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# SUMMARY REPORT

TO THE  
OFFICE OF FIELD SERVICE, O.S.R.D.

Classification changed to **UNCLASSIFIED**

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By Daw

FROM THE

## OPERATIONS RESEARCH GROUP

ASSIGNED TO

HEADQUARTERS · COMMANDER IN CHIEF · UNITED STATES FLEET  
AND  
OFFICE OF THE CHIEF OF NAVAL OPERATIONS

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1 DECEMBER 1945

CONFIDENTIAL

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OPERATIONS

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## 1. ORGANIZATIONAL HISTORY

Experience in this war has shown that scientists and scientific methods can be profitably employed in the design of new weapons of war, in their production, and also in finding out how they may best be used in actual operation. This last activity forms a part of what is now called Operations Research. Work in Operations Research covers a very wide range of activities. There are the immediate and practical tasks of advising the operational commands in the field as to the best way to use new equipment and to meet tactical situations; and of providing a technical liaison between the forces in the field and the research and development laboratories. There are also the broader, more theoretical tasks of statistically analyzing operational reports, of devising and interpreting tactical experiments and of assisting in military planning and in writing tactical doctrine.

Some of these activities can be carried out by a group assigned to a single field command. But for all of the activities to be carried on effectively it is necessary that part of the group be in the field and another part work with the general staff in Washington; with arrangements for free interchange of ideas and men between field and headquarters.

Organizational Plan - The only group in the United States which has attempted this sort of an overall coverage of the Operational Research field is the Operations Research Group, assigned to the U. S. Navy. This group also has represented the largest single contribution of OSRD to the field of Operations Research. During the first year of its activity more than half of its total effort was devoted to activities in the field; the rest of the effort being carried out in Washington on statistical, theoretical, and liaison problems. Throughout its 43 months of existence more than one third of the effort was spent on field work. Its continued growth, its extension to further fields of naval warfare, and its continuation into peace-time under Naval auspices, emphasize the fundamental correctness of the original concept of organization, which involved the field-plus-central-office combination, the rotation of man power and the resistance to fragmentation. That this organizational plan, cutting across command boundaries, was allowed to reach its full scope of usefulness, is also testimony to the range of vision and to the progressive spirit of the naval officers who supervised the major aspects of the group's work.

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Early History - The group was first set up by Division 6, NDRC, through a contract between Columbia University and OSRD, at the request of Captain W. D. Baker, then Chief of the ASW Unit, Atlantic Fleet. When it was first started in April 1942, it was known as Research Group M. Later, when it became an official part of the Headquarters of the Commander in Chief, U. S. Fleet it was given the title of the Anti-Submarine Warfare Operations Research Group (ASWORG). Finally in 1944 when its activities had extended far beyond the anti-submarine field, it was given the official title of the Operations Research Group (ORG).

The general growth of the group and its activities are pictured in Fig. 1. Details of organizational changes and of work accomplished are given in the ASWORG Report of Activity, 1 April 1942 to 31 August 1944, submitted by Columbia University to NDRC; and in the succession of Progress Reports submitted by the Group to OFS in 1944 and 1945. The tabulation of the assignments of personnel is given in Appendix B. Official correspondence concerning the assignment of the group to naval activities is given in Appendix C.

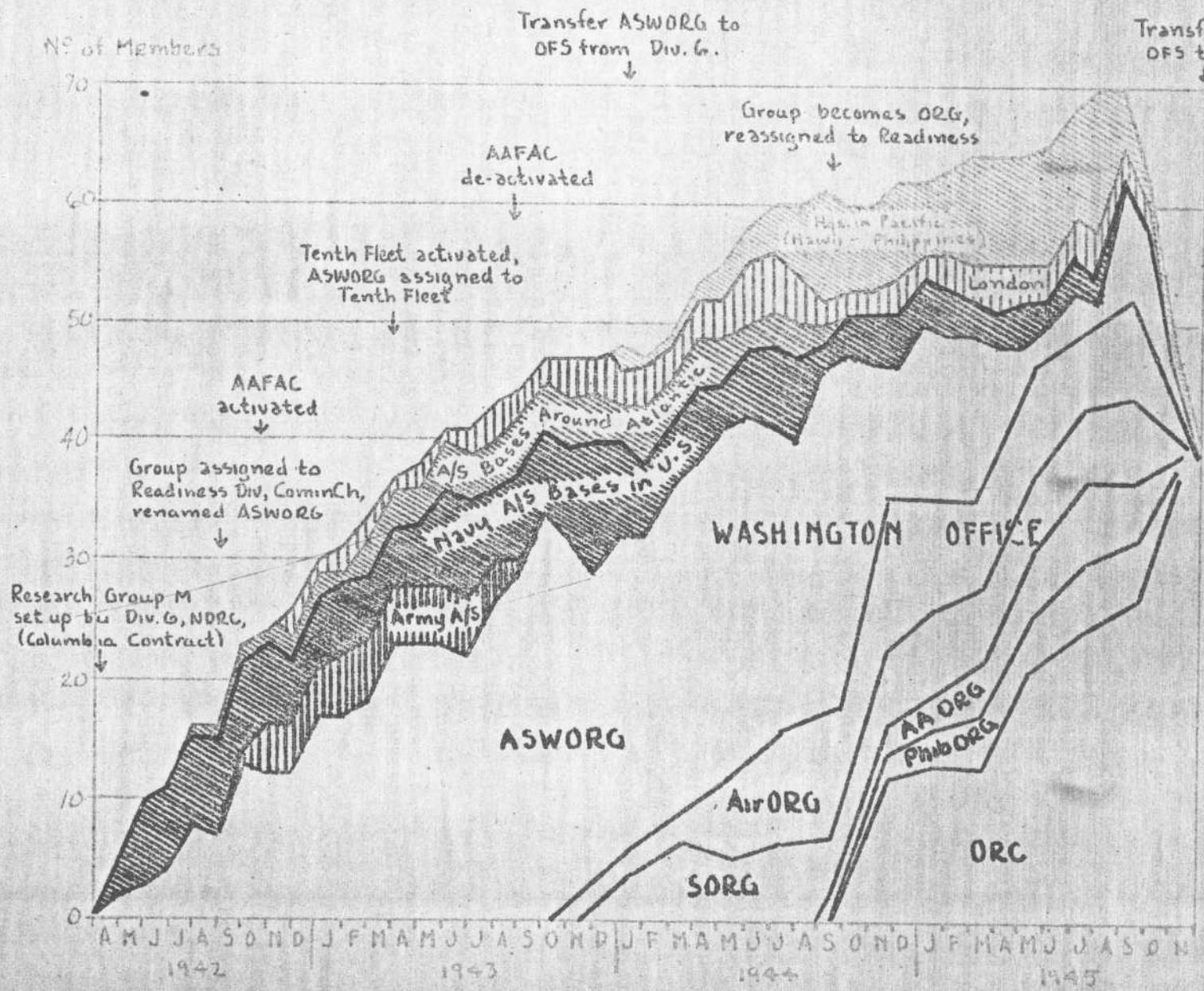


Figure 1. Growth of ORG

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## 2. Activities in the Field.

Assignment to operational commands in the field has been an extremely important part of the activities of ORG, both in providing a schooling in the operational "facts of life" for ORG members, and also in providing a proving ground for the results of Group work. Here in the field, working with the ultimate users of new weapons, ideas for new tactics could be applied in practice and new problems could be recognized and transmitted to the main Group for further work.

Sea Frontiers - In the crucial days of the Anti-Submarine War in the Atlantic, group members were assigned to nearly all of the operational bases around the Atlantic. The first assignments were to the Sea Frontier Headquarters on the continental coast. The group had its first office space with the Anti-Submarine Warfare Unit, Atlantic Fleet, located in Boston. In the summer of 1942 the main part of the group moved to Washington and was assigned to the Anti-Submarine Warfare Unit, Readiness Division, Headquarters of the Commander In Chief, United States Fleet, (CominCh). A number of members stayed in the Boston Office, however, since surface vessel anti-submarine doctrine could be worked on most effectively here. At least three members continued with this unit until the middle of 1943; and one member continued until the end of 1943, by which time the work could best be carried on in Washington.

In June of 1942 two members were assigned to Headquarters Eastern Sea Frontier in New York and one member was assigned to Headquarters Gulf Sea Frontier in Miami, to be of help at first hand in the operational headquarters of these Frontiers. Both of these field assignments were continued until the end of 1943. In both of these offices the ORG members had close connections with the Operations Officer for the Frontier, had access to details of operational records and took part in the planning of new operations.

Sea Frontier headquarters outside of the Continental United States were also covered by ORG personnel. One man was assigned to the Headquarters of Task Force 24 in Argentia, Newfoundland, where he helped to organize the statistics concerning the U. S. - British convoy system. When the U. S. Navy turned over the protection of North Atlantic convoys to the British and Canadians in April 1943, this assignment was terminated.

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One, two and sometimes three ORG members were assigned to the Caribbean Sea Frontier, where they spent part of their time at Sea Frontier Headquarters at San Juan, and most of their time at the operating base at Trinidad. Here again the collecting and publishing of local statistical records was organized, and members were active working out details of submarine hunts in the Caribbean. A great deal of extremely valuable operational experience was obtained by members assigned to this Command. Knowledge of the operational behavior of aircraft search-radar sets, and of radar anti-submarine countermeasure equipment was obtained by these members. Members were assigned to this base until September 1944.

Other A/S Bases - By January 1943 the submarine activities off Brazil had risen to such a point that the services of an ORG member were requested for the Fourth Fleet, which was responsible for anti-submarine operations off the South American Coast. One member of the group was assigned to this Headquarters during 1943 and another member was assigned for most of 1944. These members took an active part in laying out barrier patrols and submarine hunts. Their work helped sink several submarines and a number of German blockade runners coming from Japan loaded with rubber and tin.

In May 1943 a group member was assigned to the Moroccan Sea Frontier at Casablanca, North Africa. This assignment was continued, with only one change of personnel, until September 1944. Here a great deal of assistance was given in the laying out of a submarine-tight barrier using MAD and radar planes plus destroyers, across the Straits of Gibraltar. This barrier trapped three submarines and kept many more out of the Mediterranean. Much time was also spent in analyzing the results of a detailed survey of the waters between Spain and the Azores, using radar search receivers. This analysis showed that U-Boats seldom used their radar equipment (if they ever did) and made it possible to draw important conclusions concerning radar counter-tactics and equipment to be used against German submarines.

