies, on their part, made reconnaissance by the U-Boats themselves very difficult by aircraft patrols, thus forcing the U-Boats to operate submerged a large part of the time.

2.2. The Extent of Decryption Intelligence Available to the Allies

The Allies began reading the "Enigma" communications of the German submarine force in December 1942, and continued to read them sporadically with varying delay times until October 1943, from which time on to the end of the war, the messages were read completely day-by-day, with no significant delay.

The messages decrypted by the Atlantic Section of Op-20-G are filed by days. (The date of decryption was appended to the translation of each decrypted message beginning on 20 February 1943.) A complete tabulation of all decrypted messages pertaining to the North Atlantic convoy war, during the months of March, April, May, September 16 through 30, October, November, and December of 1943 and January, February, and March of 1944, is presented in Annex 2.2. In addition, there is a tabulation of all messages pertaining to U-Boat operations in the Atlantic north of the equator for the period from 1 June through 15 September 1943. The messages are classified according to content and time of delay in decryption.

With respect to their contents, the messages can be included in three general groups:

(1) Messages, either from a U-Boat or from BdU, which give the present or prospective position of a U-Boat; these are called type "P" messages in the table of Annex 2.2.

(2) Messages, chiefly from BdU, which contain operational orders to individual U-Boats, groups of U-Boats, refuellers, etc., designating patrol areas, courses, refuelling rendezvous, etc. These are called type "M" messages.

(3) Messages which deal with contacts between the U-Boats and their enemy. From March to May 1943 they were predominantly reports of contacts on convoys; from June to September 1943, almost entirely reports of contacts by the Allies on U-Boats, since no convoys were contacted during this period in the area mentioned. From October 1943 to March 1944 they were of both kinds. These messages are called type "C".

A general idea of the amount of radio intelligence made available to the Allies, and of the delay in decryption time, during the period 1 March 1943 to 31 March 1944 is given by the following grouping of the decrypted messages. Table I and Table II are arranged in three parts because of the different

(LO) 2271-52

nature of the U-Boat war in the three periods indicated. The period numbers correspond to those previously used. The classification of delay times was changed in Period III because of the small number of messages involved.

TABLE I

Volume of Radio Intelligence

Period II: 1 March - 31 May 1943:

Month	No. of Decryptions	Percent Decrypted Within 1 day	2 days	3 days	10 days
March	839	12%	33%	50%	82%
April	765	44%	61%	66%	82%
May	836	34%	53%	66%	88%
Total	2440	33%	50%	61%	84%

Period III: 1 June - 15 September 1943:

		2 days	5 days	10 days	15 days
June	109	9%	55%	69%	85%
July	80	6%	9%	21%	34%
August	67	6%	43%	67%	88%
1-15 Sept.	31	0%	61%	71%	78%
Total	287	6%	40%	56%	70%

Period IV: 16 September 1943 - 31 March 1944:

		1 day	2 days	3 days	10 days
16-30 Sept.	149	17%	58%	70%	99%
October	287	60%	72%	78%	96%
November	80	71%	86%	95%	100%
December	99	83%	93%	96%	100%
January 1944	236	94%	100%	100%	100%
February	294	87%	97%	99%	100%
March	202	89%	96%	99%	100%
Total	1347	74%	87%	91%	99%

PRNC NSS-346

Concerning the proportion of all German transmissions concerned with U-Boats that were decrypted, it was the rule that if messages on any day were read, all the transmissions were read. From Annex 2.2 it is seen that on certain days none were read within 10, or in the second period, 15 days. The number of days in each month for which no decryptions are found in the files is as follows:

March 1943	2 days
April	7 days
May	3 days
June	2 days
July	1 day
August	8 days
September	8 days
October	0 days
November	5 days
December	5 days
January 1944	0 days
February	0 days
March	0 days

Concerning the character of the intelligence obtained from decryptions, Table II presents a grouping according to the type of message, as defined above.

TABLE II

Character of Radio Intelligence.

Period II: 1 March - 31 May 1943.

Month	No. of Decryptions within 10 days	Type of Message P	M	C
March	689	31%	10%	59%
April	627	21%	13%	66%
May	739	35%	10%	55%
Total	2055	29%	11%	60%

Period III: 1 June - 15 September 1943:

	within 15 days			
June	93	44%	42%	14%
July	27	33%	34%	32%
August	59	36%	49%	15%
1-15 Sept.	24	42%	50%	8%
Total	203	35%	44%	21%

FRNC-NSS-346

TOP SECRET
SECURITY INFORMATION

Period IV: 16 September 1943 - 31 March 1944:

Month	Within 10 days	Type of Message P	M	C
16-30 Sept.	147	22%	18%	60%
October	276	30%	37%	33%
November	80	31%	39%	30%
December	99	47%	45%	8%
January 1944	236	71*%	19%	10%
February	294	69*%	11%	20%
March	202	84*%	8%	8%
Total	1334	54%	22%	23%

*Nearly all of these were weather reports sent by three U-Boats several times a day.

There is a great difference in the amount and the character of the intelligence in the three periods. The huge traffic of March to May was due to the magnitude of the convoy war carried on during those months. Each U-Boat reported every contact and loss of contact on a convoy and BdU repeated it, so that during a long chase scores of such messages might be sent back and forth in a few days. This accounts for the preponderance of type C messages during this period. During the summer no convoys were contacted, and the few type C messages were nearly all reports of attacks on the U-Boats. The great decrease in the amount of radio communications during the summer is explained partly by the lack of contacts on convoys, and partly by the fact that in July the U-Boats were sent to distant areas to prey on coastal shipping, and maintained radio silence except to report attacks and positions when ordered to do so by ComSubs. Starting on 16 September 1943, the U-Boats were once more sent back into the North Atlantic, and the volume of messages increased. From September to December, the emphasis on the type of messages sent changed from C to P until by January, February, and March the preponderance of messages sent were position reports, and these originated in large measure from three U-Boats which sent weather reports, two to three times daily. However, the positions of practically all U-Boats were known from the type M messages in which BdU gave the U-Boat position assignments.

The most valuable messages were obviously the type M. These contained important information involving groups of U-Boats, and gave patrol areas and movements of packs, refuelling rendezvous, etc. During the months March to May over 200 such messages were decrypted within 10 days, and about half of these within 2 days. During the summer about 90 type M messages

were decrypted within 15 days, 50 within 5 days, and 7 within 2 days; dealing, as they did, chiefly with refuelling rendezvous, their great importance in the hunter-killer campaigns is obvious, as can be seen from Part 4, where the manner in which these decrypted communications were exploited by the Allies is discussed. During the last period (September 1943-March 1944) the M type messages were decrypted with such promptness and efficacy that the Allies had current knowledge of the formation of practically all U-Boat groups, together with their positions, the areas they were to patrol, and even the specific convoys they were intended to intercept.

~~SECURITY INFORMATION~~

3. THE UTILIZATION OF DECRYPTION INTELLIGENCE BY THE GERMANS

The strategic use to which BdU put the information made available to him by X-B intelligence has already been mentioned in Section 2.1. Throughout the duration of the North Atlantic convoy war he placed his U-Boat packs in patrol lines at the positions which, according to calculations based in large measure on decrypted allied messages, were consistently most likely to be those of greatest convoy density. When, in January 1943, the Allies first introduced the southern route along the 40°N-45°N parallels,--heretofore shunned because of lack of enough escort ships to compensate for the absence of land-based air support for too long a period in mid-ocean--the X-B service gave him information of the change, with the result that he was able to shift the general pattern of his North Atlantic U-Boat operations in order to meet the new condition with very slight loss of time: a U-Boat group was placed across the new route by 19 January, and two weeks later carried out the first major attack of the new year on SC 118, which netted the U-Boats 12 ships sunk. Within the next six weeks, this attack was succeeded by the attacks on ON 166 (15 ships sunk), HX 229 (13 sunk) and SC 122 (9 sunk), all in the same general area.

Tactically, BdU was able to exploit the X-B intelligence profitably because the large quantity of prompt detailed information on specific convoys frequently enabled him to execute the movements required to bring the largest possible number of U-Boats to the attack. The extensive use he made of the X-B intelligence available to him is evident from a perusal of the War Diary: during the period from 1 July 1942 to 31 May 1943 one finds 24 cases in which he mentions decryptions of Allied messages as governing his placing of a U-Boat group in a definite patrol area to intercept a specifically designated convoy. Of these 24 convoys 20 were contacted, with 85 sinkings resulting from attacks on 14 of them. (These attacks included the three disastrous ones on SC 118, SC 121, and HX 229-SC 122, which netted the U-Boats 46 ships sunk.) The most dramatic example of this sort of tactical employment is found in the pursuit of HX 229 and SC 122 in March 1943; a decrypted Allied message apprised BdU of a diversion of HX 229, and he reacted so promptly (by cancelling an order only a few hours old and directing a radical course change) that the Atlantic Section of Op-20-G (who read BdU's message promptly) were convinced that the Allied cipher had been compromised. (This particular combined operation netted the U-Boats 22 ships sunk.)

In the period from September 1943 to March 1944, when BdU no longer had good intelligence available, he tried to exploit the very scanty gleanings to the utmost; in the War Diary he mentions X-B intelligence in connection with 15 convoys. Only three of these were contacted, with two attacks yielding 4 sinkings.

Precise evaluation of the operational effect of decryption intelligence requires consideration not only of the successes obtained with its use, but also some measure of the successes that would have been obtained without it. These questions are considered in the following sections. The straightforward effects of using decryption intelligence are expressed quantitatively in terms of the ability of the U-Boats: (a) to contact the convoys (Section 3.1); (b) to convert the contacts into attacks (Section 3.2) and (c) to sink ships (Section 3.2).

3.1. The Effect of X-B Intelligence on the Capability of U-Boats Contacting a Convoy.

Definition of "Contact"

In this paper the term "contact" is used in the sense that a given convoy is contacted only once, regardless of the number of U-Boats that actually contacted it. This rule is adhered to even in the case of a convoy that, having been once contacted and subsequently lost, was recontacted later.

Definition of "Compromise" of a Convoy.

A convoy is considered to have been "compromised" if there was X-B intelligence available concerning it which, according to the criterion described in Section 2.1, was potentially useful to BdU, whether he used it or not. A compromised convoy specifically mentioned as being so in the BdU War Diary is said to be "designated" by BdU.

Data for Sections 3.1 and 3.2

The basic data required for the computations in Sections 3.1 and 3.2 are tabulated in Annex 3. Data on the status of X-B intelligence and of action by BdU with respect to particular convoys are tabulated in Annex 2.1.

SECURITY INFORMATION

3.1.1. Effect of X-B Intelligence on Probability of Contact.

(a) Overall Probability. Table III is a summary showing the average probability of a convoy being contacted when it was compromised by X-B intelligence, and when not.

TABLE III

Overall Effect of X-B Intelligence on Contact Rate of U-Boats on Convoys

Number of Convoys in Area	266
Number of Convoys Contacted	91
Number of Convoys not Compromised by good X-B	168
Number of Convoys Compromised by good X-B	98
Number of Contacts on non-Compromised Convoys	43
Number of Contacts on Compromised Convoys	48
Overall Probability of a Convoy being Contacted	34%
Average Probability of a non-Compromised Convoy being Contacted	26%
Average Probability of a Compromised Convoy being Contacted	49%

The data in Table III indicate that the average chance of a convoy being contacted while traversing the North Atlantic was nearly twice as great if BdU had good X-B intelligence specifically on it.

(b) The Probability of Contact per Convoy Day per U-Boat Day.

It is clear that the averages just given do not provide an accurate estimate of the effect of good X-B intelligence on U-Boat performance, since they do not take into account the extent of the U-Boat effort nor the number of targets in the

area. This may be done, at least crudely, by computing the probability that a single U-Boat would contact the convoy per day of its transit; this quantity is the quotient of the number of contacts during a period divided by the product of the number of convoy days and U-Boat days in the area. When this is done, it is found that the average overall probability that a convoy would be contacted per day of its transit of the area per U-Boat day is 0.095% when compromised by good X-B intelligence, compared with a probability of 0.058%, approximately 5/3 as great, when not so compromised. Significant as this increase in convoy jeopardy is, it still does not reflect the full usefulness of the X-B intelligence. There were other factors that materially affected the ability of the U-Boats to utilize X-B intelligence in contacting convoys, the effects of which cannot be expressed quantitatively, but tend to make the apparent value of the X-B intelligence less than the actual value, when a statistical estimate, such as the one given here, is attempted. These factors are the following:

(1) The weather. In some cases the U-Boats failed to contact convoys of which BdU had good intelligence, and to intercept which he disposed his packs across the route the convoy actually took, because of weather conditions. Heavy seas reduced the mobility of the submarines, so that they sometimes failed to reach a prescribed patrol line in time. Snowstorms and heavy, long-enduring fogs often reduced their ability to sight targets; in several cases a convoy was able to sail directly through a patrol line without being contacted. This factor is frequently mentioned in the BdU War Diary during Period II (January - May 1943), when the Germans had the best decryption intelligence on convoys.

(2) The limitations of U-Boat operability. In order to realize the full capabilitites of the type VII C it was necessary to refuel it while on patrol, and so it happened occasionally that even when BdU had very good information on a particular convoy, he had to forego pursuit of it for logistic reasons.

(3) The German principle of mass attacks. BdU was convinced that it was more profitable to attack a convoy with as many boats as could be homed onto it. Hence it happened frequently that even when he had good X-B on several convoys during a given interval, so many boats were in pursuit of one or even more other convoys that had already been contacted, that it was not practicable to allot any boats to search for the remaining ones. For example, in the attack on ONS-5 in May, 40 U-Boats were involved, leaving hardly any available to attack other convoys on which BdU had good X-B, for a week or more. This is not to say that the U-Boats consistently contacted as

many convoys as BdU desired. From the War Diary it is evident that they disappointed BdU repeatedly.

The principle of concentration of U/B's advanced in paragraph (3) above, plus evidence such as was given in the example in that paragraph, suggests that there may have been intervals of time during which BdU had good X-B intelligence for a number of convoys in excess of the number which his U/B's could attack; that is to say, the amount of intelligence available for use had saturated the facilities for using it. If the U/B fleet were not saturated with intelligence in the sense described here, then an increase in the amount of accurate and timely X-B decryptions might be expected to increase the rate with which U/B's contacted convoys. Whether or not such saturation occurred consistently will now be investigated.

3.1.2. The "Contact Coefficient" and "Operational Sweeprate." A Measure of U-Boat performance that in some respects is more meaningful than simple probability of contact is the "operational sweeprate." The following is a brief discussion of this quantity and of its application to the situation in question.

The number of contacts that the U-Boats could be expected to make during T U-Boat days of random search effort depends on the target density during the time interval in question; that is

(1) $$C \propto \left(\frac{N}{A}\right) T$$

where

C number of contacts
N number of targets in the area
A the area searched (sq. miles)
T searching effort (U-Boat days).

By introducing a proportionality coefficient, q, one gets

(2) $$C = q \left(\frac{N}{A}\right) T$$

The coefficient q will be designated "contact coefficient". It is immediately apparent that its magnitude indicates some measure of the U-Boat's ability to contact targets apart from the density of targets and the magnitude of the search effort. The dimensions of q are "area/time", suggesting a search rate. In a case in which the targets and the searchers are positioned at random but with a uniform density over the area, and the movements of the searcher are independent of those of the target, q would be the true "sweeprate" of the searcher against

this particular target. It would equal the effective ocean area swept over by a single search craft in one day.

The value of w can be estimated from known capabilities of the searcher's detection means (the "effective detection range", or the "sweepwidth") and the speed of the search craft relative to that of the target. This is sometimes called a "theoretical" sweeprate to distinguish it from the w computed from actual operational results; that is, when a known number of contacts, and a known or assumed target density are substituted in equation (2). The latter is called the "operational" sweeprate.

The condition of uniform distribution of targets and searchers was never entirely met in the Battle of the Atlantic; although the convoys were distributed fairly evenly and their average number remained nearly constant for long periods, this was not true of the U-Boats. Except when transiting, the U-Boats were generally concentrated in packs, with the exception of a very few boats operating independently on special missions. As a consequence, at any given time, certain portions of the entire region were being more thoroughly swept over than others.

With respect to the mutual independence of searcher and target movements, this condition would be approximated at such times as neither side had reliable knowledge of the opponents' movements-a condition which occurred only sporadically during short intervals in the period considered.

In view of the restrictions on the definition of "sweeprate" required by the theory of search, and the conditions under which the convoy battle of the Atlantic was fought, there is a valid objection to using this term, as computed from the operational data, to describe the effectiveness of the U-Boats. For this reason the term "contact coefficient" has been introduced to replace "operational sweeprate". It will serve as a measure of the capability of the U-Boats to contact convoys, and should reflect the effect of intelligence on their search capability. It approximates a true operational sweepwidth to the extent that the conditions of uniform random distribution and independence of movement are met.

(a) The true operational sweeprate. The closest approximation to the true operational sweeprate of the German U-Boats in the Battle of the Atlantic would be obtained by considering only those convoys not compromised by X-B intelligence during a period when the Allies had the least amount of intelligence concerning U-Boat movements. The latter condition occurred in Period I, (from July 1942 to December 1942) during which the Allies were not reading the German cipher (except for the last days in December). On the other hand, 63 out of 100 convoys were not compromised by X-B intelligence-a good-sized sample.

During Period I the contact coefficient on non-compromised convoys was 2450 sq. miles per day. This quantity is thus the closest approximation to the true operational sweeprate. (For details of the computation see Annex 3.)

The sweeprate is given by the product of the relative speed of searcher with respect to the target by the "sweep-width" of the searcher - twice the "effective range" of detection. Using a relative speed of 10 knots, the 2450 sq. miles-per-day sweeprate would correspond to a sweepwidth of about 10 miles. Operational data on sightings by our own submarines in the Pacific on single merchant vessels gave a day-and-night average sweepwidth of 12 miles for a surfaced submarine; on large convoys it should be substantially more: theoretically proportional approximately to the cube root of the number of ships in the convoy. (Reference (i), p. 101).

The contact coefficients for Periods II (January - May 1943) and IV (September 1943 - March 1944), computed for only noncompromised convoys, are respectively 1400 and 1550 square miles-per-day. This decrease from the figure for Period I reflects the effect of the superior intelligence obtained by the Allies through decryption intelligence: during Period II they read the German communications with considerable success (see section 2.2); and during Period IV completely and currently. This enabled them to divert convoys around the U-Boat packs and was instrumental in reducing the contact coefficient from 30 - 40 per-cent.

(b) Variation of the overall value of the contact coefficient and correlation with the extent of X-B intelligence. The overall value of the contact coefficient throughout the three periods, calculated from equation (2) by inserting the total number of contacts on all convoys, the total number of U-Boat days in the area, and the overall average number of convoys in the area, is 2350 sq. miles per day. It will be noted that this number is almost equal to the closest approximation to the true operational sweeprate, which was 2450 sq. miles per day.

In general, the effect of X-B intelligence on specific convoys during given intervals should be reflected in the value of the contact coefficients for those intervals. For, if during a given interval BdU had specific information on enough convoys to keep his fleet occupied by these alone, the contact rate during that interval should be greater than during an interval in which the U-Boats had to depend more on their own reconnaissance and on BdU's guessing; since, in the former case, the U-Boats could presumably be homed on to the target, or enabled

to carry out a more intensive search of a smaller area.

Considering the three periods studied, the relation between the overall contact coefficient Q and the amount of good X-B intelligence is as shown in Table IV.

TABLE IV

Variation of Overall Contact Coefficient and Extent of X-B Intelligence by Periods

Period	% of Convoys Compromised by X-B	Overall Contact Coefficient
I. July-Dec. 1942	37%	2650 sq. mi./day
II. Jan-May 1943	73%	2050 "
IV. Sep. 1943-March 1944	5%	1700 "

The lack of correlation between the overall contact coefficient and the extent of intelligence on convoy movements might indicate that the saturation effect mentioned earlier in this section really exists; but it could be due to a generally lower effectiveness of U-Boat search, as a result of Allied countermeasures, weather, etc. The saturation effect would be significant especially during Period II, when BdU had available good X-B intelligence on 75% of all the convoys. The low value of the contact coefficient in Period IV probably represents the effect of the superlatively good Allied intelligence on the true operational sweeprate of the U-Boats.

The variation of the contact coefficient and extent of X-B intelligence for intervals of one month is shown in Table V. Figure 1 shows this variation graphically.

TABLE V

Monthly Variation in Extent of X-B Intelligence and in the Contact Coefficient

	Month	% of Compromised Convoys	Overall Contact Coefficient (Sq. Mi. per Day)
Period I. (Allies had no Decryption Intelligence)	July 1942	39%	1450
	Aug.	47%	3050
	Sep.	37%	2100
	Oct.	13%	2050
	Nov.	43%	4550
	Dec.	44%	2400

	Month	% of Compromised Convoys	Overall Contact Coefficient (Sq.Mi.per Day)
Period II. (Allies read Messages Partially)	Jan. 1943	63%	2300
	Feb.	45%	1950
	Mar.	93%	1700
	Apr.	65%	2600
	May	85%	1900
Period IV. (Allies read messages currently and completely)	Sep.	0%	2400
	Oct.	19%	1150
	Nov.	0%	1550
	Dec.	8%	650
	Jan. 1944	0%	2300
	Feb.	0%	3500
	Mar.	0%	850

A further breakdown of Period II into 10-day and 15-day intervals shows a similar lack of correlation. It is not considered necessary to include these results in this report.

(c) Comparison of Contact Coefficients Computed for Compromised and Non-Compromised Convoys.

The average value of the contact coefficient for the three periods in question, considering only non-compromised convoys, is 1750 sq. mi. per day. The average value of the contact coefficient, considering only the compromised convoys, is 2850 sq. mi. per day. It thus appears that the immediate effect of X-B intelligence was to raise the contact coefficient to about five-thirds the normal value, just as in the case of contact probability discussed above in the preceding section.

When the three periods are considered separately, the figures shown in Table VI are obtained.* The contact coefficient on non-compromised convoys is indicated by Q_0; that on compromised convoys (that is, those on which good X-B intelligence was available, whether or not used by BdU), by Q_1.

*If the contact coefficients are computed for monthly periods, it is found that the individual values fluctuate widely. (See Annex 3, Table 4.) In the case of the non-compromised convoys, the range is from 0 to 5100 sq. mi./day; during half the months it was between 1550 and 2450 sq. mi. per day. In the case of the compromised convoys, the range is from 0 (in December 1943, with only one compromised convoy) to 5100; half the values lie between 3000 and 3800 sq. mi. per day.

Fig. 1 Monthly Variation in Extent of X-B Intelligence and in Contact Coefficient.

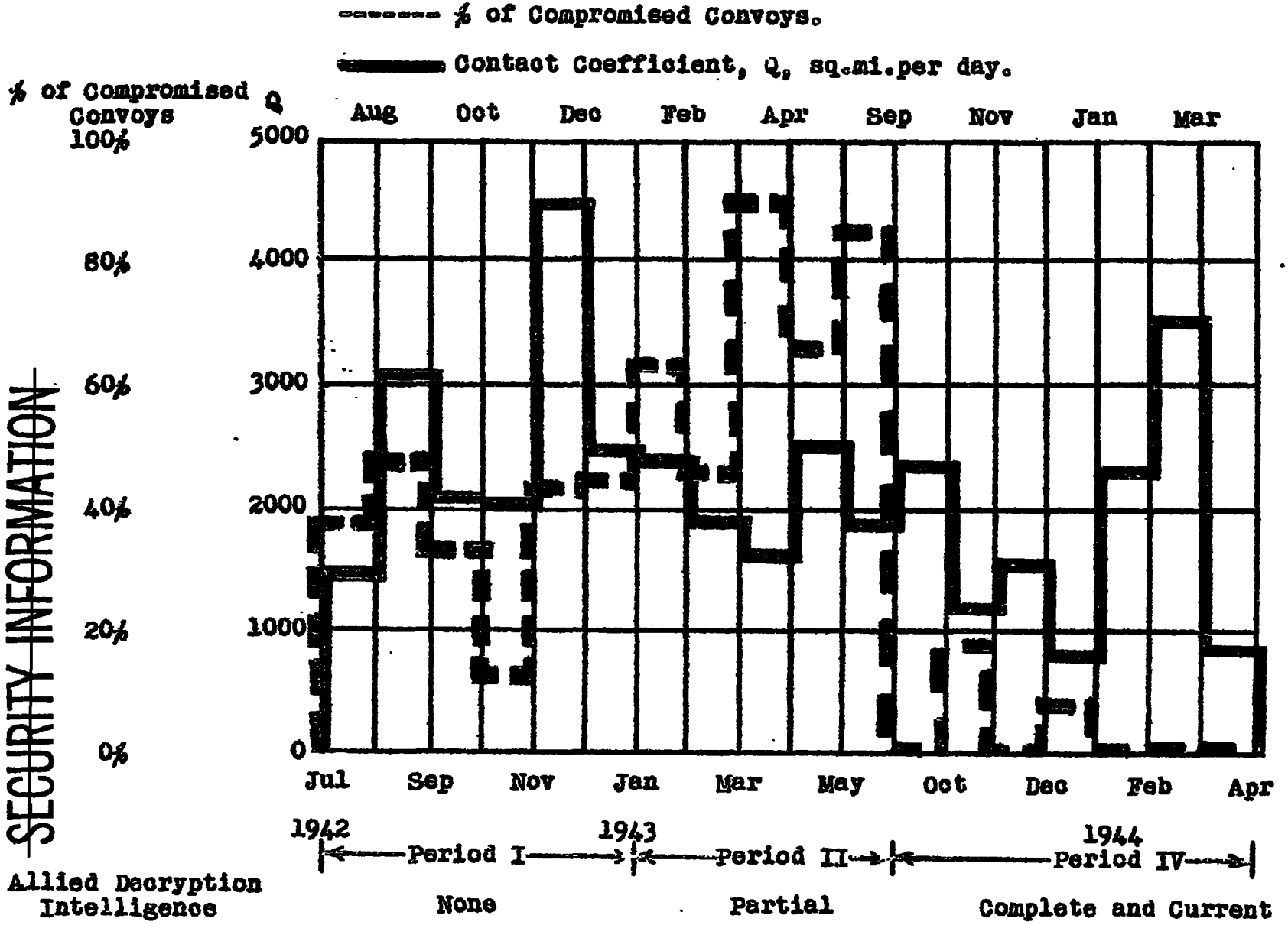

TABLE VI

	Q_0 sq. mi./day	Q_1 sq. mi./day
Average for all periods	1750	2850
Period I	2450	2950
Period II	1400	2350
Period IV	1550	4050*

*There were only four cases of compromised convoys during Period IV; three of these were contacted.

Statistical analysis of the data in Table VI (chi-squared test) indicates that the differences between the sweep-rates on non-compromised and compromised convoys are significant.

(d) The Contact Coefficient with respect to compromised convoys specifically designated by BdU for U-Boat operations.

It has been mentioned that a possible reason for the lack of correlation between the degree of X-B intelligence and the contact coefficient is the fact that during Periods I and II BdU generally had sufficient X-B intelligence on convoys to enable him to maneuver his U-Boats to attack certain compromised convoys, ignoring others unless by chance they offered a good opportunity for attack. There is considerable evidence for this in the BdU War Diary. If this hypothesis is correct, the contact coefficient for such designated convoys should be substantially greater than the value obtained by considering all compromised convoys. This is actually the case. In Period I, 3 of the 37 compromised convoys are specifically designated by BdU as having been so compromised; all 3 were contacted. In Period II, BdU mentions X-B intelligence in connection with operations against 21 convoys (out of 57 that were compromised); of these 21, contact was made on 17. In Period IV, when X-B intelligence was almost non-existent, only 4 convoys were compromised, and BdU designates all four of these for operations; 2 were contacted. The contact coefficients computed from these data are shown in Table VII; they are called Q_2. The coefficients pertaining to those compromised convoys not designated by BdU, and to non-compromised convoys, Q_3 and Q_0 respectively, are included for comparison.

TABLE VII

Contact Coefficients on Convoys Designated by BdU for Operations on the Basis of X-B Intelligence

Period	Q_2 (Sq.Mi./Day)	Q_3 (Sq.Mi./Day)	Q_0 (Sq.Mi./Day)
I	8400	2600	2450
II	3400	1650	1400
IV	4050	(a)	1700
Average for All Periods	4450	2050	1750

(a) No convoys in this class in Period IV.

In spite of the small samples in Periods I and IV of designated compromised convoys, the differences between Q_2 and Q_0, and between Q_2 and Q_3, for all the periods and for the average of all periods are significant within 90% confidence limits; that is, there is at the most a 10% chance that the differences mentioned are due to chance fluctuations. Thus it appears from the data shown in Table VII, that the value of X-B intelligence to the U-Boat command can be summed up as follows. The information obtained on specific convoys enabled BdU to select certain ones for pack operations, either ignoring others or leaving their detection to chance. As a result, the effectiveness of the U-Boats in contacting convoys was increased to about 2½ times the figure when no X-B intelligence was available, and to about twice that on convoys which, though compromised by X-B intelligence, were not specifically selected for operations.

3.2 The Effect of X-B Intelligence on the Attack Factor and the Sinking Rate.

In general, in evaluating the effect of intelligence, the contact rate is a more significant quantity than the sinking rate, since there is no direct connection between intelligence and sinking rate. The sinking rate depends directly upon the contact rate, as well as upon other factors which have no connection with intelligence, such as fire control, armament, aggressiveness, etc. on the part of the U-Boat, and on the effectiveness of anti-submarine measures on the part of the defense.

However, in view of the tactics employed by the German U-Boat command of vectoring every available U-Boat to the attack on an intercepted convoy, it seems reasonable to presume that the possession of good X-B intelligence would make it possible for BdU to dispose his boats in a manner that would not only enhance their chance of contacting a convoy, but also of conver-

ting the contact into an attack, as well as enabling him to vector larger numbers of boats to the attack, and thus obtain a greater sinking rate.

Table VIIIA presents data showing the effect of X-B intelligence on the attack factor and the sinking rate. Only those attacks that yielded at least one sinking are considered.

It might be argued that a more realistic approach would be to consider only the attacks of major proportions; i.e., those which resulted in multiple kills, in view of the argument cited above for the use of the sinking rate as a measure; for of the 65 successful attacks, half resulted in only one or two sinkings, and these include some cases in which only one or two U-Boats contacted a convoy, as well as two cases which the Germans considered independents. Table VIIIB gives the figures for attacks that resulted in three or more sinkings.

TABLE VIII

Effect of X-B Intelligence on Attack Factor and Sinking Rate.

	Non-Compromised Convoys	Compromised Convoys	Compromised Convoys Designated by BdU	Overall
A. All Attacks with at least one Sinking				
Number of Convoys	168	98	28	266
Number of Contacts	43	48	22	91
Attacks	29	36	16	65
Percent of Convoys Attacked	17%	37%	57%	24%
Percent of Contacts Converted to Attacks	68%	75%	73%	71%
Number of Ships Sunk	101	162	89	263
Average Number of Ships Sunk per Attack	3.5	4.5	5.5	4.0
Percent of Overall Attacks	45%	55%		
Percent of Overall Sinkings	38%	62%		

TABLE VIII (ctd)

Effect of X-B Intelligence on Attack Factor and Sinking Rate.

	Non-Compromised Convoys	Compromised Convoys	Compromised Convoys Designated by BdU	Overall
B. Attacks with 3 or More Sinkings				
Number of Such Attacks	12	19	9	31
Percent of Convoys Attacked	7%	19%	32%	12%
Percent of Contacts Converted to Such Attacks	28%	40%	41%	34%
Number of Ships Sunk	78	141	81	219
Average Number of Ships Sunk per Attack	6.5	7.5	9.0	
Percent of Overall Attacks	39%	61%		
Percent of Overall Sinkings	36%	64%		

Considering all the attacks (with at least one sinking), it appears that the availability of X-B intelligence had no appreciable effect on the attack factor (percent of contacts converted to attacks), which was near 70% in all categories. In the case of major attacks (3 or more sinkings), the attack factor was nearly 1½ times as great for compromised designated convoys as for non-compromised ones. This might be taken as indicating that the possession of good intelligence was of significant assistance to BdU in disposing of his U-Boats so as to enhance their chance of making a major attack.

With respect to sinkings, 62% of all sinkings, as against only 53% of all contacts, were from compromised convoys. This results in a higher average number of ships sunk per attack--4.5 from compromised convoys compared with 3.5 from non-compromised ones. In the case of the compromised convoys designated by BdU, the average number of sinkings is significantly higher than in the case of the non-compromised convoys, both when all attacks and also only the major attacks are considered.

Because the state of affairs with respect to decryption intelligence on both sides differed so greatly during Periods I, II, and IV, it is of interest to compare the effectiveness

of the average U-Boat for the three periods, as measured in terms of ships sunk per U-Boat-day per convoy-day. In Table IX the values of the contact coefficient and the sinking rate per U-Boat-day per convoy-day are expressed as ratios of the overall values for Period I.

TABLE IX

Comparison of Overall Contact and Sinking Rates.

Period	Relative Contact Coefficient	Relative Sinking Rate per U-Boat-Day per Convoy-Day
I	1.00	1.00
II	0.78	1.09
IV	0.64	0.18

It is seen that, whereas the ability of the average U-Boat to sink ships from convoys was reduced to nearly one-sixth during Period IV, compared with Periods I and II, its ability to contact the convoys was reduced to only about two-thirds of the previous figure, in spite of the almost complete lack of X-B intelligence during this period and the completeness of Allied decryptions.

Caution must be observed in interpreting these figures. On the one hand, it is not correct to conclude that the reduction in the contact rate was due entirely to the status of the intelligence on both sides during Period IV. It is equally incorrect to conclude that the reduction in the sinking rate must be ascribed entirely to the increased efficacy of other anti-submarine measures, aside from the reduction caused by the decrease in the contact rate. These are oversimplifications. It has been pointed out above why the contact rate itself does not reflect the full value to the Germans of the U-B intelligence available to them; and in Part 4 of this report it will be shown that it is difficult, if not impossible, to evaluate the complete effect of Allied decryption intelligence on the effectiveness of the U-Boats.

On the other hand, it is equally necessary to repress a tendency to ascribe the collapse of the German U-Boat effort in the winter of 1943-44 almost entirely to the conditions of decryption on both sides, following a post hoc propter hoc reasoning process. The part played by Allied decryption in the decrease of U-Boat effectiveness after May 1943 is discussed in detail in Part 4.

4. THE VALUE OF DECRYPTION INTELLIGENCE TO THE ALLIES

4.1. Strategic Use of Decryption Intelligence

The strategic importance, to the Allies, of the intelligence derived from decryptions, concerning U-Boat operations, is not readily expressible in figures. The great magnitude of the contribution, in the strategic sense, of this form of intelligence, to the eventual victory over the most serious threat of failure in this essential phase of the war is indicated by noting the particular services it rendered.

(a) Decryption intelligence made it possible to obtain a very accurate, complete, and fairly up-to-date picture of the general character of the German submarine operations: the areas of U-Boat infestation, the number and identity of the boats operating in the several areas, and their objectives--whether coastal or trans-oceanic convoys, independents, mine-laying, etc.; all of which were helpful in planning anti-submarine measures, including convoy routing and defense, and offensive operations against the U-Boats.