London - In November 1942 the first group members were sent to London. Since that time, there has been continuous Group representation in this important location. Here liaison has been carried on with operational research activities in the British forces. The members assigned to London have been a part of the staff of Commander, Naval Forces, European Theater of Operations (ComNavEu). Reports initiating in the British

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forces, and of interest to ORG or other parts of the Navy, were collected by the group members in London and transmitted through official channels to the Group in Washington. Scientific contact with Operations Research in England was maintained and duplication of efforts was thereby minimized. During most of the past three years at least three ORG members have been on duty in London at any time.

Army Air Forces - Until the middle of 1943 the AAF took an active part in anti-submarine warfare. The major part of this effort was borne by the First Bomber Command, later the Anti-Submarine Command (AAFAC) with Headquarters in New York. Since ASWORG covered the whole field of United States operations in anti-submarine warfare, Group members were assigned to AAFAC Headquarters in New York and to the Operational Test Unit at Langley Field, Virginia. At Langley new equipment was given operational tests, new tactics were tried out, and new squadrons were trained in the specialized tasks of anti-submarine warfare. In August and September of 1943, when the Navy was able to take over all anti-submarine operations, these assignments were terminated.

ASDevLant - In June of 1943 the Navy set up a tactical experimental unit at Quonset, Rhode Island. This unit, called the Anti-Submarine Development Detachment, Atlantic Fleet (ASDevLant), had planes and surface vessels and shop facilities. Here new equipment could be tested out or given further development trials; new tactics could be devised for their use; new training methods could be worked out; and experimental operational data could be obtained. It quickly became evident that ORG members could learn a great deal about tactics and equipment at ASDevLant; and conversely these members could be of considerable use to the Unit in helping lay out the tests, helping analyze the results, and in assisting in writing up the reports.

The air part of the Detachment was set up in May, and from that time onward at least two members were assigned there. The surface vessel part of the Detachment was set up in August 1943 at Quonset, and was later transferred to Fort Lauderdale, Florida. At least two members were on duty continuously with the surface section until August 1945. Experience gained at Fort Lauderdale and Quonset in setting up tactical experiments will be of extremely great value in peace time, when such experiments will be our only means of obtaining operational data.

Pacific Bases - By the end of 1943 it was apparent that the back of the U-Boat campaign had been broken and that it was important for the Operations Research Group to extend its activities, to assist if possible in the Pacific war. The first call came from our submarine forces in the Pacific. Two Group members were sent out in November 1943 to the Headquarters of Commander Submarines, Pacific (ComSubPac). The work of these members was appreciated and it was not long before a five-man sub-group was installed. This sub-group, which came to be known as the Submarine Operations Research Group - Pacific (SORG-Pac), continued until after V-J Day.

Following a trip of Dr. K. T. Compton to the Southwest Pacific, there came a request for an ORG member to be assigned to the Seventh Fleet. A member was sent out in March 1944, and thereafter one representative was maintained at Seventh Fleet Headquarters until August 1945. This representative first helped organize the anti-submarine activities in the Southwest Pacific and later helped analyze task-force defenses against suicide bombers.

Early in 1945 a request came for members to be assigned to Commander Air Forces, Pacific (ComAirPac). Two members were sent out in February 1945, and other members were added to this group in the summer. Much of the work of this group was in devising better methods for defending against suicide bombers.

Other Field Trips - In addition to this large number of regular assignments to operational commands in the field, a number of the members have had shorter assignments to study specific problems. One member was sent on an operational cruise of a CVE, hunting submarines in the Atlantic. Only in this way could background be obtained concerning carrier anti-submarine operations. Another member went on a submarine war-patrol to find out at first hand the technical problems involved in sinking Japanese shipping. Another member spent several weeks on carriers and other naval craft off Okinawa at the height of the suicide attacks. On return to Washington, he was able to initiate important tactical studies and was able to report to laboratories on the working of new equipment. In the important problem of correlation between submarines and aircraft in Air-Sea Rescue work, an ORG member visited the B-29 bases in the Marianas and went on operational flights.

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This first hand contact obtained by most of the members of ORG with the men and equipment doing the actual fighting gave the group a practical background which made reports much more immediately useful. The combination of practical background, gained in the field, with the detailed theoretical work carried on in Headquarters at Washington made the Group more valuable to the Navy. Figure 2 gives details of manpower assignments to all these bases.

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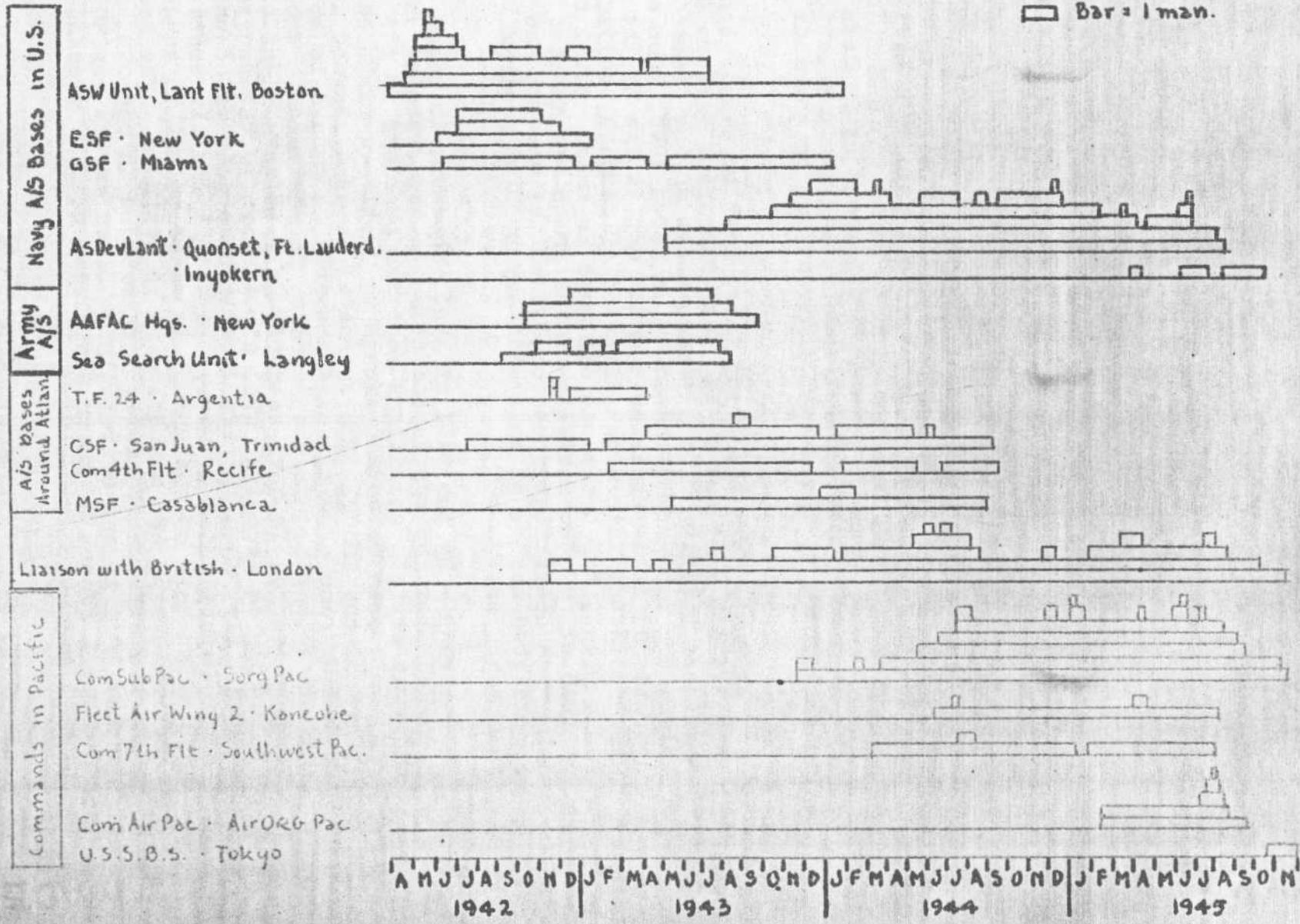


Figure 2. Manpower in ORG Field Offices

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### 3. Activities at Headquarters in Washington.

If studies carried on in the field gave the most immediate and most practical answers, the results of these studies had to be combined at the central office in Washington in order to give an over-all picture to the higher command. Conversely more generalized and more theoretical studies, carried on in Washington, were necessary to back up the work done in the field, and to bring the results of the Group's work before the planning officers and the laboratory scientists. This unification of the group, through its central Headquarters, distinguished the ORG from all other American attempts at Operations Research. It enabled the group to transfer its men rapidly from one field of activity to another as tactical and strategic aims changed; it enabled the group to use scientific specialists efficiently by moving them about from position to position; and it enabled the group at all times to present a clear and up-to-date picture of technical military requirements, and their relation to events in the field, to the Navy Department and to commands in the field.

ASWORG - When the group first went to Washington, in June 1942, it was assigned to the Anti-Submarine Warfare Unit in the Readiness Division of the Headquarters of the Commander in Chief, U. S. Fleet (CominCh). In March 1943, when all the operational anti-submarine command activities of the Navy were collected into a new division of CominCh, called the Tenth Fleet, the Group was assigned to this. Until the fall of 1943 all of the activity of the group was devoted to anti-submarine operations research, since the urgency and the complicated nature of this military problem required the Group's full energies.

AirORG - By the fall of 1943, however, it began to be apparent that the war in the Atlantic was receding in urgency, and that certain operations research problems in the Pacific war would soon be urgent enough to justify a dispersal of the effort of the Group. The technical lessons learned in the anti-submarine problem could possibly be turned to helping our own submarines in the Pacific, for instance. Some of the lessons learned in anti-submarine air attacks might also be applicable in studying naval air warfare in the Pacific. Consequently, when the Air Intelligence Section of the staff of the Deputy Chief of Naval Operations for Air requested the help of members of the group, in order to set up an Air Operations Research Group, two members were so assigned. The resulting group was soon unofficially integrated with the ORG, and in October 1944 it was officially combined as the AirORG Section of ORG. A report of their activities will be presented later in this report.

SORG - At the same time that members went to Pearl Harbor assigned to the Staff of Commander Submarines Pacific, a sub-group was set up in Washington to study submarine warfare. This group, known as SORG - Washington, analyzed all submarine action reports, issued a monthly summary of submarine operations for the Naval Staff and made analytic studies of torpedo effectiveness and tactical effectiveness for distribution to the fleet through official channels. This group averaged about five members and produced a large amount of valuable research work.

OFS - In the meantime, in January 1944 it was decided that it would be more appropriate for the Group and for other related activities to be administered directly by OSRD rather than by Divisions of NDRC. For this purpose a new office was set up in OSRD, called the Office of Field Service (OFS), with Dr. K. T. Compton as Chief. The ORG was the first group and the largest single group to be administered by OFS. Throughout 1944 and 1945, members of the Group were contract employees of OSRD, assigned as a Group to the Navy. This administrative arrangement terminates between December 1945 and January 1946; when the group will go over to a peace-time setup, involving a contract between the Navy Department and the Massachusetts Institute of Technology.

ORG - In the fall of 1944 it became apparent that the majority of the group was working on problems other than anti-submarine, so that it was inappropriate to have the group as a whole assigned to the Tenth Fleet. Consequently, in October 1944 the group was officially renamed the Operations Research Group and was reassigned to the Readiness Division of CominCh. A copy of the official letter making the transfer is given in Appendix C.

PhibORG and AAORG - At this time three more sub-divisions of the group were constituted. A new section, averaging about four members, studied problems of amphibious and landing operations. It was called PhibORG. As a result of its studies of naval gunfire support, doctrine was worked out for force requirements in beach-drenching and post-landing support fire. At the same time an anti-aircraft sub-group called AAORG was set up to study problems of anti-aircraft fire from task forces. This sub-group became very important when the problem of the defense against suicide bombers became critical. At the end of the war it was engaged in several extremely important studies in this field.

ORC - At the same time the remainder of the group was constituted into the Operations Research Center (ORC). This sub-group took care of the administrative and general scientific activities of the group as a whole. In the Center was the Intelligence Section, which distributed and filed the large amounts of material coming into the group: the technical reports, the ONI intelligence notes, the action reports and other operational data. This Section kept in touch with the men in the field, supplying them with needed material. It also took care of the publication of ORG Reports and other details of administration. By taking care of the petty details of red-tape for all of the group, the Intelligence Section made it possible for the rest of the group to work very much more efficiently. Although much of its work was unexciting, it was found just as important to assign intelligent people to this Section as to any other.

In the Operations Research Center, also, were the punched card equipment and IBM machine operators. IBM equipment had been obtained in 1942 and had been used throughout the war by the Group to preserve and tabulate the official naval anti-submarine records of actions: sightings, sinkings, and attacks. When AirORG and SORG entered the picture, codes were set up for transferring operational records of these activities on to punched cards. By the summer of 1945 practically all of the important operational data on naval warfare in World War II had been put on punched cards and is now available for a large number of possible analyses. This IBM equipment is to be kept on during peace-time, in order to have the records available for future study.

General theoretical and analytical problems which cover more than one field of naval warfare were also studied in the Operations Research Center. Sub-groups were set up in ORC which studied: the general problems of radar and other detection means; the tactical problems of search, screening, and task force deployment; radar and sonar countermeasure problems; and recently, the strategic and tactical problems connected with guided missiles and the atomic bomb.

Publications - The output of the group has consisted mainly of written documents handed to naval officers, suggesting action or giving technical background in order that the officer can reach some decision. An answer having limited interest, written to a single officer, was usually written as a Memorandum to the interested officer. If the research going into the report required more than a few days, the answer was written up as a

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Group Study. Studies put out by ASWORG were called RR's. Those put out by ORC were called CC's, etc. Studies sometimes were distributed only to one or two activities, if the field of interest was small or the security high. If the distribution list became very large the reports were made more readable and were bound in more durable manner and were then called ORG Publications. Some of these publications have had distribution lists of several hundred. A list of titles of Publications and Studies is given in Appendix A. In other cases the written material has been incorporated into official Fleet Publications, and cannot be listed as specifically originating with the Group. Many of the Fleet Tactical Publications have incorporated ORG contributions.

The remaining sections of this Report are statements, by the various Sub-groups, concerning the more important studies which the Sub-group made and some of the results which turned out to be particularly useful to the Navy.

#### 4. Research of ASWORG, 1 April 1942 to 1 January 1944

During this earlier period the group was engaged entirely in the study of anti-submarine warfare, and was known as ASWORG. Details of the research carried on in Washington and in the field are given in the final ASWORG Report of Activity for this period.

Search Problems - A great deal of time was spent on the Search Problem; first in the case of visual sightings and radar sightings by aircraft, and secondly for radar or sonar detection gear used by surface craft. The fundamental concepts had to be clarified, the measures of effectiveness had to be worked out, and from these as basis the correct tactics had to be developed. The results of this long series of studies are embodied in the official fleet publication "Fleet Tactical Publication No. 223" which is the U. S. Navy anti-submarine doctrine. Complete operational data on sightings and radar contacts made by British planes on U-Boats was obtained by one of the group members in London. The requisite theory to explain this data was worked out and checked with laboratory measurements obtained by NDRC laboratories and by tactical experiments performed at ASDevLant. From these results it was possible to work out search plans, barrier patrols, and convoy escort plans.

Similar theory was worked out for sonar search and applied to anti-submarine screening plans. The fundamental scientific principles underlying all of this work on search and screening are being collected in a Volume which will be part of the Division 6 Summary Volume Series.

Countermeasures - A great deal of work went into the study of countermeasures; both for submarine radar equipment and for U-Boat acoustic torpedoes. The survey mentioned earlier in connection with the Moroccan Sea Frontier indicated that the Germans were not using search radar on their U-Boats. Prisoner of War and other intelligence reports indicated that they were using radar search receivers. It was important, however, to keep from using countermeasures against the search receivers too early, or else the reduction in search efficiency accompanying such countermeasures would occur sooner than was necessary. Statistical tests had to be introduced in the study of sighting data, in order to determine when search receivers on U-Boats became effective enough to merit the introduction of countermeasures. These matters occupied the attention of many ORG members in Washington and in the anti-submarine bases.

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Another important and exciting study was being carried on in the field of sonic countermeasures against the German acoustic torpedo. Prisoner evidence and other intelligence reports indicated that such a torpedo was about to be introduced by the Germans and shortly thereafter a few pre-production models were fired from U-Boats. Members of the group having the requisite technical skills pieced together these scraps of information and obtained a fairly complete picture of the probable physical properties of the new torpedo and the way in which it would react to the various countermeasures under consideration. They induced an NDRC laboratory to build a presumed replica of the controls which resulted in an important change in doctrine. They coordinated the efforts of several groups in the development of countermeasures and aided the ASDeviant Surface Section in testing this equipment. One member of the group made a special visit to England to study the latest information since he was at that time the recognized authority in both countries on the subject. The results of all this study were such that when the Germans brought their new torpedo into full production the United States and Great Britain were in production with a simple and effective countermeasure; and only one or two destroyers were hit monthly, a much smaller number than the hopeful Germans had expected. German discouragement over this failure was one of the reasons for a further decline in U-Boat aggressiveness.

By the end of 1943, the group had begun to extend into wider fields, and ASWORG became only one of a federation of groups, with ORC as the unifying center. The work of the group during the rest of the war can more conveniently be divided according to each Sub-group, and the remainder of this report will be so divided. The work of the Operations Research Center will first be reviewed; and then the work of the Sub-groups, of which ASWORG is but one of several.

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5. OPERATIONS RESEARCH CENTER, 1944 - 1945.

A. Detection and Combat Information Section

At the time of the organization of the Operations Research Center a considerable research program on the application of radar to submarine and anti-submarine problems was already in progress in ASWORG. It was decided at that time to concentrate this rather specialized work into a section of the ORC which could furnish specialized information on radar to the various sub-groups, and could also carry on fundamental research on the tactical characteristics and measures of effectiveness of radar in general.

This section was originally known as the Radar Section, but later its scope was broadened to include all detection devices and the means of communicating and correlating such aboard ship, particularly the problems of the C.I.C. The name of the section was therefore changed to the Detection and Combat Information Section of ORC.

Blip-Scan Ratio - In the late fall of 1944 the most pressing problem in this field was the problem of detecting submarines equipped with "Schnorchel". In cooperation with ASDevLant a program of radar range measurements on a mock-up of "Schnorchel" was begun. It soon became apparent that on such a small target the simple concept of radar range could not be applied, for at most ranges the target gave only intermittent blips on the radar screen. It was therefore necessary to measure, as a function of range, the fraction of the scans on which blips appeared, the so-called "blip-scan ratio." By combining these data with reasonable assumptions on the number of blips required to enable recognition of the target, it was possible to estimate radar sweep widths against "Schnorchel," and on the basis of these sweep widths to construct proper search plans and to estimate military requirements. This work is now in process of being extended to other targets, and types of radar.

Radar Countermeasures - At the same time considerable attention was given to radar countermeasures, particularly those which were being used by German submarines. In this connection the ORC was involved in the setting up of projects at Radiation Laboratory and Radio Research Laboratory for the evaluation of radar camouflage and of search receivers, and also played a considerable part in the evaluation of intelligence information in this field.

AEW Studies - With the development of AEW (Cadillac I and II) the problem of evaluation of its operational characteristics was given to the ORG. To this end a Group member spent several months at San Clemente with the training squadrons. The resulting performance data have been embodied in a report.

Visual Detection - In the field of visual detection the ORG has worked closely with the Joint Army - Navy - OSRD Vision Committee. Working with this committee the ORG has collaborated in tests on look-out scanning rates with the Lookout School, SubBase, New London, in tests on the effect of shape on target visibility with the Biophysics Laboratory of Columbia University, and with the SubBase, New London, on tests of optical instruments. The role of the ORG in this work was always primarily to obtain results of value in the determination of measures of effectiveness of visual search and visual gun pointing.

C. I. C. - The work on C.I.C. was begun too late in the war to produce many results. To date it has consisted for the largest part in liaison with C.I.C. development agencies, such as the Systems Research Laboratory.

### B. General Analysis Section

This section of ORC (comprising during 1945 an average of five members) was established in the autumn of 1944 for the purpose of giving continuing attention to theoretical questions of naval warfare, with emphasis on the mathematical aspects of the problem. Since the theory of search and screening has been a traditional source in ORG of problems of this kind, it has held a central position in the attention of the General Analysis subsection; indeed, the latter started life as the "Subsection on Search and Screening."