Two striking instances of the application of decryption intelligence in this respect are the following:

(1) In January, 1943, the Allies first began reading the German submarine radio traffic promptly and completely, and hence had accurate knowledge of the current disposition of the U-Boat groups. As a consequence, some of the UK-US convoys were, for the first time, taken off the standard routes, with the result that the U-Boats made only one contact during the first two weeks in January. *

* Doenitz's remarks on this occasion are interesting. He writes in the BdU War Diary of 15 January: "Neither the 'SC' nor the 'HX' convoy were contacted...probably 'SC' and 'HX' passed to the north of submarine disposition. These two convoys bring the total up to four that have been missed since 31.12. It must be assumed that the enemy has left the convoy routes that he has been sailing for nearly 6 months and is again scattering his convoy routes. This development is a great drawback to attacks by our boats, but was only to be expected. As has already been emphasized in this War Diary, it was quite inexplicable why the English stuck so stubbornly to almost the same convoy routes for six months, which greatly simplified finding his convoys." The convoy routes in the North Atlantic remained "scattered" throughout the remainder of the period of the U-Boat menace.

(2) On 24 May 1943, BdU ordered nearly all his boats to leave the North Atlantic, and on 26 May designated 17 of them to form a patrol line some 750 miles southwest of the Azores by 1 June, in order to attack US-Gibraltar shipping. The 24 May order was decrypted the following day; the 26 May message was read on 3 June, and confirmed the previous order. As a result, not only were the threatened convoys diverted with such success that not one contact was made throughout June, but the Allies were able to re-deploy the carrier escort groups that had been protecting North Atlantic convoys, and these carrier escorts carried out a three-month's campaign of highly successful hunter-killer operations against the U-Boats in the mid-Atlantic. This campaign is discussed in Section 4.3.

(b) Decryption Intelligence provided detailed, accurate information of tactics employed by the U-Boats, hence making it unnecessary in some cases to learn them in the costly school of experience.

(c) Decryption Intelligence provided accurate and comprehensive information on new weapons and other devices, such as search receivers.

(d) Decryption Intelligence provided an excellent check on intelligence from other sources and supplemented them.

4.2. Tactical Use in the Defense of Convoys

With respect to its tactical value to the Allies, the decrypted intelligence could be used

(1) defensively, by diverting convoys already enroute when prompt decryption provided information on new concentrations of U-Boats along their original route;

(2) offensively, by using current information of U-Boat concentrations to vector hunter-killer groups to the area. This will be discussed in Section 4.3. *

* Defensive and offensive anti-submarine measures could sometimes be concurrent; that is, a convoy might be diverted because of special intelligence, while the escort carrier group attacked the U-Boat pack, keeping the boats submerged and thus making it very difficult for them to close the convoy.

The evaluation of the tactical effectiveness of decryption intelligence to the Allies in the defense of convoys is not at all as straightforward a problem as is its opposite number, discussed in Part 3. In that case, as has been shown, it is a fairly simple procedure to determine the particular convoys on which the Germans had good X-B intelligence, and hence a direct, usable measure of effectiveness of this intelligence is immediately available. This measure is not applicable to Allied intelligence.

Consider the four possible cases that might arise in a U-Boat war against convoys:

CASE I: Neither side has intelligence. This condition did not arise during any interval of 15 days or more in the period from 1 July 1942 to 31 March 1944.

CASE II: The U-Boat command has X-B intelligence on convoys; the Allies are restricted to reconnaissance. This was the case during Period I, from July 1942 to December 1942. The result should be to increase the number of contacts, since his intelligence would enable BdU to concentrate his boats in the known areas of greatest convoy density. It was seen in Part 3 of this report that the contact rate was greatest during this period.

CASE III: The Allies have accurate information on U-Boat dispositions and movements, while the enemy is dependent on U-Boat reconnaissance. This was the state of affairs during Period IV (September 1943-March 1944), and to a lesser extent in Period III (1 June-16 September 1943). This information would enable the Allies to route convoys around known U-Boat concentrations, or to divert them enroute; this should produce a decrease in the probability of a convoy being contacted. As a matter of fact, the contact rate during Period IV was less than two-thirds of that in Period I. (During Period III there were no operations against North Atlantic convoys.)

CASE IV: Both sides have partial intelligence of each other's movements. This was the usual state of affairs throughout nearly the whole Period II, from January 1943 to May 1943. In this case the contact rate might measure the effect of the X-B intelligence of convoy movements, but is not clear that it would measure the effectiveness of Allied intelligence; that is to say, it is not a priori evident that the existence of Allied intelligence would affect the number of contacts made by the U-Boats. In general, Allied intelligence restricted to U-Boats near enough to intercept convoys on which they had good intelligence, would not affect the contact rate, because the greater mobility of the U-Boat would tend to neutralize diversions. Allied

intelligence of U-Boats near convoys on which the enemy did not have good intelligence, should decrease the number of contacts. Actually, of course, the situation, as regards intelligence, in the Atlantic convoy war was not as simple as this, and was complicated by other factors, such as weather, U-Boat capabilities, etc. However, it seems likely that, on the average, the character and extent of the intelligence of U-Boat movements possessed by the Allies might, in any given time interval of significant duration, be reflected in the contact rate.

Several approaches to the problem suggest themselves, and can be formulated as follows:

(a) How did the overall quantity of pertinent decryptions--for example, the type "M" messages--during any given interval affect the contact rate?

(b) How did the knowledge of particular U-Boat wolf-packs, obtained from decryptions, affect the ability of these groups to contact convoys?

(c) What fraction of the non-contacted convoys owed their immunity to tactical diversions ordered because of knowledge of imminent U-Boat menace, when such knowledge was attributed to decryption intelligence?

The findings on these three questions are as follows:

(a) How did the overall quantity of pertinent decryptions--for example, the type "M" messages--during any given interval affect the contact rate?

In Table X the contact coefficients are listed by months together with the number of type "M" messages decrypted within 3 days of transmission, beginning with March 1943. The months from July to December are significant for comparison because during this period the Allies did no decrypting.

SECURITY INFORMATION

TABLE X

Month	Contact Coefficient Overall	Contact Coefficient Non-Compromised Convoys	Number of Type "M" Decrypted Within 3 Days
July 1942	1450	0	
August	3050	2900	
September	2100	1850	
October	2050	2000	
November	4550	5100	
December	2400	2350	
Average for Period I	2650	2450	
January 1943	2300	600	
February	1950	1750	
March	1700	3150	34
April	2600	1600	60
May	1900	2450	60
Average for Period II	2050	1400	
September 1943	2350	2350	22
October	1150	0	80
November	1550	1550	28
December	650	700	43
January 1944	2250	2250	45
February	3500	3200	31
March	850	850	33
Average for Period IV	1700	1700	

There is no direct correlation between the contact rate and the volume of promptly decrypted communications of the "M" type. This is to be expected, since the number of such messages transmitted by BdU fluctuated widely, and depended on the state of German X-B and on the number of contacts itself (there were likely to be more messages if few contacts were made, less if good intelligence was scarce).

It is apparent that the great value of decryption intelligence in the defense of convoys cannot be expressed quantitatively by this measure.

(b) How did the knowledge of particular U-Boat wolf-packs, obtained from decryptions, affect the ability of these groups to contact convoys?

The manner in which decryption intelligence played a part in the wolf-pack operations has been described in the Introduction and Part 1. From 1 March 1943 to 31 March 1944 there were 34 patrol groups (as distinct from attack groups formed after a convoy had been contacted) in the North Atlantic. The following Table XI summarizes the relation of the contact rate to the decryption intelligence possessed by the Allies.

TABLE XI

Relation between Contacts and Intelligence on U-Boat Groups

Number of cases in which decryption provided timely intelligence - - - - - - - - -	20*
Number of contacts made in these cases - - - -	16
Number of cases in which decryptions came after the contact or not at all - - - - - -	17*
Number of contacts made in these cases - - - -	15

No conclusion can be drawn from these figures, except the conclusion that this approach does not yield a quantitative measure of the value of Allied decryption intelligence. It must be borne in mind that they do not take into consideration some of the factors that affect the contact rate; for example, they do not include the fact that in some cases a diversion made, possibly, as the result of timely decryption, kept a large pack of boats uselessly sweeping a certain area, while

*The apparent discrepancy is due to the fact that a long-lived group, "MEISE", was assigned consecutive positions for three different convoys; another, "LEUTHEN", for two.

other possible targets skirted safely around the danger area; nor that in some cases, even when contact was eventually made, it had been delayed by diversions to a point such that BdU called off operations very soon after contact because too long a chase was involved.

(c) What fraction of the non-contacted convoys owed their immunity to tactical diversions ordered because of knowledge of imminent U-Boat menace, when such knowledge was attributed to decryption intelligence?

It has not been possible to find the answer to this question, for the following reasons:

(1) It is not possible to determine how many diversions were executed as a direct result of the menace of near-by submarines, as distinct from diversions ordered because of weather and ice conditions, or as a kind of routine device to confuse the U-Boat command generally. During the period from 1 December 1942 to 31 May 1943, every UK-US convoy, save one, was diverted from its original route at least once, and most of the convoys several times. In the case of about one-fifth of these diversions, the evidence available in the C&R reports indicates quite clearly that they were due to the known or assumed proximity of submarines; in the case of perhaps half, it is a reasonable assumption. In no case has it been possible to attribute the information concerning the presence of the submarines directly to decryption intelligence, as distinct from D/F and air reconnaissance.

(2) With regard to the convoys that were not contacted, it has not been found possible, save in a very few isolated cases, to state a definite reason for the failure to contact. It might be due to a tactical diversion, but also to the weather conditions, to the fact that BdU was concentrating the U-Boats on certain convoys about which he had very good X-B intelligence, or to the fact that most of the boats were chasing convoys already contacted and thus were not available for search,

4.3. Offensive Use by the Allies of Decryption Intelligence

As has been mentioned (Section 4.1), intelligence on U-Boat movements obtained by the Allies from decrypted messages in May

and June 1943, was instrumental in inaugurating the highly successful offensive campaign against the German submarines in the summer of that year. The functioning of decryption intelligence in this campaign is discussed as a representative example of the offensive possibilities of this kind of intelligence (Section 4.3.1.). In addition, the part played by decryption intelligence in the destruction of the German fleet of refueller submarines is considered in Section 4.3.2.

4.3.1. Hunter-Killer Operations Against the U-Boats in the Mid-Atlantic, June-August, 1943. On 24 May 1943 BdU ordered most of the North Atlantic U-Boats to the vicinity of 35°N, 42°W, about 750 miles southwest of the Azores, to intercept a US-Gibraltar convoy on or about 1 June. This message was decrypted within a day by the Allies, thus nullifying the expected advantages of the supposedly surprise move. A second message, transmitted by BdU on 26 May, organizing the boats into a pack with a designated patrol area, was decrypted on 7 June, and thus confirmed the shift of emphasis to the Mid-Atlantic. Throughout the summer, Allied decryptions, although scanty and frequently delayed (see Section 2.2 and Annex 2.2) continued to supply information regarding U-Boat movements to the Allied commands, which in several cases made it possible to vector CVE groups to their prey instead of having them systematically search a large area, thus effecting a very significant economy in force requirements.

(a) The Attacks on U-Boats by CVE groups.

All the attacks by CVE groups occurred in the area bounded by 25°-45°North Latitude, 20°-50°West Longitude. In this area according to the COMINCH listing, Allied A/S forces carried out during the period from 1 June to 15 September 44 attacks in which there was sufficient evidence of the presence of a submarine (A - G Assessments). Of these, 15 resulted in sinking and 9 damaging, U-Boats; the remaining 20 were assessed either as "no damage" or as "insufficient evidence of damage."

Of the 44 attacks, 35 can be identified as having been made on 30 known U-Boats. For details of the attacks on individual boats, the reader is referred to Annex 4.3, which lists all the U-Boats that, according to the daily listings in the BdU War Diary, spent more than two days in the area.

(LO) 2271-52

All but 7 of the 44 attacks occurred in nine campaigns; and six of the seven exceptions received F and G assessments. The nine campaigns are summarized in Table XII.

TABLE XII

Relation of Allied Decryption Intelligence to Attacks on U-Boats by CVE groups

	Date	CVE Group	Position	Results	Character of Allied Decryption Intelligence
1.	4 - 6 June 1943	BOGUE	30°N. 43°W	4/6: Attacked TRUTZ pack, sank U-217, damaged U-228, attacked 3 others.	Excellent. The 1 June location of the pack known by 25 May. A 26 May message, read on 7 June, confirmed formation of pack TRUTZ and gave patrol area.
2.	7-12 June	BOGUE	31°N. 34°W.	7/6: Damaged U-758 12/6: Sank U-118 (Refueller)	Very Good. U-460 and U-118 sent to help U-758, on 6 June. This message decrypted on 11 June.
3.	13-16 July	CORE	27°N. 34°W.	Sank U-487 (Refueller) and U-67, damaged another, attacked a fourth.	None. From 30 June to 12 July all decryptions 45 days or more late. From 13-16 July all at least 2 weeks late, except reports of attack.
4.	14-15 July	SANTEE	34°N. 27°W.	Sank U-160 and U-509, attacked three others.	None. See under 2.
5.	23 July	BOGUE	35°N. 28°W.	Sank U-527 and U-613, damaged U-373.	None. Same as under 2. From 17 July to 23 July all messages 2 weeks or more late.
6.	29 July	SANTEE	35°N. 35°W.	Sank U-43	None. One message sent by U-43 on 20 July was decrypted on 29 July.
7.	7-11 Aug.	CARD	39°N. 38°W.	Sank U-117 (Refueller), U-664, U-525. Attacked U-66 four times after damaging her on 3 Aug. Damaged U-262.	Good. U-117, U-66, and U-664 were ordered to a rendezvous on 30-31 July; messages decrypted by 1 August.

TABLE XII(continued)

Date	CVE Group	Position	Results	Character of Allied Decryption Intelligence
8. 23-25 Aug.	CORE	27°N. 27°W.	Sank U-185, and U-84, damaged U-406.	Very Good. From 15 - 20 August, nearly 20 pertinent messages decrypted with 4 days or less lag. A 19 August message ordering U-847 to refuel nine U-Boats (incl. U-185) at position of attack was decrypted on 21 Aug. Both CORE and CARD operated nearly simultaneously in the same area.
9. 27 Aug.	CARD	28°N 38°W	Sank U-847 (Refueller). Attacked U-508.	Very Good. See 8.

A significant characteristic of all the attacks listed in Table XII is that they involved concentrations of U-Boats, most of these refuelling rendezvous; in only one of them--the SANTEE attack of 29 July--was the bag only one boat. This fact indicates excellent intelligence.

It is evident from the chronicle of these CVE Hunter-Killer operations of the summer of 1943 that decryption intelligence was of tremendous potential aid to the Allied command. In the case of five of the nine attacks described in Table XII, decrypted messages could have been used directly to vector the CVE's to the U-Boat positions. With respect to the remaining four attacks--those in July--when no helpful decrypted messages were available, decryption intelligence was indirectly responsible to a great extent for the effectiveness of Allied intelligence in that

(i) decryption intelligence had, during the previous months, enabled the Allied command to understand the pattern of the German refuelling operations; consequently,

(ii) in the absence of actually decrypted messages designating a specific refuelling rendezvous, any unusual amount of radio traffic originating in a relatively small area and picked up by D/F could be evaluated intelligently with respect to the probability of its indicating a rendezvous;

(iii) U-Boats could be distinguished by means of RFP and TINA; but decryption intelligence definitely identified a given U-Boat as a refueller. Hence a message sent by a boat identified from previous decryptions as being a refueller, even if it could not be decrypted, might reveal the possibility of a refuelling rendezvous.

There is a possibility that the decryption service supplied good information that was not exploited by the Allied command, either because forces were not available, or in order to avoid danger of compromising this source. It is true that in the spring of the year several refuelling rendezvous were discovered promptly from decryptions, without the Allies using the information actively; during the summer, however, the evidence of the decrypted messages indicates that all the available pertinent information was fully exploited.

In passing, it should be stated that the performance of the Allied Hunter-Killer groups during July and August of 1943, aided

by decryption intelligence, appears all the more remarkable and brilliant, when it is realized that during these 60 days, nearly 40 attacks, resulting in 13 U-Boats sunk and 5 others damaged, occurred in an area extending 1200 miles by 1800 miles, in which the average number of U-Boats at any time was only 14. In fact, during the latter part of July, when the July attacks occurred, the average was 10.

(b) The Effect of Allied Decryption Intelligence on the Probability of a U-Boat Being Attacked.

The effectiveness of Allied decryption intelligence in the offensive operations just described can be expressed quantitatively by the increase in the probability of a U-Boat being attacked as a result of its movements being discovered from decrypted messages. It is assumed that if the position of a boat is revealed, it becomes more than normally vulnerable for a certain interval as a consequence. (In the calculation given here, this interval was assumed to be 5 days; the validity of this assumption is discussed below.) If the communication betraying the position, either current or prospective, is decrypted t days before the period of extra vulnerability expires, the boat is considered to be "in peril" during these t days.

Three probabilities are compared:

(1) The overall average probability of a U-Boat being attacked per day of its stay in the area selected during the period considered. This is given by the quotient of the total number of attacks during the period in the area divided by the total number of U-Boat days.

(2) The average probability of attack per day to be expected by a U-Boat imperilled as a consequence of decryption intelligence. This is the quotient of the number of attacks on these U-Boats during the period while they were in peril, divided by the total number of U-Boat days in peril.

(3) The average probability of attack per day expected by a U-Boat not imperilled because of decryption intelligence. This is the quotient of the number of attacks on these boats divided by the total number of days these boats spent in the area.