General Analysis has operated in two main ways: First, it has sought to give aid to other sections faced with problems of a particularly mathematical sort. Second, it has initiated theoretical studies, on the basis of increasing knowledge of the military situation. Finally, for reasons of expediency rather than of principle, the subsection has worked on certain questions (e.g., guided missiles) not fitting into other parts of the ORG.

Search - The chief theoretical contributions of the subsection were on the distribution of searching effort, and the analogous problem for gunnery; problems on random encounters and the theory of search about a point of fix. A good deal of theoretical thinking was also incorporated in

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the text book Search and Screening which has been written mainly by the members of the General Analysis Section of ORG.

The first large problem on search and screening attacked by the subsection was that of air escort of convoys and task forces, of all sizes and speeds. The results were transmitted to the Fleet, and form the present basis of its doctrine.

Another piece of work transmitted to the fleet was concerned with potentialities of air countermasures to the Type XXI U-boat. The principles of defensive search for it were layed out. This was done in connection with ASWORG.

An anti-shipping A/C search manual was prepared for AirORG, which has found use in the Fleet.

AA Screens - A considerable amount of work was done in connection with AAORG, the more theoretical of its problems being handled by the General Analysis subsection: fleet dispositions and AA screen evaluation; operational studies of Combat Air Patrol disposition and vectoring.

Guided Missiles - A continuing project has been work on guided missiles, chiefly in connection with the Guided Missile Committee of the Joint Chiefs of Staff Committee on New Weapons and Equipment.

A number of smaller projects have been completed by this subsection: study of smoke screens; surface craft sonar screens; gunnery problems; effectiveness of PT boat tactics and weapons; etc.

### C. Intelligence Section

Chief among the functions of the Intelligence Section were the acquiring and routing throughout the ORG of the many reports necessary to the proper functioning of the Group; also the maintenance of files of these reports in such a manner that they might be easily accessible for reference.

Reports were received from a number of sources and it was necessary to maintain close liaison with these activities to keep them acquainted with the current needs of the Group. In addition, publication lists and accession lists of various OSRD and Naval activities were continually reviewed in order to assure that all material useful to the members of the ORG came to their attention.

Not only the men stationed in Washington but also the field men had to be kept abreast of developments. Therefore, one man in this Section was given the job of looking out for the interests of the men at the bases. This man was always a man recently returned from the field for it was felt that he would then have the needs of the field men fresh in his mind. It was his duty not only to inform the field men of developments in which they were interested but also to pass on the results of their work to the proper authorities in the Navy Department.

A considerable effort was expended in filing the reports which were retained in the Group's main office in such a way that they would constitute a useful reference library rather than simply a collection of material. The reports themselves were filed according to source but a subject card index involving numerous cross references was also provided. These files were found to be useful to the Navy generally as well as to members of the ORG.

An indication of the magnitude of the tasks performed by the Intelligence Section is provided by the following figures. In an average month approximately 1600 different reports were received by the Group. Of these, 500 reports received very limited routing and were returned to the senders within 24 hours. The remaining 1100 were given more general routing within the Group and about 600 were retained in the ORG files. These files contained approximately 15,000 different items at the end of the war.

#### D. Machine Section

On 1 December 1943, the IBM unit had a tabulator, punch, verifier, two sorters, interpreter and reproducer. In October 1944, the increased amount of technical work required the addition of a multiplier and a collator, and in October 1945, a considerable increase in the volume of punching required the addition of another punch and verifier. Early in 1944 the Submarine Operations Research Group assigned to the COMSUBPAC staff felt the need of an IBM unit to aid in maintaining their statistical files. Accordingly, a tabulator, punch, verifier, sorter, reproducer and interpreter were shipped to Pearl Harbor.

The original complement of two Operations Research Group men and two enlisted WAVES was augmented by a third enlisted WAVE in May 1944. In August 1944, it was found that the full time of two ORG men was no longer required and a working procedure was adopted whereby the second ORG man was to be called upon only in an emergency, but additional WAVE assistance was made available for punching and verifying when needed.

The work of the IBI unit falls logically into two categories:

(a) Services direct to Navy offices. The IBI unit was originally assigned to work for the Tenth Fleet, and the majority of its work was done in support of analysis in anti-submarine warfare. In addition to an average of one special job per day, daily revisions were made in files recording casualties to allied merchant ships and attacks on enemy submarines by allied forces. Daily situation reports covering both of these items were made, keeping the picture for the war to date always current. All the statistical material appearing in the U. S. Fleet Anti-Submarine Bulletin were obtained from files kept by this unit.

The Air Intelligence Group (Opl6VA) coded a complete file of aircraft action reports and other miscellaneous data pertaining to naval air combat and used the file thus obtained to supply information of a statistical nature for the purpose of analyzing naval air warfare.

After V-E day, it was felt that the anti-submarine picture would fade and that this unit could handle another large job. COMINCH operations had been keeping records of ship movements and fleet casualties by hand, but this had been a laborious procedure and by its nature had prevented the quick analysis of data so often required by the Commander in Chief. A program was begun whereby an IBI file would be maintained on a day to day basis and would show at all times all damage to units of the U. S. Fleet and also show the position, duties, fleet status, assignment, and other data pertaining to each ship commissioned in the U.S. Navy. This file was used in part as the basis for redeployment after V-J day and will hereafter be used as the source of material for a great many types of reports including the fleet organization.

(b) Services to the Operations Research Group.

Since in the early days the Operations Research Group was primarily concerned with anti-submarine warfare, so also was the IBI unit. A file of cards has been maintained which shows the technical data about each attack on an enemy submarine. This file has been used frequently in preparing

research reports and overall statistical summaries of operations, tactics, and effectiveness of old and new types of weapons.

The Submarine Operations Research Group has made widespread use of the advantages of keeping data in the form of punched cards. The files used by this section show technical data on each sighting and attack by, and each counter-attack on, and aircraft sighting by, a U. S. submarine. This data has been used for preparation of a number of statistical studies as such, and also was the basis for a monthly summary of submarine operations. The Submarine Operations Research Group at Pearl Harbor has prepared several types of monthly reports giving information required by the strategic planning officer, and has also used the files as a basis for evaluation of weapons, tactics, and operations, and for answering the innumerable "on the spot" questions raised at COMSUBPAC. Further use of these files has been the preparation of a quarterly listing of all attacks made by U.S. submarines, for distribution to Fleet Commanders and Operations Officers..

The Air Operations Research Group has maintained a file showing attacks by U. S. Navy aircraft on enemy shipping. This file has been useful in preparing statistical reports and in the evaluation of weapons and tactics used in this type of warfare.

The people concerned with anti-aircraft operations have maintained a file showing pertinent data for each anti-aircraft operation. These files have been used as bases for estimating the effectiveness of various types of anti-aircraft guns and for compiling statistics showing the results of anti-aircraft action in each of the major battles.

Numerous smaller jobs have been done for the Operations Research Group including analysis of shore bombardments at Iwo Jima, the calculation and compilation of tabulations for the anti-submarine search plans appearing in FTP 223 and analysis of proposed types of approach used in firing different patterns of rockets.

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In the period being covered, the IBM unit has used approximately 415,000 cards and has turned out approximately 4,890 tabulations and listings. The figures in the following table show these and other statistics, by customer.

CUSTOMER	THOUSAND CARDS		TABULATIONS AND LISTINGS PRODUCED	TIME DISTRIBUTION	
	USED	NOW IN FILE		SUPER- VISORS	OPERA- TORS
TENTH FLEET OPERATIONS	82	26	2960	) 10 %	) 28 %
AIR INTELLIGENCE	50	11	350	)	)
OTHER NOT ORG	81	55	480	13 %	30 %
SORG	5	3	50	16 %	3 %
OTHER ORG	115	41	505	40 %	26 %
WASTE	57	43	545	21 %	13 %
TOTAL	25	--	--	--	--
TOTAL	415	179	4890	100 %	100 %

6. ANTI-SUBMARINE WARFARE OPERATIONS RESEARCH GROUP, 1944 - 1945.

Search for Submarines - The search problem is basic to anti-submarine warfare, since submarines are very hard to detect. Consequently a great deal of attention has been given to determining the basic facts and theories of submarine detection by naval craft. It was realized early that the situation must be described in terms of probability rather than a definite range of detection. A continuing study has therefore been made of the factors influencing the probability of visual and radar detection by aircraft and sonar detection by surface craft. Data from naval operations have been related to basic physical constants and correlated with information from tests and experiments to give a clear picture of the phenomena involved. Especially in radar detection of "Schnorchel" (or other small objects) such an approach proved necessary.

When the best available description of the detection was obtained, it was necessary to use this information for the design of optimum search tactics. Recommendations have been made as to the best procedure for searches, barriers, and submarine hunts for use by both surface craft and aircraft. To a large extent these recommendations have, after review by the cognizant officers, been adopted by the Fleet. The last stage in the search problem has been that of preparing the material for publication in the U. S. Fleet Anti-Submarine Bulletin or Anti-Submarine Instructions.

This work has involved a continued re-evaluation in terms of changes in enemy submarines and tactics. The adoption of "Schnorchel", in particular, required a reconsideration of search tactics, which was begun in July 1944. As a result of the greatly decreased effectiveness of visual and radar search, increased emphasis was placed on sonar search for submarine detection, especially the use of sonobuoys. Even thermal wake detection was investigated.

Screening Convoys and Task Forces - Knowledge of the detection capabilities of anti-submarine craft must also be used to determine their best employment in defensive screening of convoys and task forces. Aircraft escort plans previously designed for merchant convoys were extended to cover task forces of many types, and improved detection theories introduced as a basis for their construction. While this work was in progress it became evident that the convoy escort plans were far from satisfactory as protection against submarines using "Schnorchel", or possible submarines of high submerged speed, and various necessary modifications were made. This was followed by a complete revision of all aircraft convoy escort plans on the basis of the most reliable detection theory.

Surface craft escort tactics were also subjected to considerable study. In general only minor modifications were made to convoy escort procedures, though it became evident that the introduction of high-submerged speed U-Boats would require some changes. A number of screens were designed for use by Fleet dispositions.

Anti-Submarine Attacks - A large number of problems relating to choice of weapons and tactics for attack have been studied. Members at ASDevLant have aided in analysis of operational tests of attack procedures, especially use of Squid. Proper explosion depth of aircraft depth bombs has been an important matter for study. Results of both surface craft and aircraft attacks have been analyzed statistically to determine the performance of gear and personnel.

Counter-measures to the German Acoustic Torpedo - Soon after the Germans first used their acoustically homing torpedo in September, 1943, a considerable fraction of the effort of ASWORG was devoted to the study of possible counter-measures to it. A fundamental problem was that of analyzing and assimilating all the available intelligence information so as to determine as closely as possible what the characteristics of the torpedo were. At the same time complete information had to be assembled as to the exact physical performance of all the devices which were proposed for use to defeat it. In these measurements ASWORG, working closely with ASDevLant, played a large part.

On the basis of this information it was then necessary to determine the best devices for use as counter-measures and the proper methods of using them. Such analyses were made repeatedly as knowledge of torpedo characteristics increased and improved material countermeasures were developed.

These considerations eventually led to a general study of countermeasures to various types of acoustic torpedoes other than that employed by the U-Boats, a study which was presently assigned to CRC.

Counter-measures to Radar Search Receivers - After the Germans introduced gear which detected transmissions from our search radar, it was necessary to determine the optimum use of radar under those conditions. The theoretical principles of radar search were applied, based on the best available estimates of the physical capabilities and operational performance of the German gear.

Countermeasures to "Schnorchel" - The effect of "Schnorchel" on the general problems of search and screening have already been mentioned in those sections. It was a major factor in these problems after June 1944.

Counter-measures to High Submerged Speed U-Boats - The threat of German high submerged speed U-Boats (which did not, in fact, become operational) was sufficient to occupy considerable ASWORG attention starting early in 1944. Again there was a dual problem: first to estimate the capabilities of the enemy craft and second to devise appropriate counter tactics. Both were done.

7. SUBMARINE OPERATIONS RESEARCH GROUP

Organization - The subsection of ORG known as the Submarine Operations Research Group was founded in November 1943 with the assignment of an ORG representative to the Staff of Commander Submarines, Pacific Fleet at Pearl Harbor. This initial assignment resulted from a request from ComSubPac to CominCh for an ORG man to be temporarily stationed at Pearl Harbor to survey the potentialities of rendering the same type of service to the Submarine Force that ASWORG had so successfully effected to the Atlantic Anti-Submarine War.

Early investigation indicated to the satisfaction of the Submarine Command that work of considerable value could be done by ORG, and as a result the Submarine division of ORG, SORG, grew both at Pearl Harbor and in Washington, until steady-state complements of five ORG men at Pearl Harbor and six in the CominCh section were reached in mid-1944.

The Pearl Harbor section was responsible to the Strategic Planning Officer, ComSubPac, while the CominCh section was responsible to the submarine desk in CominCh, F-4253. For the most part, the Pearl Harbor section worked on problems of immediate urgency to the Submarine Force, problems which either were suggested by the submarine officers themselves or were discovered by SORG personnel. On the other hand, SORG CominCh devoted itself largely to longer range problems suggested by officers in the Bureaus, discovered by SORG CominCh, or relayed to the latter by the Pearl Harbor section. Complete and fruitful liaison was maintained between the two sections. Personnel were exchanged between the two sections on a six month tenure basis in order to maintain in SORG CominCh personnel indoctrinated with the practical viewpoint of operating forces.

Problems Studied - During its war existence SORG solved many problems and made many studies, nearly all of which were utilized by the Submarine Force in modifying and improving its operations. The strategic selection and evaluation of submarine operating areas, torpedo fire control and protection of the submarine are some of the broad categories in which many SORG studies lay. Most of this work had a direct effect on operations, but a detailed itemization of these studies is beyond the scope of this summary. Some of the more interesting studies are enumerated below.

Causes of Loss of U. S. Submarines - From the point of view of the Submarine Force one of the most valuable studies was made on the subject of allocation of causes of loss of U.S. submarines and the protection of the submarine. This presented a knotty problem since almost never was any information available on the probable cause and circumstances of loss of a submarine. However, by a study of contact rates

on enemy submarines, SORG was able to determine in mid-1944 that the most important single cause of loss of U. S. submarines was probably Jap submarines. As a direct result of this study, a modification of existing sound equipment to torpedo detection use was successfully undertaken by Underwater Sound Laboratories, New London, Conn. By the end of 1944, nearly all submarines were fitted with this equipment. Prior to the first installations SORG had already worked out the optimum evasion tactics to be used both for visual and for sonar detection of torpedoes. These tactics were issued as doctrine to the submarine fleet. By the time the war ended three cases had occurred in which the new equipment and tactics had enabled a submarine to take successful evasion against enemy torpedoes which would probably not have been otherwise detected in time to institute evasion measures. Several submarine commanding officers have specifically credited the torpedo detection equipment and associated tactics with saving their ships from destruction.

In addition SORG made determinations of the probable losses of submarines to enemy surface craft attack, to enemy aircraft attack, and to causes associated with material failure. These estimates, although calculated by widely different methods, turned out to be essentially self-consistent.

Radar and Radar Countermeasures - In the summer and fall of 1944, the Japanese anti-submarine flying effort was at its peak. The numerous aircraft contacts made by our submarines led them to believe that the enemy had devised new methods of locating them. By analogy with certain aspects of the U-Boat war in the Atlantic, the belief was widely held that the reason for this high contact rate was that enemy aircraft were equipped with radar search receivers which enabled them to "home" on the submarine's radar set from great distances. As this belief spread, many submarines turned off their aircraft-warning radar sets rather than expose themselves to certain detection. A detailed statistical study by SORG showed that there was no basis for the fear of detection. The number of aircraft contacts per day in area was shown to be the same regardless of whether the radar was turned on or off, when due allowance was made for the difference in detection range between the radar and visual lookout.

The APR-1 intercepts by our submarines in the Yellow Sea and Southern Empire Regions were used by SORG to prepare a chart of Japanese land-based stations in this region and an attempt was made to evaluate the effectiveness of the Japanese shore-based radar network.

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Torpedo Studies - Numerous studies were made with the object of determining the sources of error in torpedo firing and evaluating the effectiveness of our present torpedoes. Important findings were that the low speed of the Mark 18 was responsible for its poor performance as compared with the Mark 14, and that both types of torpedoes were under-running shallow draft targets. As a result of these studies a set of recommendations for torpedo spread and firing plans was prepared.

Submarine Tactics - Studies of various tactical problems which arose in connection with submarine operations were also performed by SORG men both at Pearl Harbor and Washington. A comprehensive theory of coordinated attack groups was worked out to predict how much improvement over individual operation was to be expected under different conditions. It was possible in this way to estimate the optimum number of subs to put into "wolf-packs" and also what spacings to put between adjacent submarines on a patrol line.

Prior to the Japan Sea operations in June 1945 SORG developed tactics for mine field running by submarines and assisted in the design of fairing for the submarines assigned for this operation. The tactics were issued as doctrine for all submarines involved in the operation. Of some twelve submarines engaging in operations in the Japan Sea, not one was lost to mine fields in the dangerous entrance and exit passages of the mined straits.

The results of SORG work were presented in eleven Submarine Operations Research Reports promulgated by the Commander-in-Chief, in some sixty less formal and more widely disseminated Submarine Studies, in the Monthly Summary of Submarine Operations promulgated by the Commander-in-Chief, and by numerous informal memoranda.

8. AIR OPERATIONS RESEARCH GROUP.

Organization - The Air Operations Research Group was officially constituted a sub-group of ORG in October 1944. Its services were loaned to the Air Intelligence Group of the Office of Naval Intelligence, and throughout the War the two organizations worked in close cooperation.

The Air Operations Research Group was formed from Office of Field Service personnel already on assignment to the Air Intelligence Group, from experienced members of ORG, and from new members specifically recruited for the work of the new organization.

In January 1945 two members proceeded to Commander Air Force Pacific Fleet, at the latter's request, to act as operations analysts on his staff. This led later to the formal establishment of AirORG-(AirPac) as a Staff Section of ComAirPac, under the Force Tactical Officer.

At the War's end the complement of AirORG (Washington) was eleven, including one part-time analyst and two research assistants. In addition, a liaison analyst from the British Air Ministry was present as a working member, and a naval officer was on loan from CNO as Technical Aide for the Group. The membership of AirORG-(AirPac) was four, with the full complement of five soon to have been realized.

Flak Analysis - At a time when the losses of naval aviation to enemy anti-aircraft were mounting, and there was reason to believe that even higher proportions of combat losses would arise from that source, AirORG inaugurated a program of Flak Analysis aimed at reducing flak hazard to naval aircraft. In order to accomplish this purpose it first was necessary to learn exactly how our planes were receiving AA damage. To this end extensive studies were made of the relative frequency with which the various calibers of AA damaged our planes, the frequency with which various components were hit, the severity of the damage done, the portion of the attack in which it was suffered, etc. In addition, a detailed study was made - partly theoretical, partly empirical - of the probability of hitting aircraft on various courses, at various speeds, and at different angles of dive. From this work came the Navy's Flak

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Computer, a device which enables the safest heading of attack (and the relative hazards of all headings) to be computed for an air assault on a gun-defended target.

In cooperation with the Air Intelligence Group, a number of officers were specially trained in the use of the Flak Computer and indoctrinated in the principles of flak evasion generally. These Flak Intelligence Officers were assigned to Staffs of Carrier Task Forces and Groups and aided in the planning of missions. The program has been praised by Vice Admiral Mitscher for reducing loss of aircraft, and was credited by Vice Admiral McCain with saving the lives of many of his pilots.

Anti-Shipping Analysis - An early and continuing project of the AirORG was the study of anti-shipping attacks by naval aviation. The results of this study have been presented in a series of reports which emphasized weapons and fuze selections employed in attacks on various categories of shipping and combatant vessels, and which recommended improved selections for those cases in which other than optimum choices were made. Accuracy of attacks was consistently analyzed for all weapons employed, and the effect of enemy anti-aircraft fire on accuracy was examined.

In addition to the basic series of anti-shipping reports, special studies were made of ship vulnerability and of "force requirements" necessary to assure a given probability of sinking certain types of ships. An especially detailed study was made of the Battle for Leyte Gulf, the results of which were a basis for discussion in conferences between Third Fleet and Bureau of Ordnance on the optimum charge-weight ratios for anti-shipping weapons.

Accuracy of Airborne Weapons - The AirORG has made extensive studies of the accuracy achieved with the various weapons employed by naval aviation, both in training and in combat. These accuracy figures, together with the associated probabilities of hitting targets of given sizes, have been forwarded to the Fleet for use in operational planning.

Special accuracy studies also were undertaken, notably in cooperation with ComFairWestCoast and with NAS, Patuxent River, with a view to the formation of aviation doctrine.