The data required for the calculations are tabulated in Table I of Annex 4.3, which lists, for all U-Boats that spent three or more days in the area during the period 1 June -

15 September 1943:

(i) The decrypted messages pertaining to each boat, with date of position or rendezvous, and delay in decryption;

(ii) The number of days "in peril" as a consequence of each decrypted communication;

(iii) attacks on each boat during the days it was "in peril."

The analysis yields the following results:

Total number of U-Boat Days in Area.....	1919
Total Number of Attacks.....	44
Total Number of U-Boats Sunk.....	15
Number of days U-Boats were in peril.....	246
Number of known attacks on U-Boats in peril.....	9*
Number of imperilled U-Boats sunk.....	5*
Number of U-Boat Days U-Boats were not in peril..	1673
Number of Attacks on U-Boats not imperilled.....	35
Number of not-imperilled U-Boats sunk.....	10

From these data we get:

(1) Overall average probability of attack per day in the area.....	2.3%
(2) Average probability of attack of imperilled U-Boat per day in the area.....	3.7%
(3) Average probability of attack of non-imperilled U-Boats per day in the area.....	2.1%

*Not including U-117, which was sunk one day after the jeopardy interval expired.

It appears that the average chance of attack per day to be expected by a U-Boat assumed to be in extra jeopardy if his position was discovered by decryption within 5 days was nearly twice as great as that to be expected by boats of which this was not the case.

A similar, more pronounced trend is noted in the comparative average probabilities per day of being sunk:

(1) Overall average probability of being sunk per day in the area..... 0.8%

(2) Average probability of imperilled U-Boat being sunk per day in the area..... 2.0%

(3) Average probability of non-imperilled U-Boat being sunk per day in the area..... 0.6%

The choice of five days as the "extra-jeopardy" interval is only to a certain extent arbitrary. A 10-day interval places most of the boats in jeopardy, and includes a large fraction of the total number of U-Boat days and nearly all the identified attacks. A 3-4 day interval results in a trivial case because of the extremely small number of decryptions made within that time during this period and because practically no attacks would be included. A 6-day interval gives probabilities comparable with those found by using a 5-day interval. These considerations make it reasonable to conclude (a) that the assumption of 5-6 days as the "extra jeopardy" interval is valid; and (b) that the direct tactical value of decryption intelligence in offensive operations dropped sharply if decryption was delayed more than 5-6 days.

4.3.2. Allied Decryption Intelligence in Relation to the Destruction of the German Refuelling Fleet.

Unless they could refuel while on station, the small 500-ton Type VII and 750-ton Type IX U-Boats were restricted to operating within 500-600 miles from their bases. The German command first used surface ships for supplying the boats, but this became impracticable in view of the increasing Allied superiority in surface ships and VLR aircraft, and the Germans were forced to build submersible supply boats. Two types were designed:

(1) Type X B, a combined minelayer and supply boat, with a fuel capacity of about 426 cubic meters, and equipped with two torpedo tubes;

(2) Type XIV, for supply purposes only, with a fuel capacity of about 740 cubic meters; no mines were carried, and they had no torpedo tubes.

The first refuellers, one of each type, were put in operation in April 1942. The Germans pushed construction of these vital craft with such energy that a year later they had nine in operation, besides having lost two. Up to the end of the war they commissioned 18 refuellers (10 type XIV, and 8 Type X B). Of these 18, 16 were sunk, all by June 1944.

The loss to the Germans of a refueller was extremely painful. It meant not merely that a very valuable, hard-to-replace craft was lost; but it also involved the shattering of carefully prepared refuelling schedules, and the consequent disruption of equally carefully prepared operations programs against convoys. This was especially the case if the refueller was sunk while on station in mid-ocean. It was among the latter that the CVE task groups took their heavy toll, and it was in this task, as shown in Section 4.3.1, that decryption intelligence was of such decisive potential importance.

A list of all the German refuellers, with data concerning sinkings and the contribution of decryption intelligence in each case, is presented in Table II of Annex 4.3. Following is a summary chronicle of the refuellers. Of the 16 refuellers sunk,

(a) Six were sunk in transit to (or from) their stations, five of these in the Bay of Biscay. In these cases there was, of course, no decryption intelligence, since the boats were not mentioned over the air until they arrived at their stations.

(b) of the ten sunk on station,

(i) two were sunk in 1942, before the Allies were decrypting;

(ii) in the case of three there is no evidence that decryption intelligence was of direct aid in locating them;

(iii) in the case of the remaining five, decryption intelligence was so prompt and complete, as to be a potential direct means of locating the boats. Two of these cases (U-117 and U-118) have been discussed in the preceding Section 4.3.1. One more was sunk in October 1943, two days after transmitting a rendezvous position which was decrypted a few hours later; a fourth in April 1944, four days after transmitting a rendezvous decrypted the same day; and the fifth in June 1944, on the day after she betrayed her position in a message which was decrypted within a few hours.

5. SUMMARY AND CONCLUSIONS

The findings of the study of the effectiveness of decryption intelligence in the case of both sides in the Convoy Battle of the Atlantic are summarized as follows:

5.1. Value of Decryption Intelligence to the Germans.

(a) The Germans obtained operationally useful decryption intelligence on roughly half of all our convoys from July 1942 to May 1943. As a result of the change of code in June 1943, useful X-B intelligence was obtained on only 4 out of 87 convoys from September 1943 to March 1943.

(b) From July 1942 to May 1943, there were nearly always sufficient convoys on which decryption intelligence was available to keep the U-Boats which had any degree of tactical mobility, well occupied. There is, therefore, no consistent relation between fluctuations in amount of intelligence available to the enemy, and his rate of contacting or attacking convoys.

(c) The above facts must not be interpreted as indicating that the availability of good radio intelligence did not have a marked effect on the success of U-Boat operations. The information obtained by X-B intelligence on specific convoys enabled the U-Boat command to select certain ones for pack operations, either ignoring others or leaving their detection to chance. As a result, the effectiveness of the U-Boats in contacting such selected convoys was increased to about 2½ times the figure when no X-B intelligence was available.

(d) Regarded from the opposite point of view, discovery of, and estimation of the magnitude of this effect, has permitted us for the first time to determine the true capabilities of World War II U-Boats, operated as the Germans operated, to find and attack targets without benefit of decryption intelligence. This information is potentially of the greatest value as a base in determining force requirements for the future, and extrapolating to the magnitude of future threats by boats having the same or different characteristics.

(e) U-Boats having no decryption intelligence were apparently capable of searching approximately only 1750 square miles per day for North Atlantic convoys. Their apparent search rate when all convoys are included (even those whose locations were compromised by decryption) was about 2350 square miles per day. Their ability to find compromised convoys alone was significantly higher--if it is expressed, purely conventionally, as a search rate corresponding to them, it is equivalent to 2850 square miles per day; indicating an effectiveness per

Summary

&

Conclusions

U-Boat about 160% as great as the U-Boat operating without intelligence. The ability of U-Boats to find compromised convoys specifically selected by the U-Boat command for attack was very high--expressed as a search rate, it was equivalent to 4450 square miles per day - a 250% increase over the search rate on non-compromised convoys.

(f) The figures cited above include the effects of Allied decryption of German U-Boat communications. During the period from July to December 1942, the Allies had no decryption intelligence on U-Boats; during this period the U-Boat search rate, computed on non-compromised convoys, was 2450 square miles per day. This is the nearest approximation to the real operational search rate provided by the data. It corresponds roughly to a sweep width of about 10 miles.

(g) Comparison of ship sinkings from compromised and non-compromised North Atlantic convoys makes it appear that, during the period from July 1942 to March 1944, probably about 100 fewer ships might have been sunk from these convoys if the U-Boats had been denied the benefit of decryption intelligence.

5.2 Value of Decryption Intelligence to the Allies.

(a) With respect to the defensive use of decryption intelligence by the Allies, (to divert and route convoys in order to evade known concentrations of U-Boats) it is not possible to express statistically the effect of such intelligence on the ability of convoys to avoid contact by the U-Boats. The overall figures indicate that during the period from September 1943 to March 1944, when the Allies read the German communications currently, the contact rate was reduced to two-thirds of the contact rate during the period from July to December 1942, when the Allies were not reading the German Cipher. This figure does not describe the value of Allied decryption completely. The relative sinking rate (per U-Boat day per convoy day in the area), on the other hand, during the Sep. 1943-March 1944 period, fell to about one-sixth the value of the July-December 1942 period. A part of this collapse of the U-Boat effort must be ascribed to the availability of prompt intelligence on U-Boat movements; increased effectiveness of anti-submarine measures and the failure of the X-B service to provide intelligence on convoys to the U-Boats, were responsible for some of it. It is not possible to determine how much credit should be ascribed to each of these factors.

(b) The offensive use of decryption intelligence in hunting down and killing U-Boats was studied for the period 1 June to 15 September 1943, in the area lying between 25°N - 45°N and 20°W - 50°W.

Of nine major attacks carried out by CVE task groups, decrypted messages could have been used directly to vector the CVE's to the U-Boat positions in the case of five; these attacks resulted in 15 U-Boats sunk and 9 more damaged.

On the basis of assumptions explained in the body of the report, it is found that the average probability of a U-Boat compromised by Allied decryption being attacked per day of its stay in the area was 3.7% as compared with 2.1% per day for a boat not so compromised--nearly a two-fold increase.

The corresponding probability per day of a U-Boat being sunk was 2.0% as compared with 0.6%--a three-fold increase.

Decryption intelligence was directly of assistance in the destruction of the highly important German submarine refuelling fleet. Of ten of these refuellers sunk on station in mid-ocean, decryptions of messages revealing their position could have been used directly to find them in the case of five. In the case of three others, decryption intelligence aided indirectly in providing general information concerning the refuelling procedure used by the U-Boats.

Submitted by:

C.E. BEHRENS
Operations Evaluation Group

Approved by:

JACINTO STEINHARDT
Director, Operations Evaluation Group

ANNEX 2.1.

GERMAN X-B INTELLIGENCE OF NORTH ATLANTIC CONVOYS

Table I of Annex 2.1 presents a summary by months of the percentage of the HX, SC, and ON convoys on which the Germans had good X-B intelligence.

TABLE I

Extent of German X-B Intelligence

Month and Year	No. of Convoys in Area	No. of Convoys on which X-B Provided "Good" Intelligence	Percent
Period I - 1 July-31 December 1942			
July 1942	18	7	39%
August 1942	17	8	47%
September 1942	19	7	37%
October 1942	16	2	13%
November 1942	14	6	43%
December 1942	16	7	44%
		Entire Period - - - -	37%
Period II - 1 January-31 May 1943			
January 1943	16	10	63%
February 1943	11	5	45%
March 1943	15	14	93%
April 1943	17	11	65%
May 1943	20	17	85%
		Entire Period	72%
Period IV - 16 September 1943-31 March 1944			
16-30 September 1943	9	0	0%
October 1943	16	3	19%
November 1943	12	0	0%
December 1943	13	1	8%
January 1944	12	0	0%
February 1944	12	0	0%
March 1944	13	0	0%
		Entire Period- - - - -	5%
		Average for All Three Periods- - - - -	37%

Table II of Annex 2.1 presents a detailed "case history" of each HX, SC, and ON convoy during the period under consideration, comprising an estimate of the quality of the X-B intelligence on each convoy, pertinent data extracted from the BdU War Diary, and data concerning contacts and attacks. Information on diversions of convoys is not included, since examination of the Convoy & Routing jackets of these convoys during the period December 1942-May 1943 showed that every convoy except one was diverted at least once; reasons for the diversions are not evident, and ascribing a given diversion to intelligence concerning U-Boat dispositions would be a matter of subjective opinion.

The manner in which the German U-Boat command exploited the available decryption intelligence on convoys is discussed in Part 3.

The following explanatory comments on Table II are pertinent:

TABLE II

(a) Estimate of the quality of the X-B intelligence is indicated by the letters "G" and "N". "G" indicates the availability of X-B information on the given convoy which is considered to have been potentially useful to BdU in disposing his U-Boats if he wished to operate against it. "N" indicates that, with respect to a given convoy, he had either no intelligence, or that the intelligence available was of no direct use, because it came too late, or was too indefinite or scanty. The estimate in each case is made according to the criterion defined in Section 2.1 of the report.

(b) The remarks in Column 3 are extracts from the BdU War Diary. The numbers are designations applied to specific convoys in the Diary, and are included for convenience in reference. In each case in which BdU mentions X-B intelligence pertaining to a given convoy, this is indicated, together with the use he made of it, if any.

SECURITY INFORMATION

TABLE II (1)

Convoys between U.S.-Canada and U.K.
1 July 1942-31 May 1943
and
16 September 1943-31 March 1944.

Month	Convoy	X-B Intelligence	BdU War Diary	Contact	Sinkings
July 1942	HX 196	N			
	HX 197	N			
	HX 198	G			
	HX 199	N			
	SC 89	N			
	SC 90	N			
	SC 91	N			
	SC 92	G			
	SC 93	N			
	ON 107	N			
	ON 108	N			
	ON 109	N			
	ON 110	G			
	ON 111	N			
	ON 112	G			
	ON 113	G	No. 37	23/7	3
	ON 114	G			
	ON 115	G	No. 38	3/8	4

~~SECURITY INFORMATION~~

TABLE II (2)

Month	Convoy	X-B Intelligence	BdU War Diary	Contact	Sinkings
August 1942	HX 200	N			
	HX 201	N			
	HX 202	N			
	HX 203	G			
	SC 94	N	No. 40	5/8	11
	SC 95	N	No. 42. Doubt that it is convoy.	15/8	2
	SC 96	G			
	SC 97	G	No. 49	31/8	2
	ON 116	N	No. 39. No attack.	4/8	
	ON 117	N			
	ON 118	N			
	ON 119	N	X-B pos. for 14/8 on 13/8. Confused with SC 95.	14/8	
	ON 120	G			
	ON 121	G			
	ON 122	G	No. 47	22/8	4
	ON 123	G			
	ON 124	G			

TABLE II (3)

Month	Convoy	X-B Intelligence	BdU War Diary	Contact	Sinkings
September 1942	HX 204	N			
	HX 205	N			
	HX 206	N	No. 52	13/9	
	HX 207	G			
	HX 208	G			
	SC 98	N			
	SC 99	N			
	SC 100	G	No. 54. 23 U/B's to attack.	18/9	5
	SC 101	G		28/9	1
	SC 102	G			
	ON 125	N			
	ON 126	N			
	ON 127	N	No. 50	9/9	8
	ON 128	N			
	ON 129	N	No. 53. Poor weather.	11/9	5
	ON 130	N			
	ON 131	N		24/9	1
	ON 132	G	No. 56. Lost Contact.	26/9	1
	ON 133	G			

~~SECURITY INFORMATION~~ TABLE II (4)

Month	Convoy	X-B Intelligence	BdU War Diary	Contact	Sinkings
October 1942	HX 209	N		4/10	1
	HX 210	N			
	HX 211	N			
	HX 212	N	No. 62	26/10	7
	SC 103	N	Sighted 9/10.	9/10	1
	SC 104	N	No. 59	12/10	8
	SC 105	N			
	SC 106	G			
	ON 134	N			
	ON 135	N			
	ON 136	N	No. 58	11/10	4
	ON 137	N	No. 60	16/10	2
	ON 138	N			
	ON 139	G	No. 61	22/10	
	ON 140	N			
	ON 141	N			

TABLE II (5)

Month	convoy	X-B Intelligence	BdU war Diary	contact	Sinkings
November 1942	HX 213	N	No. 64. Confused with SC 107.	30/10	
	HX 214	G			
	HX 215	G			
	HX 216	N		26/11	1
	SC 107	G	No. 64. X-B: places pack.	1/11	16
	SC 108	G			
	SC 109	G	Prob. No. 67.	18/11	1
	SC 110	N		26/11	1
	ON 142	N	No. 65. (Confused with ON 143)	7/11	2
	ON 143	N			
	ON 144	G	No. 66	16/11	5
	ON 145	N	U-518 attacks a C/V in this vicinity.	21/11	1
	ON 146	N		3/12	1
	ON 147	N			
December 1942	HX 217	N	No. 68. Confused with SC 111 nearby. (SC 111 lost no ships).	6/12	3
	HX 218	G	No. 69. X-B course.	13/12	
	HX 219	N			
	HX 220	N			

TABLE II (6)

Month	convoy	X-B Intelligence	BdU war diary	contact	sinkings
December 1942 (ctd.)	SC 111	N			
	SC 112	G			
	SC 113	N			
	SC 114	N			
	ON 148	G		7/12	1
	ON 149	N			
	ON 150	G			
	ON 151	G			
	ON 152	G	No. 69. (confused with HX 218).	16/12	2
	ON 153	N	No. 70	15/12	6
	ON 154	G	No. 72	26/12	13
	ON 155	N			
January 1943	HX 221	G			
	HX 222	G	X-B: pos. to place pack.	17/1	1
	HX 223	G	X-B: pos. to place pack.	25/1	1
	HX 224	N	No. 4	1/2	3
	SC 115	G		10/1	2
	SC 116	G			
	SC 117	G	No. 3	23/1	3
	SC 118	G	No. 6. X-B: pos. to place pack.	4/2	12

TABLE II (7)

Month	Convoy	X-B Intelligence	BdU War Diary	Contact	Sinkings
January 1943 (ctd.)	ON 156	G		29/12	
	ON 157	G			
	ON 158	G			
	ON 159	N			
	ON 160	N			
	ON 161	N			
	ON 162	N			
	ON 163	N			
February 1943	HX 225	N			
	HX 226	G	X-B pos. to place pack.		
	HX 227	G	No. 13. X-B pos. to place pack.	27/2	1
	SC 119	G			
	SC 120	N			
	ON 164	N			
	ON 165	N	No. 9	17/2	3
	ON 166	N	No. 10	20/2	15
	ON 167	N	No. 11	18/2	2
	ON 168	G	No. 13. Confused with HX 227.	1/3	1
	ON 169	G	X-B to place pack. No mention of sinking.	7/3	1