At the request of the Bureau of Aeronautics a lengthy study was made of the Navy's program for electronic aids in

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low altitude bombing. This included a review of the equipment available, a critique of the training program, an analysis of training accuracy, and an evaluation of operational results.

Several members of the Group have acted as advisors to the Sight Assessment Group, NOTS Inyokern, and in that capacity have aided in the planning and analysis of trials of airborne sighting systems.

Other Research - In addition to the large blocks of continuing research outlined above, AirORG (Washington) made studies of shorter duration in many other fields of naval aviation.

Range of naval aircraft, and the means of increasing it was a subject of study, in conjunction with the Panel for Range of Naval Aircraft established by the Secretary of the Navy. In the course of this study a member of the Group toured forward Pacific bases and visited Carrier Forces afloat in order to obtain first-hand information.

Shortly after the Japanese Air Forces commenced to employ suicide tactics as standard doctrine, studies were begun of the role of the Combat Air Patrol in thwarting suicide attacks. This work was transferred to AAORG when that Group was expanded in July 1945.

Studies also were made in such a wide range of subjects as air-to-air combat, night fighter operations, defense of convoys, dispositions of combat and trainer planes in the JAF, and effectiveness of air-bursting fragmentation bombs against personnel.

AirORG-(AirPac), as a Staff Section of ComAirPac, received projects directly from that Command. Among these were:

- (a) The study of the optimum aircraft complement for Fast Carriers.
- (b) The design and conduct of tests of the altitude errors of the SM/SP radars.

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(c) The rationalization of Carrier Bills of Organization.

(d) The devising of plans for radar control of close support air missions.

(e) The general analysis of air operations.

The work of the Air Operations Research Group to date has appeared in thirty Air Research Reports, in numerous memoranda, and in many articles published in the Flak Information Bulletin.

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9. ANTI-AIRCRAFT OPERATIONS RESEARCH GROUP.

In September 1944 AAORG was set up as a new subgroup in ORG, to work on anti-aircraft problems of the Fleet. The first task of this group was to determine all that could be learned about the status of AA defense from operational reports. After a short survey of the available information, it was decided to use the ORG IBM facilities in order to simplify the task of collection and tabulation of data.

Defense Against Suicide Planes - In the latter half of October 1944, the first systematic use of Jap suicide planes in attacks against our ships was begun. From this time until the end of the war, one of the principal projects of AAORG was to obtain all information possible from action reports regarding our own and enemy tactics. Part of the duties of AAORG was to obtain complete and integrated information of this type, which was used in information bulletins published by the Commander-in-Chief and circulated throughout the Fleet. This material was also used as an aid to setting up operational requirements, particularly with respect to anti-aircraft material.

With the setting up of a Special Defense Section in the Headquarters of the Commander-in-Chief which was charged with speeding up development of tactics and material to combat the suicide attack, AAORG was expanded to include the study of all phases of the defense of ships against attack, including the use of radar and the Combat Air Patrol.

SpecORG - At this time (7 July 1945) AAORG was reorganized as SpecORG (Special Defense ORG), and assigned to the Special Defense Section of the Navy. Under these arrangements, work continued on the analysis of ship anti-aircraft actions, and in addition a number of studies were made of air defense actions.

In addition to the studies of material available in action reports, SpecORG, with assistance from other members of ORG, especially those in the ORC, participated in a number of special studies. These included studies of the lethality of various weapons, studies of the effectiveness of AA screens as affected by the type of ship formation, and studies of optimum placement of air patrols around a task force. With the aid of AirORG personnel at Pearl Harbor, measurements were made of the accuracy of height finding

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radars and means were studied for improving the efficiency with which they are used.

The end of the war saw the beginning of active participation of SpecORG in the activities of the experimental task force established to perform tactical tests of suggested methods of improving the defense of ships.

#### 10. AMPHIBIOUS OPERATIONS RESEARCH GROUP.

In October 1944 a subsection of the Operations Research Center was created at the request of the Research and Development Section of CominCh to study the results of and possible methods for the improvement of naval gunfire support during amphibious landings. Two men were assigned initially and the subsection grew slowly until the end of the war found it with a complement of six, averaging about 3.4 during this period.

Information regarding the effectiveness of the various support weapons and methods of delivery were first sought by examination of reports of amphibious operations, with analysis of volumes of effort and results obtained. Conclusions of interest and some value were derived. It was found, however, that procedures for the reporting of this newest form of naval activity by operational forces were not yet in a form to provide the data necessary for complete study of the problem from such reports alone. Recommendations for improvement of action reports were made.

Force Requirements - A need existed for estimates of "force requirements" for the various phases of gunfire support in terms of weapons, ranges, and control methods used. Measures of naval gunfire accuracy were obtained from target practice reports and applied to throw new light on the effects of range, target type, and ammunition expenditures in support problems. To improve such accuracy measures, recommendations were made through studies and visits to personnel concerned for the recording of data during actual shore bombardment practices in form suitable for analysis. This type of information enabled such work as an evaluation of long range destructive bombardments, and the derivation of safety distances when firing naval guns in close support of troops.

Bombardment Problems - The tactical planning of neutralizing and beach-preparing bombardments required knowledge of the relative effectiveness for such purposes of various naval projectiles and their fuzings. Advantage was taken of Army experience and their extensive studies of artillery projectile performance, and needed results extrapolated to naval weapons.

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Attention was given to the optimum tactical use of a new support craft, and assistance rendered in script preparation and technical advice during production of a tactical training film.

Heavy losses among beachhead troops inflicted by hidden enemy mortars demanded methods for mortar location from fire support ships. Studies were made of means of location by shipborne radar.

In the course of this work, two ORG Reports, eleven Research Studies and numerous memoranda were prepared and distributed.

11. FUTURE PLANS.

In the fall of 1945, in response to a request from CominCh, plans were evolved for continuing the Operations Research Group into peacetime at a strength of approximately 25 members. It was felt that the Group could be of continuing value to the Navy in studying the scientific aspects of military requirements for new equipment, in guiding the tactical experiments of fleet units to determine optimum tactics, and in providing a liaison between the Fleets and the scientific laboratories (see Appendix C , last Directive).

Contract negotiations have been set up between the Navy and the Massachusetts Institute of Technology. Some 15 or 20 veteran members of the Group have indicated their interest in staying on. It is to be hoped that the Group will continue its value to the Navy, and will do its part in keeping the military defenses of this country up-to-date scientifically.



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APPENDIX A  
PUBLICATIONS  
OF THE  
OPERATIONS RESEARCH GROUP



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OPERATIONS RESEARCH GROUP

STUDIES

<u>CG No.</u>	<u>Title</u>	<u>Date</u> <u>Classification</u>
1.	Aerial Escort Plans for Slow Task Forces	23 Oct 44 CONFIDENTIAL
2.	Effective Visibilities for Aircraft Radar Search	26 Oct 44 CONFIDENTIAL
3.	Analysis of Naval Support Gunfire, Makin Atoll	11 Nov 44 CONFIDENTIAL
4.	The Distribution of Searching Effort	24 Nov 44 (Unclassified)
5.	Radar Corner Reflectors and Targets	11 Dec 44 CONFIDENTIAL
6.	Japanese Anti-Aircraft Fire Control Radar	1 Jan 45 SECRET
8.	JANET Demonstration (Demolition of Beach Defenses)	13 Jan 45 SECRET
9.	5" Spin Stabilized Rockets in Support of Landings	20 Jan 45 SECRET
10.	Probabilities that Units Traveling at Random Reach a Fixed Range of a Cruising Force	24 Feb 45 CONFIDENTIAL
11.	Comments on Proposed Rocket Cable Barrage for Protection of Submarines Against Enemy Aircraft Attack	23 Feb 45 SECRET
12.	Comparative Neutralization Effectiveness of Spin Stabilized Rockets and Standard Naval and Artillery Shells <u>WITHDRAWN SEE CG 32</u>	26 Feb 45 CONFIDENTIAL
13.	Number of Rounds Required to Hit Small Targets <u>REPRINTED AS ORG MEMO 47</u>	8 Mar 45 CONFIDENTIAL

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ORC Studies (Continued)

<u>CC No.</u>		
14.	The Boundary of the Region of Submerged Approach for a Type XXI U-Boat	12 Mar 45 SECRET
15.	Evaluation of Effectiveness of Plan Love and a Modified Plan Against Surfaced and Schnorchel Type XXI U-Boats	17 Mar 45 CONFIDENTIAL
16.	Outline of Analysis of Gunfire Support on British Beaches, Operation Overlord	10 Mar 45 SECRET
17.	Naval Gunfire and Air Support of Landing Operations on Peleliu	17 Apr 45 CONFIDENTIAL
18.	Determination of Naval Gunfire Accuracy Against Shore Targets by Photographic Means	5 May 45 RESTRICTED
19.	Harassing Bombardment of Inshore Cities	30 Apr 45 SECRET
20.	Vulnerability of Japanese Tanks to Aircraft Rockets	30 May 45 CONFIDENTIAL
21.	Possible Use of Rockets by PT Boats	2 Jun 45 SECRET
22.	Measures of Effectiveness in the Task Force Defense Problem	14 Jun 45 CONFIDENTIAL
23.	Search for Stationary and for Moving Target about Point of Fix	20 Jun 45 CONFIDENTIAL
24.	Possibilities and Potentialities of Japanese Suicide Torpedoes	20 Jul 45 SECRET
25.	Search Radar Coverage Against Aircraft	28 Jul 45 SECRET
26.	Aerial Search for Surface Targets <u>ALSO PUBLISHED AS OP-16-V#A120</u>	23 Jul 45 CONFIDENTIAL
27.	Determination of Minimum Safe Distances from Own Troops for Engagement of Targets with Naval Gunfire	1 Aug 45 CONFIDENTIAL

## ORC Studies (Continued)

CC No.

- |     |   |                           |
|-----|---|---------------------------|
| 28. | A Discussion of the Vulnerable Areas of Japanese Gun Positions and Probable Ammunition Expenditures Required for Destruction with Naval Gunfire | 8 Aug 45<br>CONFIDENTIAL  |
| 29. | An Estimate of the Effectiveness of Long Range Area Bombardment of Enemy Shore Defenses by Surface Craft  | 19 Aug 45<br>SECRET       |
| 30. | An Estimate of the Possibilities of Mortar Location by Shipborne Radar during Support of Amphibious Landings                                    | 15 Aug 45<br>SECRET       |
| 31. | A Quantitative Theory of Unequal Aircraft Combat in Case of the Inapplicability of Lanchester's Theory  | 18 Aug 45<br>RESTRICTED   |
| 32. | The Relative Effectiveness of Naval Projectiles for Neutralization  | 17 Aug 45<br>CONFIDENTIAL |
| 33. | Disposition of Vectored CAP Units   | 5 Sep 45<br>CONFIDENTIAL  |
| 34. | Defensive Patterns for Interception   | 25 Sep 45<br>CONFIDENTIAL |
| 35. | Tests of Certain Visual Sighting Laws   | 14 Nov 45<br>CONFIDENTIAL |
| 36. | Capabilities, Limitations and Tactical Employment of Airborne Early Warning Radar   | 19 Nov 45<br>CONFIDENTIAL |

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ANTI-AIRCRAFT OPERATIONS RESEARCH GROUP

and

SPECIAL DEFENSE OPERATIONS RESEARCH GROUP

STUDIES

<u>AA No.</u>	<u>Title</u>	<u>Date</u> <u>Classification</u>
1.	Note on Plane Safety in AA Fire	6 Sep 44 CONFIDENTIAL
2.	Preliminary Report of AA Action - Biak Landing	13 Oct 44 CONFIDENTIAL
3.	Summary of Information on Suicide Attacks	3 Feb 45 SECRET
4.	Anti-Aircraft Action in the Philippines, 17 Oct 44 - 13 Jan 45	28 May 45 SECRET
5.	Effect of Ship Maneuvers and Certain Enemy Tactics on Success of Suicide Planes	14 Jul 45 SECRET
6.	Battle Time Lost by Naval Vessels as a Result of Damage from Air Attacks <u>WITHDRAWN</u>	20 Jul 45 SECRET
7.	Some Advantages of Early Interception	27 Jul 45 SECRET
8.	AA Defense of Fast Carrier Task Force, 24 October 1944 to 21 March 1945	11 Sep 45 SECRET
9.	Brief History of Fast Carrier Task Forces in the Pacific 23 October 1944 to March 1945 <u>WITHDRAWN</u>	6 Aug 45 SECRET
10.	Fighter Defense Problems	3 Aug 45 SECRET
11.	Evaluation of AA Screens, Considering Only the 5" Guns, VT-Fuzed	10 Sep 45 CONFIDENTIAL

AA Studies (Continued)

AA No.

12. Not yet issued.

13. Anti-Aircraft Actions in the Okinawa Campaign

12 Oct 45  
SECRET

SUBMARINE OPERATIONS RESEARCH GROUPSTUDIES

<u>SS No.</u>	<u>Title</u>	<u>Date</u> <u>Classification</u>
1.	Contacts with Japanese AH Made by U.S. Submarines in 1943	28 Mar 44 SECRET
2.	Japanese Anti-Submarine Measures	7 Apr 44 SECRET
3.	Variation of Percent Hits with Range for Periscope and Radar Approaches	7 Apr 44 SECRET
4.	Effect of Speed on the Safety of Independents and Convoys	14 Apr 44 SECRET
5.	Torpedo Salvo Size for Maximum Expected Sinkings per Patrol; Method of Calculation of Optimum Torpedo Salvo	5 May 44 SECRET
6.	Study of Torpedo Track Plans	16 May 44 SECRET
7.	Grenade Timing and Probability of Flashback	18 May 44 CONFIDENTIAL
8.	Theory of Zigzag Torpedoes	20 May 44 SECRET
9.	An Analysis of the First Three Submarine Coordinated Attack Groups to Operate from Pearl Harbor <u>SUPERSEDED BY SONG MEMO #7</u>	23 May 44 SECRET
10.	Initial Detection of Submarine by Echo-Ranging	3 Jun 44 SECRET
11.	Effect of Evasive Action by Target on Probability of a Successful Attack	22 Jun 44 CONFIDENTIAL
12.	Importance of Visual Sightings	11 Jun 44 (Unclassified)

**UNCLASSIFIED**

## SORG Studies (continued)

SS No.

13.	Long Range Torpedo Shots	27 Jun 44 SECRET
14.	Comparison of Submarine Activity of Task Force 17, Task Force 71 and Task Force 72	2 Aug 44 SECRET
15.	Gunfire Actions by U. S. Submarines	25 Aug 44 SECRET
16.	Evaluation of Echo-ranging by Surfaced Submarine	20 Sep 44 SECRET
17.	Comparison of Operational Results for Various Submarine Types	20 Sep 44 SECRET
18.	Contacts between U. S. and Japanese Submarines	9 Oct 44 SECRET
19.	Japanese Aircraft Homing on SD Transmission <u>SUPERSEDED BY SS/38</u>	5 Oct 44 SECRET
20.	Effect of Depth Setting on Torpedo Effectiveness	16 Oct 44 SECRET
21.	Effect of Increased Submerged Speed on Number of Attacks <u>SUPERSEDED BY SORR/11</u>	23 Oct 44 SECRET
22.	Effect of Depth Setting on Torpedo Performance	3 Nov 44 SECRET
23.	Torpedo Expenditures in the Pacific	4 Nov 44 SECRET
24.	Sono-bombs reported by Submarines	10 Nov 44 SECRET
25.	A/C-S/M Joint Operations - An Analysis: Coordinated Air-Submarine Convoy Exercises	18 Aug 44 SECRET
26.	Evasive Routing by Japanese After M/V Losses to U. S. Submarines	9 Nov 44 SECRET

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## SORG Studies (continued)

SS No.

27.	Enemy A/S Flying	29 Oct 44 SECRET
28.	Submarine APR-1 Contacts on Japanese Radar Stations	29 Oct 44 SECRET
29.	Yields in Southern Empire Areas	29 Oct 44 SECRET
30.	The Accuracy of Torpedo Fire Control - An Analysis of Salvos Fired on War Patrols, January to June 1944	1 Jan 45 SECRET
31.	Torpedo Evasion by Submarines	23 Dec 44 SECRET
32.	Prematures on Mk 18 Torpedoes	28 Dec 44 CONFIDENTIAL
33.	Successful Ping Ranges from Submarines	1 Jan 45 SECRET
34.	Effect of Position of Sun on Submarine- Plane Sightings	11 Dec 44 (Unclassified)
35.	Increase in Enemy Submarine Threat to U.S. Submarines During 1944	23 Dec 44 SECRET
36.	Effect of Torpedo Speed on the Success of a Torpedo Attack	7 Jan 45 CONFIDENTIAL
37.	Relative Effectiveness of Electric (Mk 18) and Air (Mks 14 & 23) Torpedoes Against Shallow Draft Escorts	13 Feb 45 SECRET
38.	Preliminary Examination of Methods of Search from the Flank <u>SUPERSEDED BY SS/49</u>	19 Jan 45 CONFIDENTIAL
39.	Are the Japs Homing Effectively on the SD Radar?	5 Mar 45 CONFIDENTIAL
40.	Analysis of Lifeguard Missions by U. S. Submarines	9 Mar 45 CONFIDENTIAL

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SORG Studies (continued)

SS No.

41.	Special Procedure for Avoiding German T-5 Torpedoes Fired at our Submarines <u>SUPERSEDED BY SS/60</u>	14 Mar 45 SECRET
42.	Comparison of the Performance of the Mk 18 with the Mk 14 and 23 Torpedoes in Attacks on Large Warships	21 Mar 45 SECRET
43.	Successful Submarine Attacks on Warships	21 Mar 45 SECRET
45.	Summary of Air-Sea Rescue Aids and Their Application to the Submarine Lifeguard Problem	27 Mar 45 CONFIDENTIAL
47.	Japanese Defensive Tactics in Torpedo Attacks	13 Apr 45 SECRET
48.	Effect of Torpedo Hits on Japanese Merchant Vessels	18 Apr 45 SECRET
49.	Search from the Flank Compared with Search from Ahead	21 May 45 (Unclassified)
50.	Charge Weight for Submarine Torpedoes	15 May 45 SECRET
51.	Comparative Performance of Light and Heavy Hulled Submarines under Counterattack	18 May 45 SECRET
52.	Submarine Tactics against Mine Fields	19 May 45 SECRET
53.	Effect of Target Coverage on the Success of Torpedo Salvos	30 May 45 SECRET
54.	Target Tracking and Torpedo Aim	25 May 45 SECRET
55.	Operational Data on Japanese Sonar and A/S Tactics Relevant to Submarine Sonar Countermeasures	13 Jun 45 SECRET

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## SORG Studies (continued)

SS No.

- |     |   |                           |
|-----|---|---------------------------|
| 56. | Probable Explanation for the Sono-Bombs<br>or Light Explosions Reported by U. S.<br>Submarines                            | 31 Jul 45<br>RESTRICTED   |
| 57. | Submarine Radar Phantoms  | 21 Aug 45<br>CONFIDENTIAL |
| 58. | Linear Lag in Target's Turns  | 20 Aug 45<br>RESTRICTED   |
| 59. | Use of Sound Gear in Submerged Approach   | 22 Aug 45<br>CONFIDENTIAL |
| 60. | Improvement of the TDM, with Applications<br>to Evasion of Acoustic Torpedoes   | 24 Sep 45<br>SECRET       |
| 61. | The Desirability of Additional Gun Ammunition<br>at the Expense of Torpedoes for Submarines<br>Patrolling Areas 9 and 12. | 12 Jul 45<br>CONFIDENTIAL |

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SUBMARINE OPERATIONS RESEARCH GROUP

MEMORANDA

<u>SORG</u> <u>Memo No.</u>	<u>Title</u>	<u>Date</u> <u>Classification</u>
<u>SORR</u> 1.	Preliminary Statistical Review of Submarine Operations, Dec 41 through Jun 43	1 Jan 44 SECRET
2.	Effect of Firing Position on the Success of Torpedo Attacks	1 Mar 44 SECRET
3.	Sightings of Enemy Vessels, 1943	1 May 44 SECRET
4.	Estimate of Losses of U. S. Submarines Due to Enemy Submarine Action	1 Aug 44 SECRET
5.	Summary of Attacks on U. S. Submarines by Japanese Air and Surface Craft	15 Aug 44 SECRET
6.	Study of Evasive Turning	1 Sep 44 SECRET
7.	Theory of the Effectiveness of Coordinated Attack Groups	15 Nov 44 SECRET
8.	Comparison of Torpedo Performance, Mk 14 & 23 vs. Mk 18	20 Jan 45 SECRET
9.	Effective Submarine Approach	20 Jul 45 RESTRICTED
10.	Loss Rates of U. S. Fleet Type Submarines by Number of Patrols Undertaken and an Estimate of the Percent of Submarine Losses Due to Operational Causes	20 Aug 45 SECRET
11.	Quantitative Advantage of 20-knot Submerged Speed for U. S. Submarines	20 Sep 45 SECRET