TABLE II (8)

Months	Convoy	X-B Intelligence	BdU War Diary	Contact	Sinkings
March 1943	HX 228	G	No. 16. X-B to place pack.	10/3	7
	HX 229	G	No. 19. X-B gives diversion.	15/3	13
	HX 229A	G			
	HX 230	G	No. 21	29/3	1
	SC 121	G	No. 15. X-B to place pack.	6/3	14
	SC 122	G	X-B pos. combined ops with HX 229.	15/3	9
	SC 123	G	X-B pos. to place pack.		
	SC 124	G			
	ON 170	G	Contact not developed.	13/3	
	ON 171	G			
	ON 172	G			
	ON 173	G			
	ON 174	N	No. 20	26/3	
	ON 175	G			
	ONS 1	G	X-B to place pack.		
April 1943	HX 231	G	No. 24	4/4	6
	HX 232	G	No. 26	10/4	4
	HX 233	G	No. 27	15/4	1

~~SECURITY INFORMATION~~ TABLE II (9)

Month	Convoy	X-B Intelligence	B&U War Diary	Contact	Sinkings
April 1943 (ctd.)	HX 234	G	No.28. X-B to place pack.	21/4	3
	HX 235	G	Pack to Expect.		
	HX 236	N			
	SC 125	G			
	SC 126	G			
	SC 127	G	X-B pos. & Diversion.		
	SC 128	G	No. 34. X-B pos. to place pack.	1/5	
	ON 176	N	No. 25	10/4	2
	ON 177	N			
	ON 178	N	No. 29	18/4	1
	ON 179	G		22/4	
	ONS 2	N			
	ONS 3	N			
	ONS 4	G	No. 30	23/4	
May 1943	HX 237	G	No. 38. X-B pos. 8/5.9/5		4
	HX 238	G			
	HX 239	G	No. 42. X-B pos. 19/5.	22/5	
	HX 240	G			
	HX 241	G			
	SC 129	G	No. 39. X-B diversion.	11/5	2

~~SECURITY INFORMATION~~ TABLE II (10)

Month	Convoy	X-B Intelligence	BdU War Diary	Contact	Sinkings
May 1943 (ctd.)	SC 130	G	No. 41. X-B to place pack.	18/5	
	SC 131	N	No. 43	25/5	
	SC 132	G			
	ON 180	G			
	ON 181	G			
	ON 182	G			
	ON 183	G			
	ON 184	G	X-B pos. No. ops.	22/5	
	ON 185	N			
	ON 186	N			
	ONS 5	G	No. 33. Exp. 28/4. No. 36-Confused with ON 180 nearby 4/5.	29/4 5/5	2 11
	ONS 6	G	C/V of U-418 (6/5) and U-952 (8/5).	6/5	
	ONS 7	G	No. 40	13/5	1
	ONS 8	G			
16-30 September 1943	HX 255	N			
	HX 256	N			
	HX 257	N	Pack to operate.		
	HX 258	N			
	SC 142	N	Sighted. No U/B's available for ops.	23/9	

TABLE II (11)

Month	Convoy	X-B Intelligence	BdU War Diary	Contact	Sinkings
16-30 September 1943 (ctd.)	ON 201	N			
	ON 202	N	No. 43. Dead Reckoning places pack to intercept.	19/9	5
	ON 203	N	Pack placed by X-B straggler route.		
	ONS 18	N	(Merged with ON 202).	20/9	1
October 1943	HX 259	N	X-B places pack (CV evades).		
	HX 260	N			
	HX 261	N	Dead Reckoning pos. fails.		
	HX 262	N			
	HX 263	N	Dead Reckoning pos. fails.		
	SC 143	G	No. 44. X-B Straggler Route (Checks actual course of C/V).	9/10	3
	SC 144	N	X-B too late.		
	SC 145	N			
	ON 204	G	X-B: Straggler Route and Rendezvous. (CV crosses pack line).		
	ON 205	N	X-B late.		
	ON 206	N	X-B to plan attack.		
	ON 207	N			
	ON 208	N			

TABLE II (12)

Month	Convoy	X-B Intelligence	BdU War Diary	Contact	Sinkings
October 1943 (ctd.)	ONS 19	N	X-B suspect deception.		
	ONS 20	G	No. 45. X-B helps to place pack.	15/10	1
	ONS 21	N	X-B late. Straggler Route used to place pack.		
November 1943	HX 264	N	Says X-B gives route. (No evidence. C/V evades).		
	HX 265	N	X-B: place pack. Contact too late for ops.	14-15/11	
	HX 266	N			
	HX 267	N			
	SC 146	N			
	SC 147	N	X-B: place pack.		
	ON 209	N			
	ON 210	N	Says X-B shows C/V South. (No evidence). Attack unsuccessful.	13/1	
	ON 211	N			
	ON 212	N			
	ONS 22	N	X-B too late.		
	ONS 23				
December 1943	HX 268	G	X-B place pack. (C/V evades).		

TABLE II (13)

Month	Convoy	X-B Intelligence	BdU War Diary	Contact	Sinkings
December 1943 (ctd.)	HX 269	N			
	HX 270	N			
	HX 271	N		26/12	
	HX 272	N			
	SC 148	N			
	SC 149	N			
	ON 213	N	X-B: place pack.		
	ON 214	N			
	ON 215	N	A/C recce. to place pack.		
	ON 216	N			
	ONS 24	N	Dead Reckoning to place pack.		
	ONS 25	N			
January 1944	HX 273	N			
	HX 274	N			
	HX 275	N			
	HX 276	N			
	SC 150	N			
	SC 151	N			
	ON 217	N	Northern U/B contacts. C/V too far North for pack ops.	30/12	2
	ON 218	N			

TABLE II (14)

Month	Convoy	X-B Intelligence	BdU War Diary	Contact	Sinkings
January 1944 (ctd.)	ON 219	N	U-960 sinks ship 16/1. (This ship in ON 219).	16/1	1
	ON 220	N	A/C sighting followed by U/B contact next day.	19/1	
	ONS 26	N			
	ONS 27	N			
February 1944	HX 277	N			
	HX 278	N	Contact near Nfdld.	9/2	1
	HX 279	N			
	SC 152	N	U/B contacts-No attack. Pack to operate. Fails.	7/2	
	SC 153	N			
	ON 221	N			
	ON 222	N	U/B contact followed by ops by 7 U/B's. Fails.	3/2	
	ON 223	N		10/2	
	ON 224	N	Escorts sighted. 10/2.	?	
	ON 225	N			
	ONS 28	N			
	ONS 29	N	X-B rendezvous to place pack. Failed.		

~~SECURITY INFORMATION~~ TABLE II (15)

Month	Convoy	X-B Intelligence	BdU War Diary	Contact	Sinkings
March 1944	HX 280	N	U/B claims hit on DD. (No record)	10/3	
	HX 281	N			
	HX 282	N	U/B driven off by escort. C/V not contacted.		
	HX 283	N			
	HX 284				
	SC 154	N			
	SC 155	N			
	ON 226	N			
	ON 227	N			
	ON 228	N			
	ON 229	N			
	ONS 30	N			
	ONS 31	N			

ANNEX 2.2.

DAY BY DAY SUMMARY OF DECRYPTIONS

TYPE OF MESSAGE	P				M				C				TOTALS				TOTAL
DELAY IN DAYS	1	2	3	4-10	1	2	3	4-10	1	2	3	4-10	1	2	3	4-10	
MARCH 1	0	1	0	4	0	0	1	3	0	4	1	13	0	5	2	20	27
2	2	0	0	8	1	0	0	3	0	0	0	3	3	0	0	14	17
3	3	1	0	4	0	0	0	2	0	0	0	0	3	1	0	6	10
4	2	2	0	2	0	2	0	1	0	1	0	0	2	5	0	3	10
5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
6	0	0	0	6	0	0	0	6	0	0	1	13	0	0	1	25	26
7	0	0	0	0	0	0	0	3	0	0	1	5	0	0	1	8	9
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	7	0	0	0	2	0	0	0	10	2	0	0	19	2	21
10	1	5	4	8	0	2	0	2	0	18	3	11	1	25	7	21	54
11	2	0	0	1	0	0	0	1	3	2	0	7	5	2	0	9	16
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	3	2	4	0	0	0	0	0	26	7	9	0	29	9	13	51
17	1	5	5	5	0	1	1	0	0	36	22	16	1	42	28	21	92
18	7	2	8	6	0	0	0	0	15	5	12	11	22	7	20	17	66
19	0	0	1	4	0	0	0	0	7	0	8	39	7	0	9	43	59
20	0	4	12	7	0	1	5	1	0	2	3	0	0	7	20	8	35
21	0	2	0	0	0	0	0	0	1	0	0	1	1	2	0	1	4
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	2	0	1	0	1	0	0	0	1	0	0	0	4	0	1	5
24	0	0	0	1	0	2	0	1	0	0	0	3	0	2	0	5	7
25	0	0	0	6	0	0	0	5	0	0	0	6	0	0	0	17	17
26	0	0	0	6	0	0	0	6	0	0	0	11	0	0	0	23	23
27	0	[illegible]	[illegible]	0	0	0	2	1	0	21	12	2	0	22	14	3	39
28	7	2	2	2	2	1	0	0	5	9	1	3	14	12	3	5	34
29	[illegible]	[illegible]	0	1	2	2	0	0	2	3	0	0	8	12	0	1	21
30	22	[illegible]	0	1	2	0	0	0	4	1	0	0	28	4	0	1	33
31	[illegible]	[illegible]	[illegible]	0	2	2	0	0	1	0	0	0	6	6	0	0	12
TOTALS	54	44	41	77	9	14	11	36	38	129	81	155	101	187	133	268	
TOTAL	216				70				403				689				689

ANNEX 2.2.

DAY BY DAY SUMMARY OF DECRYPTIONS

TYPE OF MESSAGE	P				M				C				TOTALS				TOTAL
DELAY IN DAYS	1	2	3	4-10	1	2	3	4-10	1	2	3	4-10	1	2	3	4-10	
APRIL 1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	2
4	0	10	1	1	0	6	0	1	0	22	2	0	0	38	3	2	43
5	3	3	1	0	3	1	0	0	38	13	7	3	44	17	8	3	72
6	6	4	0	0	4	0	0	0	15	7	0	0	25	11	0	0	36
7	4	0	0	0	0	0	0	0	3	0	0	0	7	0	0	0	7
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
10	0	1	0	0	3	0	0	0	19	5	0	0	22	6	0	0	28
11	1	0	0	8	0	0	0	4	12	0	0	30	13	0	0	42	55
12	0	2	6	3	0	0	3	2	0	5	4	21	0	7	13	26	46
13	0	8	0	2	0	1	0	3	0	4	0	3	0	13	0	8	21
14	0	0	0	2	0	0	0	1	0	0	0	1	0	0	0	4	4
15	0	0	0	6	0	0	0	8	0	0	0	3	0	0	0	17	17
16	0	0	3	1	0	1	3	0	0	0	2	4	0	1	8	5	14
17	1	2	0	0	1	0	0	0	0	4	0	0	2	6	0	0	8
18	6	1	0	0	1	0	0	0	2	0	0	0	9	1	0	0	10
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	2	1	0	0	0	0	0	0	2	0	0	0	4	1	0	5
21	2	0	0	0	7	0	0	0	30	0	0	0	39	0	0	0	39
22	1	11	0	2	1	3	0	1	10	2	0	2	12	16	0	5	33
23	5	0	1	0	8	0	0	1	52	2	5	2	65	2	6	3	76
24	3	0	0	0	3	0	0	0	52	5	0	5	58	5	0	5	68
25	9	0	1	0	9	0	0	0	14	0	0	0	32	0	1	0	33
26	2	0	0	0	2	0	0	0	4	0	0	0	8	0	0	0	8
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS	43	46	16	25	42	12	6	21	251	71	20	74	336	129	42	120	
TOTALS	130				81				416				627				627

(1)22(1)-32

TOP SECRET

SECURITY INFORMATION

TOP SECRET

TOP SECRET CANOE

TOP SECRET

ANNEX 2.2

DAY BY DAY SUMMARY OF DECRYPTIONS

TYPE OF MESSAGE		P				M				C				TOTALS				
DELAY IN DAYS		1	2	3	4-10	1	2	3	4-10	1	2	3	4-10	1	2	3	4-10	TOTAL
MAY	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	3	2	0	0	1	1	0	0	0	0	0	0	4	3	0	7
	4	6	2	0	0	6	0	0	0	24	1	0	4	36	3	0	4	43
	5	10	1	0	3	1	0	0	2	36	0	1	55	47	1	1	60	109
	6	0	0	15	2	0	0	4	0	0	0	23	8	0	0	42	10	52
	7	0	4	0	0	0	2	0	0	0	3	3	1	0	9	3	1	13
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	11	0	0	0	4	0	0	0	4	0	0	0	19	19
	11	0	0	0	12	0	0	0	6	0	0	0	25	0	0	0	43	43
	12	0	27	5	8	0	7	3	1	0	45	23	7	0	79	31	16	126
	13	16	6	1	3	3	1	0	0	38	13	1	2	63	20	2	5	90
	14	4	0	16	4	0	0	3	0	8	0	5	0	12	0	24	4	40
	15	0	6	0	0	0	2	0	0	0	2	0	1	0	10	0	1	11
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	17	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	3	3
	18	2	0	0	0	2	0	0	0	0	0	0	0	4	0	0	0	4
	19	0	1	0	0	3	1	0	0	25	5	0	1	28	7	0	1	36
	20	11	3	0	3	0	4	0	0	9	7	0	0	20	14	0	3	37
	21	8	0	0	1	4	0	0	1	7	0	0	0	19	0	0	2	21
	22	5	4	0	2	0	1	0	0	3	4	0	0	8	9	0	2	19
	23	27	2	2	0	4	0	0	0	7	0	0	0	36	2	2	0	42
	24	8	0	0	1	1	0	0	0	0	0	0	0	9	0	0	1	10
	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	28	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	2
	29	0	0	0	9	0	0	0	0	0	0	0	1	0	0	0	10	10
	30	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	2
	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		97	59	41	63	30	19	11	16	157	80	56	110	284	158	108	189	
TOTAL		260				76				403				739				739

ANNEX 2.2

DAY BY DAY SUMMARY OF DECRYPTIONS

TYPE OF MESSAGE		P				M				C				TOTALS				TOTAL
DELAY IN DAYS		1-2	3-5	6-10	11-15	1-2	3-5	6-10	11-15	1-2	3-5	6-10	11-15	1-2	3-5	6-10	11-15	
JUNE	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8	0	5	0	0	0	3	0	0	0	3	0	0	0	11	0	0	11
	9	3	4	0	0	0	3	0	0	0	0	0	0	3	7	0	0	10
	10	0	2	0	0	0	2	0	0	0	0	0	0	0	4	0	0	4
	11	0	0	0	0	0	3	0	0	0	0	0	0	0	3	0	0	3
	12	1	0	0	0	1	1	0	0	4	1	0	0	6	2	0	0	8
	13	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1
	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2	0	2
	16	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2	0	2
	17	0	0	4	0	0	0	2	0	0	0	0	0	0	0	6	0	6
	18	0	6	0	0	0	6	0	0	0	0	0	0	0	12	0	0	12
	19	0	1	0	0	0	0	0	0	0	1	0	0	0	2	0	0	2
	20	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	3	3
	21	0	1	0	0	0	3	0	2	0	0	1	0	0	4	1	2	7
	22	0	3	0	0	0	1	0	0	0	0	0	0	0	4	0	0	4
	23	0	1	0	1	0	0	0	1	0	0	0	1	0	1	0	3	4
	24	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	2
	25	0	0	2	2	0	0	0	2	0	0	0	0	0	0	2	4	6
	26	0	0	2	0	0	0	1	0	0	0	0	0	0	0	3	0	3
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	28	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	2
	29	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		4	23	8	6	2	22	7	8	4	5	3	1	10	50	16	17	
TOTAL			41				39				13				93			93

ANNEX 2.2

DAY BY DAY SUMMARY OF DECRYPTIONS

TYPE OF MESSAGE	P				M				C				TOTALS				TOTAL
DELAY IN DAYS	1-2	3-5	6-10	11-15	1-2	3-5	6-10	11-15	1-2	3-5	6-10	11-15	1-2	3-5	6-10	11-15	
JULY 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1
13	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	2
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2	2
18	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
19	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	2	2
20	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
24	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	2	2
25	0	0	0	0	0	0	1	0	0	0	2	0	0	0	3	0	3
26	0	0	0	0	0	0	3	0	0	0	1	0	0	0	4	0	4
27	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	2
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	1	0	0	0	2	0	0	0	0	0	0	0	3	0	0	0	3
31	1	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	2
TOTALS	2	0	3	4	3	0	4	3	0	2	3	3	5	2	10	10	
TOTAL	9				10				8				27				27

ANNEX 2.2

DAY BY DAY SUMMARY OF DECRYPTIONS

TYPE OF MESSAGE		P				M				C				TOTALS				TOTAL
DELAY IN DAYS		1-2	3-5	6-10	11-15	1-2	3-5	6-10	11-15	1-2	3-5	6-10	11-15	1-2	3-5	6-10	11-15	
AUGUST	1	1	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	2
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	2	2
	4	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	3	3
	5	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2	0	2
	6	0	0	3	0	0	0	3	0	0	0	0	0	0	0	6	0	6
	7	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1
	8	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2	2
	9	0	0	1	0	0	0	0	2	0	0	0	1	0	0	1	3	4
	10	0	0	2	0	0	0	1	2	0	0	1	0	0	0	4	2	6
	11	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1
	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	13	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1
	14	0	1	0	0	0	5	0	1	0	0	0	0	0	6	0	1	7
	15	0	1	1	0	0	1	0	0	0	0	0	0	0	2	1	0	3
	16	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
	17	0	2	0	0	0	1	0	0	0	0	0	0	0	3	0	0	3
	18	0	1	0	0	0	3	0	0	0	1	0	0	0	5	0	0	5
	19	1	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	2
	20	0	2	0	1	0	2	0	0	0	0	0	0	0	4	0	1	5
	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	23	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1
	24	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1
	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1
	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		2	8	8	3	2	14	5	8	0	3	3	3	4	25	16	14	
TOTAL			21				29				9				59			59

2.2-6

ANNEX 2.2

DAY BY DAY SUMMARY OF DECRYPTIONS

TYPE OF MESSAGE		P				M				C				TOTALS				TOTAL
DELAY IN DAYS		1-2	3-5	6-10	11-15	1-2	3-5	6-10	11-15	1-2	3-5	6-10	11-15	1-2	3-5	6-10	11-15	
SEPT.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	2	2
	6	0	0	0	0	0	1	0	0	0	1	0	0	0	2	0	0	2
	7	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
	8	0	3	0	0	0	2	2	0	0	0	0	0	0	5	2	0	7
	9	0	1	0	0	0	0	0	0	0	1	0	0	0	2	0	0	2
	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	13	0	1	0	0	0	2	1	0	0	0	0	0	0	3	1	0	4
	14	0	1	0	0	0	1	0	0	0	0	0	0	0	2	0	0	2
	15	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	2
TOTALS		0	9	0	1	0	8	3	1	0	2	0	0	0	19	3	2	
TOTAL			10				12				2				24			24

ANNEX 2.2

DAY BY DAY SUMMARY OF DECRYPTIONS

TYPE OF MESSAGE	P				M				C				TOTALS				TOTAL
DELAY IN DAYS	1	2	3	4-10	1	2	3	4-10	1	2	3	4-10	1	2	3	4-10	
SEPT. 16	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3
17	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	1	2
20	0	0	0	0	0	0	0	4	0	0	0	16	0	0	0	20	20
21	0	0	1	4	0	0	1	1	0	0	5	13	0	0	7	18	25
22	0	9	0	0	0	3	0	0	0	26	0	0	0	38	0	0	38
23	2	1	3	0	2	1	0	0	12	1	8	1	16	3	11	1	31
24	2	3	0	0	0	3	0	0	0	4	0	0	2	10	0	0	12
25	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	0	2
26	0	0	0	2	1	0	0	0	0	0	0	0	1	0	0	2	3
27	0	0	0	1	0	4	0	0	0	0	0	0	0	4	0	1	5
28	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1
29	1	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	2
30	0	0	0	0	2	0	0	0	1	0	0	0	3	0	0	0	3
TOTALS	5	16	4	7	8	13	1	5	13	31	13	31	26	60	18	43	
TOTAL		32				27				88				147			147

2.2-8

ANNEX 2.2

DAY BY DAY SUMMARY OF DECRYPTIONS

TYPE OF MESSAGE		P				M				G				TOTALS				TOTAL
DELAY IN DAYS		1	2	3	4-10	1	2	3	4-10	1	2	3	4-10	1	2	3	4-10	
OCTOBER	1	0	0	1	0	1	0	1	1	1	0	1	1	2	0	3	2	7
	2	0	0	1	1	0	0	2	1	0	0	0	0	0	0	3	2	5
	3	0	0	0	1	0	1	0	4	0	0	0	3	0	1	0	8	9
	4	0	0	0	2	0	0	0	4	0	0	0	3	0	0	0	9	9
	5	0	0	0	1	0	2	0	0	0	1	0	1	0	3	0	2	5
	6	1	0	0	0	4	0	0	0	2	0	0	0	7	0	0	0	7
	7	3	0	0	0	5	2	0	0	3	2	0	0	11	4	0	0	15
	8	4	0	0	0	7	0	1	0	12	0	0	0	23	0	1	0	24
	9	4	0	1	0	1	0	0	1	3	0	0	0	8	0	1	1	10
	10	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	3	3
	11	0	0	1	2	0	0	1	0	0	0	0	0	0	0	2	2	4
	12	0	3	0	0	0	1	2	0	1	3	0	0	1	7	2	0	10
	13	3	1	1	0	1	2	0	0	1	0	0	0	5	3	1	0	9
	14	0	3	0	0	1	2	0	0	0	0	0	0	1	5	0	0	6
	15	7	0	0	0	2	2	0	0	0	3	0	0	9	5	0	0	14
	16	3	0	0	0	4	0	0	0	11	0	0	0	18	0	0	0	18
	17	9	0	0	0	7	0	0	0	18	0	0	0	34	0	0	0	34
	18	4	0	0	1	2	0	0	5	3	0	0	2	9	0	0	8	17
	19	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	3	3
	20	0	0	0	1	0	0	0	3	0	0	0	1	0	0	0	5	5
	21	0	0	0	5	0	0	0	0	0	0	0	1	0	0	0	6	6
	22	0	0	0	1	9	0	4	0	0	0	0	0	0	0	4	1	5
	23	0	1	0	0	0	1	0	1	0	0	0	0	0	2	0	1	3
	24	3	0	0	0	2	0	0	0	0	0	0	0	5	0	0	0	5
	25	0	0	0	0	1	0	0	0	2	0	0	0	3	0	0	0	3
	26	1	1	0	0	5	0	0	0	6	0	0	0	12	1	0	0	13
	27	3	0	0	0	2	0	0	0	1	0	0	0	6	0	0	0	6
	28	2	0	0	0	3	0	0	0	1	0	0	0	6	0	0	0	6
	29	1	0	0	0	2	0	0	0	2	0	0	0	5	0	0	0	5
	30	1	0	0	0	2	2	0	0	1	0	0	0	4	2	0	0	6
	31	2	0	0	0	2	0	0	0	0	0	0	0	4	0	0	0	4
TOTALS		51	9	5	17	54	15	11	23	68	4	1	13	173	33	17	53	
TOTAL			82				103				91				276			276

ANNEX 2.2

DAY BY DAY SUMMARY OF DECRYPTIONS

TYPE OF MESSAGE	P				M				G				TOTALS				TOTAL
DELAY IN DAYS	1	2	3	4-10	1	2	3	4-10	1	2	3	4-10	1	2	3	4-10	
NOV. 1	1	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	2
2	2	0	0	0	6	0	0	0	0	1	0	0	8	1	0	0	9
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1
5	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	1	2
6	0	1	0	0	0	3	0	0	0	2	0	0	0	6	0	0	6
7	2	0	0	0	1	0	0	3	0	0	0	0	3	0	0	3	6
8	0	0	3	0	0	0	1	0	0	0	1	0	0	0	5	0	5
9	1	0	0	0	1	0	0	0	2	1	0	0	4	1	0	0	5
10	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	2
11	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1
12	0	2	0	0	0	1	0	0	0	0	0	0	0	3	0	0	3
13	0	0	0	0	1	0	0	0	4	0	0	0	5	0	0	0	5
14	0	0	0	0	5	0	0	0	1	0	0	0	6	0	0	0	6
15	0	0	0	0	2	0	0	0	1	0	0	0	3	0	0	0	3
16	3	0	0	0	1	0	0	0	4	0	0	0	8	0	0	0	8
17	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
18	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
19	1	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	2
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	1	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	2
24	1	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	2
25	2	0	0	0	0	0	0	0	1	0	0	0	3	0	0	0	3
26	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1
27	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
28	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	1	0	0	0	1	0	0	0	2	0	0	0	2
TOTALS	18	3	3	1	23	4	1	3	10	5	3	0	57	12	7	4	
TOTAL		25				31				24				80			80

ANNEX 2.2

DAY BY DAY SUMMARY OF DECRYPTIONS

TYPE OF MESSAGE		T				M				C				TOTALS				TOTAL
DELAY IN DAYS		1	2	3	4-10	1	2	3	4-10	1	2	3	4-10	1	2	3	4-10	
DEC.	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
	2	2	0	0	0	1	0	0	0	0	0	0	0	3	0	0	0	3
	3	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
	4	1	0	0	1	0	0	1	0	0	0	0	0	1	0	1	1	3
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	2
	7	0	0	0	0	3	0	0	0	0	0	0	0	3	0	0	0	3
	8	3	0	0	0	3	0	0	0	0	0	0	0	6	0	0	0	6
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3
	11	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	2
	12	0	0	0	0	4	0	0	0	0	0	0	0	4	0	0	0	4
	13	1	0	0	0	3	0	0	0	0	0	0	0	4	0	0	0	4
	14	6	0	0	0	4	0	0	0	0	0	0	0	10	0	0	0	10
	15	5	0	0	0	5	0	0	0	0	0	0	0	10	0	0	0	10
	16	2	0	0	0	1	0	0	0	0	0	0	0	3	0	0	0	3
	17	0	0	0	0	0	0	2	0	1	0	0	0	1	0	2	0	3
	18	1	4	0	0	0	3	0	0	1	0	0	0	2	7	0	0	9
	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	20	1	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	2
	21	1	0	0	0	3	0	0	0	0	0	0	0	4	0	0	0	4
	22	3	0	0	1	1	0	0	0	0	0	0	0	4	0	0	1	5
	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	24	1	1	0	0	2	0	0	0	1	0	0	0	4	1	0	0	5
	25	3	0	0	0	1	0	0	0	0	0	0	0	4	0	0	0	4
	26	1	1	0	0	0	1	0	0	1	0	0	0	2	2	0	0	4
	27	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
	28	1	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	2
	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	30	1	0	0	0	0	0	0	0	2	0	0	0	3	0	0	0	3
	31	0	0	0	0	1	0	0	0	1	0	0	0	2	0	0	0	2
TOTALS		39	6	0	2	36	4	3	2	7	0	0	0	82	10	3	4	
TOTAL			47				45				7				99			99

ANNEX 2.2

DAY BY DAY SUMMARY OF DESCRIPTIONS

TYPE OF MESSAGE		P				M				C				TOTALS				TOTAL
DELAY IN DAYS		1	2	3	4-10	1	2	3	4-10	1	2	3	4-10	1	2	3	4-10	
JAN.	1	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2
	2	5	0	0	0	2	0	0	0	0	0	0	0	7	0	0	0	7
	3	5	1	0	0	0	0	0	0	0	1	0	0	5	2	0	0	7
	4	6	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	6
	5	5	0	0	0	1	0	0	0	0	0	0	0	6	0	0	0	6
	6	8	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	8
	7	5	0	0	0	0	1	0	0	0	2	0	0	5	3	0	0	8
	8	4	0	0	0	1	0	0	0	0	0	0	0	5	0	0	0	5
	9	6	0	0	0	0	0	0	0	1	0	0	0	7	0	0	0	7
	10	5	1	0	0	0	2	0	0	0	2	0	0	5	5	0	0	10
	11	7	0	0	0	3	0	0	0	1	0	0	0	11	0	0	0	11
	12	2	0	0	0	2	0	0	0	0	0	0	0	4	0	0	0	4
	13	5	0	0	0	4	0	0	0	0	0	0	0	9	0	0	0	9
	14	4	0	0	0	1	0	0	0	1	0	0	0	6	0	0	0	6
	15	6	1	0	0	1	0	0	0	1	0	0	0	8	1	0	0	9
	16	6	0	0	0	1	0	0	0	0	0	0	0	7	0	0	0	7
	17	7	0	0	0	1	0	0	0	1	0	0	0	9	0	0	0	9
	18	4	0	0	0	2	0	0	0	1	0	0	0	7	0	0	0	7
	19	4	0	0	0	2	0	0	0	0	0	0	0	6	0	0	0	6
	20	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3
	21	5	0	0	0	3	0	0	0	0	0	0	0	8	0	0	0	8
	22	7	0	0	0	1	0	0	0	0	0	0	0	8	0	0	0	8
	23	7	0	0	0	2	0	0	0	1	0	0	0	10	0	0	0	10
	24	6	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	6
	25	6	0	0	0	1	0	0	0	3	0	0	0	10	0	0	0	10
	26	5	0	0	0	5	0	0	0	0	0	0	0	10	0	0	0	10
	27	9	0	0	0	1	0	0	0	0	0	0	0	10	0	0	0	10
	28	5	0	0	0	1	1	0	0	3	2	1	0	9	3	1	0	13
	29	5	0	0	0	3	0	0	0	3	0	0	0	11	0	0	0	11
	30	4	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	4
	31	6	0	0	0	3	0	0	0	0	0	0	0	9	0	0	0	9
TOTALS		164	3	0	0	41	4	0	0	16	7	1	0	221	14	1	0	
TOTAL			167				45				24				236			236

PRC-RSS-346

ANNEX 2.2

DAY BY DAY SUMMARY OF DECRYPTIONS

TYPE OF MESSAGE	P				M				C				TOTALS				TOTAL
DELAY IN DAYS	1	2	3	4-10	1	2	3	4-10	1	2	3	4-10	1	2	3	4-10	
FEB. 1	5	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	5
2	8	1	0	0	2	0	0	0	0	0	0	0	10	1	0	0	11
3	5	0	0	0	2	0	0	0	2	0	0	0	9	0	0	0	9
4	9	0	0	0	1	0	0	0	6	0	0	0	16	0	0	0	16
5	9	0	0	0	0	0	0	0	1	0	0	0	10	0	0	0	10
6	9	0	0	0	2	0	0	0	1	0	0	0	12	0	0	0	12
7	10	0	0	0	1	0	0	0	2	0	0	0	13	0	0	0	13
8	8	0	0	0	0	0	0	0	5	0	0	0	13	0	0	0	13
9	7	0	0	0	0	0	2	0	2	0	1	0	9	0	3	0	12
10	1	6	0	1	1	1	0	0	5	4	0	0	7	11	0	1	19
11	9	0	0	0	0	0	0	0	1	2	1	0	10	2	1	0	13
12	0	5	0	0	0	1	0	0	0	1	0	0	0	7	0	0	7
13	6	0	0	0	0	0	0	0	0	1	0	0	6	1	0	0	7
14	6	0	0	0	2	0	0	0	0	0	0	0	8	0	0	0	8
15	6	0	0	0	0	2	0	0	1	0	0	0	7	2	0	0	9
16	6	0	1	0	1	0	0	0	2	0	0	0	9	0	1	0	10
17	4	0	0	0	2	0	0	0	0	0	0	0	6	0	0	0	6
18	8	0	0	0	0	0	0	0	2	0	0	0	10	0	0	0	10
19	11	0	0	0	3	2	0	0	11	1	0	0	25	3	0	0	28
20	6	0	0	0	2	0	0	0	2	0	0	0	10	0	0	0	10
21	3	1	0	0	0	1	0	0	1	0	0	0	4	2	0	0	6
22	11	0	0	0	1	0	0	0	0	0	0	0	12	0	0	0	12
23	5	0	0	0	0	0	0	0	2	0	0	0	7	0	0	0	7
24	8	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	8
25	8	0	0	0	1	1	0	0	0	0	0	0	9	1	0	0	10
26	7	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	7
27	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3
28	5	0	0	0	1	0	0	0	0	0	0	0	6	0	0	0	6
29	5	0	0	0	1	0	0	0	0	0	0	1	6	0	0	1	7
TOTALS	188	13	1	1	23	8	2	0	46	9	2	1	257	30	5	2	
TOTAL	203				33				58				294				294

ANNEX 2.2

DAY BY DAY SUMMARY OF DECRYPTIONS

TYPE OF MESSAGE		P				M				C				TOTALS				TOTAL
DELAY IN DAYS		1	2	3	4-10	1	2	3	4-10	1	2	3	4-10	1	2	3	4-10	
MARCH	1	0	2	3	1	0	0	0	0	0	0	0	0	0	2	3	1	6
	2	5	0	1	0	1	0	0	0	1	0	0	0	7	0	1	0	8
	3	4	0	1	0	1	0	0	0	0	0	0	0	5	0	1	0	6
	4	0	4	1	0	0	1	0	0	0	1	0	0	0	6	1	0	7
	5	6	0	0	0	1	0	0	0	0	0	0	0	7	0	0	0	7
	6	4	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	4
	7	5	0	0	1	2	0	0	0	0	0	0	0	7	0	0	1	8
	8	6	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	6
	9	8	0	0	0	1	0	0	0	0	0	0	0	9	0	0	0	9
	10	7	2	0	0	0	0	0	0	0	4	0	0	7	6	0	0	13
	11	4	0	0	0	0	0	0	0	2	0	0	0	6	0	0	0	6
	12	4	0	0	0	0	0	0	0	1	0	0	0	5	0	0	0	5
	13	6	0	0	0	2	0	0	0	2	0	0	0	10	0	0	0	10
	14	7	0	0	0	1	0	0	0	0	0	0	0	8	0	0	0	8
	15	6	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	6
	16	6	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	6
	17	5	0	0	0	1	0	0	0	1	0	0	0	7	0	0	0	7
	18	5	0	0	0	0	0	0	0	1	0	0	0	6	0	0	0	6
	19	2	0	0	0	1	0	0	0	0	0	0	0	3	0	0	0	3
	20	5	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	5
	21	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3
	22	7	0	0	0	1	0	0	0	0	0	0	0	8	0	0	0	8
	23	6	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	6
	24	7	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	7
	25	5	0	0	0	0	0	0	0	1	0	0	0	6	0	0	0	6
	26	7	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	7
	27	6	0	0	0	0	0	0	0	1	0	0	0	7	0	0	0	7
	28	5	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	5
	29	3	0	0	0	2	0	0	0	1	0	0	0	6	0	0	0	6
	30	5	0	0	0	1	0	0	0	0	0	0	0	6	0	0	0	6
	31	5	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	5
TOTALS		154	8	6	2	15	1	0	0	11	5	0	0	180	14	6	2	
TOTAL			170				16				16				202			202

ANNEX 3.

1. Annex 3 contains the following:

   (a) Basic operational data used in the calculation of contact probabilities and contact coefficients, Tables 1 and 2;

   (b) Contacts per convoy day per U-Boat day, for monthly intervals, and averages for periods, Table 3;

   (c) Contact coefficients for monthly intervals and averages for periods, Table 4.

   (d) Data on attacks and ship sinkings, Table 5.

2. In computing contact coefficients, equation (2) of Part 3 of the text is used; namely:

$$Q = \frac{CA}{NT}$$

where

Q = the contact coefficient,
A = the area under consideration; in this study, the region lying between 40°-63° N, 25°-60°W and 48°-63°N, 15°-25°W; roughly, 3 million square miles;

N = the average number of convoys in the area during a given interval. This quantity was determined from the Cominch daily plots of submarine and convoy positions.

T = the number of U-Boat days spent in the area. This quantity was determined from the daily listings in the BdU War Diary.

C = the number of convoys contacted by the U-Boats during a given interval.
NOTE: The term "contact" is used in the sense that a given convoy is contacted only once, regardless of the number of U-Boats that actually contacted it. This rule is adhered to even in the case of a convoy that, having been once contacted and subsequently lost, was recontacted later.

The value used for the number of contacts, C, is obviously a very critical quantity in the determination of the contact coefficient. The chief source of information on convoys contacted is the BdU War Diary. The U-Boats were required to report every sighting of a convoy, and the War Diary consistently mentions these. In doubtful cases a check is provided by comparing the reported location of the contact with the position of the convoy given in the daily U-Boat plots, which also plot the convoy positions. In a few cases in which the War Diary was uncertain whether a contact (or attack) was on a convoy or an independent, the IBM listing of ships sunk in convoy and the Convoy & Routing jacket of the particular convoy furnished a clue. It is believed that any errors in the determination of the number of convoys contacted are so small as not to significantly affect the average values of the contact coefficients for the three Periods I, II, and IV, and hence, the general conclusions stated in the report.

TABLE 1

BASIC OPERATIONAL DATA

	Month	Convoys	Convoy Days	Average No. of Convoys	U-Boat Days	Contacts	Ships Sunk
1942	July	18	246	8.0	506	2	7
	August	17	226	7.3	811	6	19
	September	19	260	8.7	1158	7	20
	October	16	224	7.2	1414	7	23
	November	14	209	7.0	845	9	28
	December	16	196	8.0	941	6	24
	Total	100	1361	7.6	5675	37	121
1943	January	16	222	7.3	1237	7	7
	February	11	168	6.0	1540	6	34
	March	16	239	7.7	1741	8	48
	April	16	184	6.2	1594	8	20
	May	20	252	8.1	1733	9	19
	Total	79	1065	7.1	7845	38	128
	Sep.(16-30)	9	103	6.9	550	3	6
	October	16	201	6.5	*860	2	4
	November	12	142	4.8	810	2	0
	December	13	169	5.6	852	1	0
1944	January	12	168	5.6	709	3	3
	February	12	146	5.0	689	4	1
	March	13	159	5.1	676	1	0
	Total	87	1088	5.6	5146	16	14
Grand	Total	266	3514	6.7	18,666	91	263

*Estimated. Records of 16/10-31/10 not available.

TABLE 2

BASIC OPERATIONAL DATA WITH RESPECT TO COMPROMISE BY X-B INTELLIGENCE

Year	Month	TOTAL				NOT COMPROMISED				COMPROMISED - Total			
		No. of Convoys	Convoy Days	Average No. of Convoys	Contacts	No. of Convoys	Convoy Days	Average No. of Convoys	Contacts	No. of Convoys	Convoy Days	Average No. of Convoys	Contacts
1942	July	18	246	8.0	2	11	151	4.9	0	7	95	3.1	2
	August	17	226	7.3	6	9	116	3.8	3	8	110	3.5	3
	September	19	260	8.7	7	12	164	5.5	4	7	96	3.2	3
	October	16	224	7.2	7	14	200	6.4	6	2	24	0.8	1
	November	14	209	7.0	9	8	124	4.2	6	6	85	2.8	3
	December	16	196	8.0	6	9	81	2.7	2	7	115	3.7	4
	Total	(100)	(1361)	(7.6)	(37)	(63)	(836)	(4.7)	(21)	(37)	(525)	(2.9)	(16)
1943	January	16	222	7.3	7	6	123	4.1	1	10	99	3.2	6
	February	11	168	6.0	6	6	95	3.4	3	5	73	2.6	3
	March	15	227	7.3	7	1	17	0.55	1	14	210	6.8	6
	April	17	196	6.5	9	6	68	2.3	2	11	128	4.3	7
	May	20	252	8.1	9	3	22	0.7	1	17	230	7.4	8
	Total	(79)	(1065)	(7.1)	(38)	(22)	(325)	(2.2)	(8)	(57)	(740)	(4.9)	(30)
	Sep.(16-30)	9	103	6.9	3	9	103	6.9	3	0	0	0	0
	October	16	201	6.5	2	13	160	5.5	0	3	41	1.3	2
	November	12	142	4.8	2	12	142	4.8	2	0	0	0	0
	December	13	169	5.6	1	12	156	5.2	1	1	13	0.4	0
1944	January	12	168	5.6	3	12	168	5.6	3	0	0	0	0
	February	12	146	5.0	4	12	146	5.0	4	0	0	0	0
	March	13	159	5.1	1	13	159	5.1	1	0	0	0	0
	Total	(87)	(1088)	(5.6)	(16)	(83)	(1034)	(5.3)	(14)	(4)	(54)	(0.85)	(2)
Grand Total		266	3514	6.4	91	168	2195	4.0	43	98	1319	3.3	48

(Table 2 continued on next page)

TABLE 2 (Continued)

BASIC OPERATIONAL DATA WITH RESPECT TO COMPROMISE BY X-B INTELLIGENCE

Year	Month	COMPROMISED: Designated by BdU for Operation — No. of Convoys	Convoy Days	Average No. of Convoys	Contacts	COMPROMISED: Not Designated by BdU for Operation — No. of Convoys	Convoy Days	Average No. of Convoys	Contacts
1942	July	0	0	0	0	7	95	3.1	2
	August	1	18	0.6	1	7	92	2.9	2
	September	0	0	0	0	7	96	3.2	3
	October	0	0	0	0	2	24	0.8	1
	November	1	12	0.4	1	5	73	2.4	2
	December	1	8	0.3	1	6	107	3.4	3
	Total	(3)	(38)	(0.2)	(3)	(34)	(487)	(2.7)	(13)
1943	January	3	38	1.2	3	7	61	2.0	3
	February	3	43	1.5	2	2	30	1.1	1
	March	6	82	2.6	4	8	128	4.1	2
	April	3	39	1.3	2	8	89	3.0	5
	May	6	81	2.6	6	11	149	4.8	2
	Total	(21)	(283)	(1.9)	(17)	(36)	(457)	(3.0)	(13)
	Sept.(16-30)	1 (c)	13 (c)	0.9	0	0	0	0	0
	October	7 (c)	63 (c)	2.0	2 (a)	0	0	0	0
	November	4 (c)	44 (c)	1.5	1 (b)	0	0	0	0
	December	2 (c)	27 (c)	0.9	0	0	0	0	0
1944	January	0	0	0	0	0	0	0	0
	February	1 (c)	12 (c)	0.4	0	0	0	0	0
	March	0	0	0	0	0	0	0	0
	Total	(15)(d) (4)(e)	(159)(c) (54)(e)	(1.2)(c) (0.85)(e)	(3) (2)	0	0	0	0
Grand Total		39 (d) 28 (e)	480 (d) 375 (e)	1.2 (d) 1.2 (e)	23 22	70	944 (e)	2.8	26

NOTES ON TABLE 2

(a) Estimated. The BdU diary from 16 October 1943 to 31 October 1943 is not available.

(b) BdU guessed the convoy route correctly from very scanty X-B intelligence on stragglers' routes.

(c) Numbers designated by (c) pertain to convoys which, in the diary, BdU mentions specifically, stating that X-B provided some information that influenced his disposition of the U-Boat groups. During Period IV the intelligence available to BdU contained only scanty information concerning straggler routes and early rendezvous, some of which was actually false. The numbers given in the "COMPROMISED-TOTAL column" pertain only to those convoys for which the evidence indicates that X-B actually had useful X-B intelligence. This explains the discrepancy between this column and the next one.

(d) These numbers are based on the numbers explained in (c).

(e) These numbers are based on the figures in the "COMPROMISED-TOTAL column"; i.e., the particular convoys are considered to have been actually compromised by the X-B available.

TABLE 3

CONTACTS PER CONVOY DAY PER U-BOAT DAY (P)

Year	Month	P_0	P_1	P_2	P_3	P
		(Multiply all numbers by 10^{-4})				
1942	July	0	12.6	(i)	12.6	4.8
	Aug.	9.6	10.2	20.7	8.1	9.9
	Sept.	6.3	8.1	(i)	8.1	6.9
	Oct.	6.3	9.0	(i)	8.7	6.6
	Nov.	17.1	12.6	29.7	9.6	15.3
	Dec.	7.8	11.1	39.9	9.0	9.9
	Average	8.1	9.9	28.0	8.6	8.8
1943	Jan.	2.1	14.7	19.2	12.0	7.8
	Feb.	6.3	8.1	9.0	6.6	6.9
	Mar.	10.2	4.8	8.4	2.7	5.4
	Apr.	5.4	10.2	9.6	10.5	8.7
	May	7.8	6.0	12.9	2.4	6.3
	Average	4.7	7.8	11.5	5.5	6.9
	Sept.	8.0	(i)	(i)(e) 0d	(i)	8.0
	Oct.	0	17.0	17.0	(i)	3.6
	Nov.	5.1	(i)	(i)(e) 8.4d	(i)	5.1
	Dec.	2.4	0	0	(i)	2.1
1944	Jan.	7.5	(i)	(i)(e) (i)d	(i)	7.5
	Feb.	12.0	(i)	(i)(e) 0d	(i)	12.0
	Mar.	2.7	(i)	(i)(e) (i)d	(i)	2.7
	Average	5.6	13.4	13.4(e) 6.8d	(i)	5.6
Average for Entire Period		5.8	9.5	14.8e 13.2d	6.8	7.8

(i) = Indeterminate - i.e., there were no convoys of the respective category present in the area during the period in question.

(d) = (See Note (d) on Table 2 of Annex 3)

(e) = (See note (e) on Table 2 of Annex 3)

Notes

P_0 = Contacts per Convoy Day per U-Boat considering only convoys not compromised by X-B intelligence.

P_1 = Contacts per Convoy Day per U-Boat considering only convoys compromised by X-B intelligence.

P_2 = Contacts per Convoy Day per U-Boat considering only those compromised convoys specifically designated for operations by BdU utilizing X-B intelligence.

P_3 = Contacts per Convoy Day per U-Boat considering only those convoys compromised by X-B Intelligence, but not specifically designated by BdU for operations.

P = Contacts per Convoy Day per U-Boat considering all convoys, compromised or not.

(The source for data for P_2 and P_3 is the War Diary of BdU.)

TABLE 4

CONTACT COEFFICIENTS (c)

Year	Month	c_0	c_1	c_2	c_3	c
			(Square miles per Day)			
1942	July	0	3800	(i)	3900	1450
	August	2900	3150	6400	2500	3050
	Sept.	1850	2400	(i)	2450	2100
	Oct.	2000	2650	(i)	2700	2050
	Nov.	5100	3800	8950	2900	4550
	Dec.	2350	3450	12500	2750	2400
	Average	2450	2950	8400	2600	2650
1943	Jan.	600	4550	6000	3700	2300
	Feb.	1750	2250	2500	1850	1950
	Mar.	3150	1500	2600	850	1700
	Apr.	1600	3050	2900	3150	2600
	May	2450	1850	4000	750	1900
	Average	1400	2350	3400	1650	2050
	Sept.	2350	(i)	0(d)(i)(e)	(i)	2400
	Oct.	0	5100	5100	(i)	1150
	Nov.	1550	(i)	2500 d i e	(i)	1550
	Dec.	700	0	0	(i)	650
1944	Jan.	2250	(i)	(i)(d)(i)(e)	(i)	2300
	Feb.	3200	(i)	0(d)(i)(e)	(i)	3500
	Mar.	850	(i)	(i)(d)(i)(e)	(i)	850
	Average	1550	4050	2050(d) 4050(e)	(i)	1700
Average for Entire Period		1750	2850	3950(d) 4450(e)	2050	2350

(i) ≡ Indeterminate - i.e., there were no convoys of the respective category present in the area during the period in question.

(d) ≡ (See Note (d) on Table 2 of Annex 3)

(e) ≡ (See Note (e) on Table 2 of Annex 3)

Notes

c_0 ≡ Contact Coefficient considering only convoys not compromised by X-B intelligence.

c_1 ≡ Contact Coefficient considering only all convoys compromised by X-B intelligence.

c_2 ≡ Contact Coefficient considering only those convoys specifically designated for operations by BdU utilizing X-B intelligence.

c_3 ≡ Contact coefficient considering only those convoys compromised by X-B intelligence, but not designated as such by BdU.

c ≡ Contact coefficient considering all convoys, compromised or not.

(The source for data for c_2 and c_3 is the War Diary of BdU)

~~TOP SECRET~~

PRNC-NSS-346

TABLE 5
ATTACKS AND SHIP SINKINGS

		OVERALL								NOT COMPROMISED								COMPROMISED - Total							
				Attacks			Ships Sunk					Attacks			Ships Sunk					Attacks			Ships Sunk		
		Convoys	Contacts	(a)	(b)	T	(a)	(b)	T	Convoys	Contacts	(a)	(b)	T	(a)	(b)	T	Convoys	Contacts	(a)	(b)	T	(a)	(b)	T
1942	July	18	2	2	0	2	7	0	7	11	0	0	0					7	2	2	0	2	7	0	7
	August	17	6	2	2	4	15	4	19	9	3	1	1	2	11	2	13	8	3	1	1	2	4	2	6
	September	19	7	3	3	6	18	3	21	12	4	2	1	3	13	1	14	7	3	1	2	3	5	2	7
	October	16	7	3	3	6	19	4	23	14	6	3	3	6	19	4	23	2	1	0	0				
	November	14	9	2	6	8	21	7	28	8	6	0	5	5	0	6	6	6	3	2	1	3	21	1	22
	December	16	6	3	2	5	22	3	25	9	2	2	0	2	9	0	9	7	4	1	2	3	13	3	16
	Total	100	37	15	16	31	102	21	123	63	21	8	10	18	52	13	65	37	16	7	6	13	50	8	58
1943	January	16	7	3	3	6	18	4	22	6	1	1	0	1	3	0	3	10	6	2	3	5	15	4	19
	February	11	6	2	4	6	18	5	23	6	3	2	1	3	18	2	20	5	3	0	3	3	0	3	3
	March	15	7	4	1	5	43	1	44	1	1	0	0					14	6	4	1	5	43	1	44
	April	17	9	3	3	6	13	4	17	6	2	0	2	2	0	3	3	11	7	3	1	4	13	1	14
	May	20	9	2	2	4	17	3	20	3	1	0	0					17	8	2	2	4	17	3	20
	Total	79	38	14	13	27	109	17	126	22	8	3	3	6	21	5	26	57	30	11	10	21	88	12	100
	Sep.(16-30)	9	3	1	1	2	5	1	6	9	3	1	1	2	5	1	6	0	0						
	October	16	2	1	1	2	3	1	4	13	0	0	0					3(e)	2	1	1	2	3	1	4
	November	12	2	0	0					12	2	0	0					0	0						
	December	13	1	0	0					12	1	0	0					1	0						
1944	January	12	3	0	2	2	0	3	3	12	3	0	2	2	0	3	3	0	0						
	February	12	4	0	1	1	0	1	1	12	4	0	1	1	0	1	1	0	0						
	March	13	1	0	0					13	1	0	0					0	0						
	Total	87	16	2	5	7	8	6	14	83	14	1	4	5	5	5	10	4	2	1	1	2	3	1	4
Grand	Total	266	91	31	34	65	219	44	263	168	43	12	17	29	78	23	101	98	48	19	17	36	141	21	162

(Table 5 Continued on next page)

(a) Attacks yielding 3 or more sinkings.
(b) Attacks yielding 1-2 sinkings.
T Attacks yielding at least one sinking.
Note: Only those attacks yielding at least one sinking are considered.

(d) See Note (d) to Table 2 of Annex 3.
(e) See Note (e) to Table 2 of Annex 3.

TABLE 5 (Continued)
ATTACKS AND SHIP SINKINGS

		Designated by BdU for Operations — COMPROMISED:								Not Designated by BdU for Operations — COMPROMISED:							
				Attacks			Ships Sunk					Attacks			Ships Sunk		
		Convoys	Contacts	(a)	(b)	T	(a)	(b)	T	Convoys	Contacts	(a)	(b)	T	(a)	(b)	T
1942	July	0	0	0	0					7	2	2	0	2	7	0	7
	August	1	1	0	0					7	2	1	1	2	4	2	6
	September	0	0	0	0					7	3	1	2	3	5	2	7
	October	0	0	0	0					2	1	0	0				
	November	1	1	1	0	1	16	0	16	5	2	1	1	2	5	1	6
	December	1	1	0	0					6	3	1	2	3	13	3	16
	Total	3	3	1	0	1	16	0	16	34	13	6	6	12	34	8	42
1943	January	3	3	1	2	3	12	2	14	7	3	1	1	2	3	2	5
	February	3	2	0	2	2	0	2	2	2	1	0	1	1	0	1	1
	March	6	4	4	0	4	43	0	43	8	2	0	1	1	0	1	1
	April	3	2	1	0	1	3	0	3	8	5	2	1	3	10	1	11
	May	6	6	1	2	3	4	3	7	11	2	1	0	1	13	0	13
	Total	21	17	7	6	13	62	7	69	36	13	4	4	8	26	5	31
	Sep.(16-30)	1(d) 1(e)	0	0	0					0	0						
	October	7(d) 3(e)	2	1	1	2	3	1	4	0	0						
	November	4(d) 0(e)	1(d) 0(e)							0	0						
	December	2(d) 0(e)	0							0	0						
1944	January	0(d) 0(e)	0							0							
	February	1(d) 0(e)	0							0							
	March	0(d) 0(e)	0							0							
	Total	15(d) 4(e)	3 2(e)	1	1	2	3	1	4	0	0	0	0	0	0	0	0
Grand Total		39(d) 28(e)	23 22(e)	9	7	16	81	8	89	70	26	10	10	20	60	13	73

(a) Attacks yielding 3 or more sinkings.
(b) Attacks yielding 1-2 sinkings.
T Attacks yielding at least one sinking.
Note: Only those attacks yielding at least one sinking are considered.

(d) See Note (d) to Table 2 of Annex 3.
(e) See Note (e) to Table 2 of Annex 3.

ANNEX 4.3 TABLE I

DECRYPTIONS ON INDIVIDUAL U-BOATS

U-Boat	Date of Message	Date of Position or R/V	Delay in Decryption	Days in Peril	Attack	Assessment
U-43	20/7	20/7	9 da.	0		
	23/7	23/7	13	0		
U-66	31/7	31/7	1	4	3/8	D
	1/8	1/8	1	1		
	4/8	4/8	12	0		
	6/8	6/8	8	0		
	8/8	8/8	14	0		
	10/8	10/8	7	0		
	10/8	10/8	9	0		
	14/8	14/8	5	0		
	17/8	17/8	4	0		
U-67	23/6	29/6	14	0		
	24/7	28/7	11	0		
U-84	18/6	20/6	5	2		
	3/8	3/8	13	0		
	14/8	18/8	5	4		
	18/8	19/8	3	1	24/8	B
U-86	18/8	No Info	0	0		
	20/8	No Info	0	0		
J-92	26/5	1/6	12	0		
	8/6	8/6	3	2		
	8/6	9/6	4	1		
	9/6	10/6	3	1		
U-107	4/8	4/8	12	0		
#U-117	27/7	27/7	6	0		
	30/7	1/8	2	4		
	1/8	1/8	1	1		
U-118	8/6	8/6	3	1	12/6	A
	9/6	9/6	2	0		
	10/6	10/6	3	0		
	11/6	11/6	4	0		

#Sunk 7/8, one day after period of peril expired.

ANNEX 4.3

TABLE I (continued)

U-Boat	Date of Message	Date of Position or R/V	Delay in Decryption	Days in Peril	Attack	Assessment
U-[illegible]	8/9	8/9	5 da.	0		
U-[illegible]	29/5	3/6	6	4		
	18/6	27/6	5	9		
U-129	10/8	10/8	11	0		
	14/8	14/8	5	0		
	17/8	19/8	4	2		
	20/8	20/8	4	1		
U-134	21/6	21/6	13	0		
	15/8	No Info.	4	0		
U-135	18/6	18/6	4	1		
	22/6	22/6	6	0		
U-154	29/5	3/6	6	4		
	18/6	27/6	5	9		
U-155	18/7	18/7	12	0		
U-160	18/7	19/7	12	0		
U-161	14/8	14/8	11	0		
U-168	15/7	15/7	5	0		
	18/7	18/7	12	0		
U-170	16/6	16/6	6	0		
	18/6	20/6	5	2		
	21/6	21/6	13	0		
	6/9	9/9	5	3		
	14/9	14/9	3	0		
U-172	11/6	11/6	4	1		
	12/6	12/6	2	1		
	3/8	3/8	13	0		
	19/8	19/8	2	3		
	24/8	26/8	3	4		
U-180	8/6	8/6	3	2		
	9/6	9/6	4	1		
U-183	18/7	24/7	12	0		

ANNEX 4.3

TABLE I (continued)

U-Boat	Date of Message	Date of Position or R/V	Delay in Decryption	Days in Peril	Attack	Assessment
U-185	18/6	18/6	6 da.	0		
	3/8	3/8	13	0		
	19/8	19/8	2	3	24/8	A
	24/8	26/8	3	0		
U-188	17/7	17/7	13	0		
	18/7	24/7	12	0		
U-190	6/8	6/8	8	0		
U-193	26/6	26/6	7	0		
U-198	13/9	13/9	5	0		
U-211	24/5	1/6	1	5		
	26/5	1/6	12	0		
	26/6	26/6	7	0		
U-214	8/6	8/6	3	2		
	9/6	9/6	4	1		
	17/6	17/6	8	0		
	25/6	25/6	12	0		
	13/9	13/9	5	0		
U-217	24/5	1/6	1	4	5/6	A
	26/5	1/6	12	0		
U-221	24/5	1/6	1	5		
	26/5	1/6	12	0		
	22/6	22/6	4	1		
	26/6	26/6	7	0		
U-228	24/5	1/6	1	5	4/6	E
	26/5	1/6	12	0		
	26/6	26/6	7	0		
U-230	10/8	10/8	11	3		
	14/8	14/8	5	0		
	19/8	19/8	2	3		
	20/8	20/8	10	0		

TABLE I (continued)

U-Boat	Date of Message	Date of Position or R/V	Delay in Decryption	Days in Peril	Attack	Assessment
U-232	24/5	1/6	1 da.	5		
	26/5	1/6	12	0		
	26/6	26/6	7	0		
U-257	19/6	19/6	13	0		
	3/8	3/8	13	0		
	19/8	19/8	2	3		
U-262	30/7	30/7	2	3		
	4/8	4/8	12	0		
	9/8	9/8	12	0		
	10/8	10/8	8	0		
	16/8	16/8	4	1		
	18/8	18/8	3	2		
U-306	18/6	20/6	5	2		
	30/7	1/8	2	5		
U-333	9/6	9/6	4	1		
	18/6	18/6	6	0		
	3/8	3/8	13	0		
	6/8	6/8	8	0		
	14/8	14/8	5	0		
U-336	24/5	1/6	1	5		
	26/5	1/6	12	0		
	26/6	26/6	7	0		
U-340	24/7	24/7	11	0		
U-358	18/6	18/6	5	0		
	21/6	21/6	13	0		
	19/8	19/8	2	3		
U-373	19/7	19/7	10	0		
	25/7	25/7	10	0		
	26/7	26/7	7	0		
	27/7	27/7	6	0		
	31/7	31/7	1	4		
	5/8	5/8	9	0		
U-382	20/6	20/6	14	0		
	25/6	25/6	9	0		

TABLE I (continued)

U-Boat	Date of Message	Date of Position or R/V	Delay in Decryption	Days in Peril	Attack	Assessment
U-406	23/8	23/8	4da.	1		
U-413	27/5	27/5	10	0		
U-415	19/6	19/6	13	0		
	21/6	21/6	13	0		
	14/8	14/8	5	0		
	19/8	19/8	2	3		
U-435	24/5	1/6	1	5		
	26/5	1/6	12	0		
	26/6	26/6	7	0		
U-445	18/8	No Info.	3	0		
U-455	11/6	11/6	4	1		
	19/6	19/6	4	1		
U-460	28/5	28/5	10	0		
	8/6	8/6	3	2		
	9/6	9/6	4	1		
	10/6	10/6	3	1		
	17/6	17/6	5	0		
	8/9	8/9	6	0		
U-466	3/8	3/8	13	0		
U-487	23/6	23/6	13	0		
	25/6	25/6	8	0		
U-488	11/6	11/6	4	1		
	15/6	15/6	7	0		
	18/6	18/6	5	0		
	21/6	21/6	13	0		
U-508	9/6	9/6	4	1		
	18/6	18/6	5	0		
	3/8	3/8	13	0		
	19/8	19/8	2	3		
U-510	9/6	9/6	4	1		
	3/8	3/8	13	0		
	14/8	14/8	6	0		
U-515	8/6	No Info	3	0		
	8/9	8/9	5	0		

TABLE I (continued)

U-Boat	Date of Message	Date of Position or R/V	Delay in Decryption	Days in Peril	Attack	Assessment
U-516	18/7	24/7	12 da.	0		
	26/7	No Info	7	0		
	15/8	No Info	4	0		
U-518	27/8	27/8	9	0		
U-525	10/8	10/8	11	0		
U-527	17/7	17/7	13	0		
	18/7	18/7	12	0		
	24/7	24/7	11	0		
U-530	11/6	11/6	4	1		
U-532	15/7	15/7	5	0		
	18/7	24/7	12	0		
	26/7	No Info	7	0		
U-533	18/7	24/7	12	0		
	26/7	No Info	7	0		
U-535	15/6	18/6	7	1		
	18/6	20/6	5	2		
U-536	18/6	20/6	5	2		
	21/6	21/6	13	0		
	8/9	8/9	6	0		
	9/9	9/9	3	2		
U-552	30/5	30/5	5	0		
	31/5	31/5	6	0		
U-558	24/5	1/6	1	5		
	26/5	1/6	12	0		
	26/6	26/6	7	0		
U-566	13/7	13/7	13	0		
	16/7	16/7	14	0		
U-569	24/5	1/6	5	0		
	26/5	1/6	12	0		
U-571	15/6	18/6	7	1		
	3/8	3/8	13	0		
	14/8	14/8	5	0		

TABLE I (continued)

U-Boat	Date of Message	Date of Position or R/V	Delay in Decryption	Days in Peril	Attack	Assessment
U-572	11/6	11/6	4 da.	1		
	23/6	23/6	3	2		
	23/6	29/6	14	0		
	3/8	3/8	13	0		
U-590	15/6	18/6	7	1		
	17/6	17/6	5	0		
U-591	Nil			0		
U-592	8/6	8/6	3	2		
U-598	Nil			0		
U-600	15/6	15/6	7	0		
	19/6	19/6	13	0		
	21/6	21/6	13	0		
	25/6	25/6	9	0		
	3/8	3/8	13	0		
	14/8	14/8	5	0		
	17/8	17/8	4	1		
U-603	24/5	1/6	1	5	4/6	G
	26/5	1/6	12	0		
	26/6	26/6	7	0		
U-604	Nil			0		
U-606	24/5	1/6	1	5		
	26/5	1/6	12	0		
	26/6	26/6	7	0		
U-613	17/7	17/7	13	0		
U-615	15/6	15/6	7	0		
	19/6	19/6	13	0		
	21/6	21/6	13	0		
	18/8	No Info	3	0		
U-618	15/6	18/6	7	1		
	3/8	3/8	13	0		
	14/8	14/8	5	0		
	17/8	17/8	4	1		
U-621	6/9	6/9	5	0		
	14/9	14/9	3	2		
	15/9	15/9	3	1		

TABLE I (continued)

U-Boat	Date of Message	Date of Position or R/V	Delay in Decryption	Days in Peril	Attack	Assessment
U-634	18/6	18/6	5 da.	0		
	19/6	19/6	13	0		
	21/6	21/6	13	0		
	15/8	15/8	7	0		
	19/8	19/8	2	3		
	20/8	20/8	4	1		
	20/8	20/8	10	0		
U-641	24/5	1/6	1	5	4/6	F
	26/5	1/6	12	0		
	26/6	26/6	7	0		
U-642	24/5	1/6	1	5		
	26/5	1/6	12	0		
	26/6	26/6	7	0		
U-645	2/9	2/9	4	1		
	8/9	8/9	6	0		
U-648	17/7	17/7	13	0		
	18/7	18/7	12	0		
	24/7	24/7	11	0		
	25/7	25/7	10	0		
U-653	18/6	18/6	5	0		
	21/6	21/6	13	0		
	3/8	3/8	13	0		
	14/8	14/8	5	0		
	19/8	19/8	2	3		
U-662	Nil			0		
U-664	30/7	30/7	2	3		
	4/8	4/8	12	0		
	9/8	Sunk 9/8	13	0		
	18/8	18/8	3	0		
U-666	24/5	1/6	1	5		
	26/5	1/6	12	0		
	26/6	26/6	7	0		
	8/9	8/9	6	0		
	14/9	14/9	4	0		
U-709	13/7	13/7	13	0		
U-732	18/6	20/6	5	2		
U-757	Nil			0		

PRNC-NSS-346

TABLE I (continued)

U-Boat	Date of Message	Date of Position or R/V	Delay in Decryption	Days in Peril	Attack	Assessment
U-758	8/6	8/6	3 da.	2		
	9/6	9/6	2	1		
	9/6	9/6	4	0		
	10/6	10/6	3	1		
	17/6	17/6	5	0		
	18/6	18/6	5	0		
	6/9	6/9	5	0		
	8/9	8/9	4	1		
	13/9	13/9	5	0		
	14/9	14/9	3	0		
U-759	11/6	11/6	4	1		
U-760	30/7	30/7	2	3		
	4/8	4/8	12	0		
	6/8	6/8	8	0		
	9/8	9/8	3	0		
	10/8	10/8	8	0		
	10/8	10/8	7	0		
	13/8	13/8	5	0		
	14/8	14/8	5	0		
	18/8	19/8	3	2		
U-847	14/8	16/8	5	2		
	18/8	18/8	3	2		
	19/8	19/8	2	1		
	24/8	Sunk 27/8	3	1	27/8	B
U-951	24/5	1/6	1	5		
	26/5	1/6	12	0		
	8/6	8/6	3	2		
	26/6	26/6	7	0		
U-953	24/5	1/6	1	5		
	26/5	1/6	12	0		
	26/6	26/6	7	0		

TTABLE II

ANNEX 4.3

U-BOAT REFUELLING FLEET

U-Boat Number	Type	Month of First Operation	Sunk	Character of Allied Decryption Intelligence
U-116	X-B	Spring 1942	Not known. Probably Oct. 1942	None. Before decryption began functioning.
U-117	X-B	October 1942	7 Aug. 1943. 40°N, 38°W CVE A/C	Good. Two messages involving U-117, transmitted 7 days before the attack, were decrypted within 2 days. (See Section 4.3.1.) (Sailed 22/7 from Bordeaux.)
U-118	X-B	Sept. 1942	12 June 1943 31°N, 34°W CVE A/C	Very good. Messages giving her position for 8-9 June were decrypted 11 June--the day before the attack. (See Section 4.3.1.)
U-119	X-B	Feb. 1943	24 June 1943 45°N, 12°W Surface Ships	Of doubtful value. 18/6 message (decrypted 23/6) gave probable rendezvous position at 44°N, 32°W for 21/6. Known to be returning. Sunk in Biscay.
U-219	X-B	Oct. 1943	Active at end of war.	
U-220	X-B	Sept. 1943	28 October 1943 49°N, 33°W CVE A/C	Very good. 26/10 (decrypted 27/10): no position. Mentions discontinuing provisioning because of heavy sea. 26/10 (decrypted 27/10) gives his position, says he is leaving square for 2 days. 27/10 at 1105A (decrypted 1815/27Z) BdU orders refuelling rendezvous. (Also a message from BdU giving D/V for U-488 at 37°N., 43°W. 27/10-2042 (decrypted 0350/27) orders 2 U-Boats to refuel from U-220.

ANNEX 4.3

TABLE II (continued)

U-Boat Number	Type	Month of First Operation	Sunk	Character of Allied Decryption Intelligence
U-233	X-B	May 1944	5 July 1944. 42°N. 60°W. Surface Ships.	No messages found referring to U-233 for 10 days previous to attack.
U-234	X-B	April 1945	Active	Nil.
U-459	XIV	April 1942	24 July 1943. 46°N. 10°W. Landbased A/C	No mention in messages. Outward passage. Sailed 22/7 from Bordeaux.
U-460	XIV	July 1942	4 October 1943 43°N. 29°W. CVE A/C	No decrypted message until 4/10 (decrypted 10/10) ordering rendezvous position.
U-461	XIV	June 1942	30 July 1943 46°N. 11°W. Landbased A/C	Nothing until report of attack on 30/7. Outward passage. Sailed 27/7 from Bordeaux.
U-462	XIV	September 1942	30 July 1943. 45°N. 11°W. Landbased A/C.	Nothing until report of attack on 30/7. Outward passage. Sailed 27/7 from Bordeaux.
U-463	XIV	August 1942	15 May 1943. 45°N. 10°W. Landbased A/C.	Sailed from Bordeaux 12 May 1943; sunk in Biscay. No mention in messages.
U-464	XIV	August 1942	20 August 1942 61°N. 14°W. Landbased A/C	Nil.
U-487	XIV	March 1943	13 July 1943 31°N. 34°W. CVE A/C	Not good. Messages on 23/6 (decrypted 6/7) and 25/6 (decrypted 3/7) gave position. Sunk 18 days after latter message.

ANNEX 4.3. TABLE II (continued)

U-Boat Number	Type	Month of First Operation	Sunk	Character of Allied Decryption Intelligence
U-488	XIV	May 1943	26 April 1944 18°N. 38°W. Surface Ships.	Very good. Message 20/4 (decrypted same day) gave 22/4 rendesvous position. 22/4 message decrypted same day gave new position.
U-489	XIV	July 1943	8 August 1943. 62°N. 13°W. Landbased A/C.	Not mentioned in messages. Sailed 22/7 from Kiel, outward bound.
U-490	XIV	May 1944	11 June 1944 43°N. 40°W. CVE A/C and Surface Ships	Good. Message of 10 June, decrypted the same day, gave position.