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ANTI-SUBMARINE OPERATIONS RESEARCH GROUP

REPORTS

<u>RR No.</u>	<u>Title</u>	<u>Date</u> <u>Classification</u>
1.	Tactics for Renewal of Submarine Con- tacts by Aircraft <u>SUPERSEDED BY RR/81. MATERIAL INCLUDED</u> <u>IN FTP 223A</u>	13 May 43 CONFIDENTIAL
2.	Bay of Biscay <u>SUPERSEDED BY RR/23</u>	1 Oct 43 CONFIDENTIAL
3.	Relation of Various US-UK Convoy Routes via the Azores to the Planes Needed to Provide Continuous Air Coverage	25 Oct 43 SECRET
4.	Mini-mines, Mini-torpedoes, and other Weapons for Use by Submarines for Anti- Submarine Surface Craft	30 Oct 43 SECRET
5.	An Analysis of the U. S. Coastal Trade Convoys <u>REPRINTED AS ORG MEMO #44</u>	1 Nov 43 SECRET
6.	Aircraft Search Plans <u>MATERIAL INCLUDED IN FTP 223A</u>	29 Jan 44, 28 Nov 43 CONFIDENTIAL
7.	A Determination of the Increase in Aircraft Radar Contacts on Submarines Afforded by a Near 130° Antenna Sweep	23 Dec 43 CONFIDENTIAL
8.	Battery Charging Rates and Submarine Per- formance	25 Nov 43 CONFIDENTIAL
9.	A Description of German Echo-ranging Gear (S-Gear)	29 Dec 43 CONFIDENTIAL
10.	The Accuracy of Practice Stern-dropped Attacks	11 Jan 44 CONFIDENTIAL
11.	Operations from the Azores	2 Jan 44 SECRET

## ASWORG Reports (Continued)

RR No.

12.	Study of UG-GU Convoys During 1943	29 Jan 44 CONFIDENTIAL
13.	The Use of ASWORG Photo grids for the Analysis of Oblique Photographs	2 Oct 43 CONFIDENTIAL
14.	Barrier Patrols by Aircraft	20 Jan 44 SECRET
15.	A Basic Theory of Aircraft Search Plans <u>PART INCLUDED IN FTP 223A</u>	14 Jan 44 CONFIDENTIAL
	A Theory of Sighting Probabilities	18 Jan 44 CONFIDENTIAL
16.	Offshore Gain Effect in the MSP	2 Feb 44 CONFIDENTIAL
17.	Aerial Search for Convoys	24 Feb 44 CONFIDENTIAL
18.	A/S Air Activities in MSP	25 Feb 44 CONFIDENTIAL
19.	Aerial Escort Plans (HTA) <u>SUPERSEDED BY RR/13, RR/90, RR/95, RR/96</u> <u>SEE ALSO RR/55, 73, 92</u>	25 Feb 44 CONFIDENTIAL
20.	Use of the Outrigger in Countering the German Acoustic Torpedo <u>WITHDRAWN</u>	29 Feb 44 SECRET
21.	An Analysis of Submarine Sighting Data from the 6A-S Exercise	26 Jan 44 CONFIDENTIAL
22.	Underwater Explosions Heard by Task Group 21.15; 31 Dec 43 and 1, 2 Jan 44	14 Mar 44 SECRET
23.	Accuracy of Dissimilar Bombing Runs	16 Mar 44 CONFIDENTIAL
24.	Preliminary Study of Convoy Formations	23 Dec 43 CONFIDENTIAL
25.	Review of ASW in 1943	31 Jan 44 SECRET

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## ASWORG Reports (Continued)

<u>RR No.</u>		
26.	Countermeasures to the Acoustic Torpedo; Criteria for Adequate Noisemaker Output	27 Mar 44 SECRET
27.	A/S Operations by CVE-based Aircraft	1 Apr 44 SECRET
28.	Patrol Altitudes for Anti-Submarine Search	23 Mar 44 CONFIDENTIAL
29.	Probability of Hits with Ordinary and Acoustic Torpedoes	4 Apr 44 SECRET
30.	MAD Search Tactics	7 Apr 44 CONFIDENTIAL
31.	Evaluation of Italian Naval Anti-Submarine Attack Charts	25 Mar 44 SECRET
32.	Analysis of the A/S Bombing Errors of a Squadron of TBF's	24 Feb 44 CONFIDENTIAL
33.	Coastal Command A/S Offensive in the Bay of Biscay	6 Apr 44 SECRET
34.	Scouting Plans for Airship-based Aircraft	1 Apr 44 CONFIDENTIAL
35.	Analysis of Progress Reports of Aircraft with Special Equipment for U/B Radar Investigation (Flights of 11 Nov 43 thru 15 Feb 44)	6 Apr 44 SECRET
36.	Importance of the Depth at which Aircraft Depth Bombs Explode	18 Apr 44 CONFIDENTIAL
37.	Tables for Determining Aircraft Requirements (for escort of convoys)	9 Feb 44 CONFIDENTIAL
38.	Intermittent Radar Use as a Countermeasure to German Search Receiver for Offensive Flying <u>WITHDRAWN</u>	24 Feb 44 SECRET
39.	Tactics for Approach to and Attacks on U/Boats	18 Apr 44 SECRET

## ASWORG Reports (continued)

RR No.

40.	Summary of Information on the Lethal Radius of Depth Charges against U/Boats	28 Apr 44 CONFIDENTIAL
41.	Listening Ranges of the Expendable Radio Sono-buoy	2 May 44 CONFIDENTIAL
42.	Japanese Submarines and Tactics	24 Apr 44 CONFIDENTIAL
43.	U/Boats with Snouts <u>WITHDRAWN</u>	16 Apr 44 SECRET
44.	Visible Evidence of U/Boat Damage Associated with Air Attacks Assessed A, B and D, Respectively	5 May 44 SECRET
45.	Recent ASW Trends, Dec 43 - Apr 44	8 May 44 SECRET
46.	Operations of the German Magnetic Pistol P12	19 May 44 SECRET
47.	Comparison of Mk 47 and Mk XI Depth Charges	29 Apr 44 CONFIDENTIAL
48.	Sonar Ranges During Noisemaker Output	26 May 44 CONFIDENTIAL
49.	Study of Attacks Utilizing Ahead-Thrown A/S Weapons	20 May 44 CONFIDENTIAL
50.	Evaluation of Sono-Buoy Action by PAW7	21 May 44 CONFIDENTIAL
51.	Intervalometer Settings for Glide Bombing	8 Jun 44 CONFIDENTIAL
52.	Range Requirements for Torpedo Detectors	31 May 44 CONFIDENTIAL
53.	Derivation of Firing Time for Two-Ship Attack on Deep Submarine	25 May 44 CONFIDENTIAL
54.	Anti-Submarine Screening by Surface Ships	5 Jun 44 CONFIDENTIAL

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ASWORG Reports (Continued)

RR No.

55.	Anti-Submarine Screens for Small Task Forces	6 Jun 44 CONFIDENTIAL
56.	Damaging Effect of Depth Bombs Against Surface Craft	12 Jun 44 SECRET
57.	Attacks on U-Boats by U. S. Naval S/C, Atlantic and Mediterranean, Jan 43 thru Feb 44	16 Jun 44 CONFIDENTIAL
58.	Statistical Analysis of A/C Attacks on U/B Aug 43 - Feb 44	23 Jun 44 CONFIDENTIAL
59.	Theory of Hits with Ordinary and Acoustic Torpedoes	24 May 44 CONFIDENTIAL
60.	Effectiveness of New U/Boat Equipment <u>WITHDRAWN</u>	5 Jul 44 CONFIDENTIAL
61.	German Search Receiver Doctrine	23 Jun 44 CONFIDENTIAL
62.	Recent Advances in German Search Receiver	23 Jun 44 SECRET
63.	Use of Sono-Buoys in Joint Air-Surface Action	1 Aug 44 CONFIDENTIAL
64.	Steering a Collision Course in Radar Homing	7 Aug 44 CONFIDENTIAL
65.	Results Achieved in Attacks on U/Bs in Atlantic and Mediterranean, On an Opportunity Basis	14 Aug 44 CONFIDENTIAL
66.	Retiring Search Plans <u>SUPERSEDED BY RR/75</u>	14 Aug 44 CONFIDENTIAL
67.	Average Speed of Advance of U-Boats	1 Sep 44 SECRET
68.	Anti-Submarine Operations in the Pacific; A/S Attacks by S/C in the Pacific; A/C Attacks by S/M in the Pacific	6 Jun, 6 Jul 19 Aug 44 SECRET

## ASWORG Reports (Continued)

RR No.

69.	Search Plans for Schnorchel U-Boats	5 Sep 44 SECRET
70.	Scanning Methods for S.M Screens	2 Oct 44 CONFIDENTIAL
71.	Future Consumption of Depth Charges	23 Sep 44 SECRET
72.	Large Sonar-Buoy Patterns for Localizing Submarines During Quiet Seas	20 Sep 44 CONFIDENTIAL
73.	Aerial Escort Plans for a CVE or a Small Task Force of Over 12 Knot Speed	4 Oct 44 CONFIDENTIAL
74.	Japanese Anti-Submarine Doctrine	25 Sep 44 CONFIDENTIAL
75.	Revision of Surface Craft Search Plans in FFP 223	26 Aug, 6 Oct 44 CONFIDENTIAL
76.	Acoustic and Magnetic Fields Around Ships	5 Nov 44 SECRET
77.	Searching for a Submarine Which May Bottom	7 Nov 44 SECRET
78.	Depth Charge Pattern for Creeping Attacks	31 Oct 44 CONFIDENTIAL
79.	Anti-Aircraft Defense of Merchant Convoys	25 Aug 44 CONFIDENTIAL
80.	Underwater Listening and Echo-Ranges	16 Dec 44 CONFIDENTIAL
81.	A Discussion of Theoretical and Practical Considerations in the Development of Continuous Gambit Plans for Aircraft	6 Nov 44 CONFIDENTIAL
82.	Protection of Convoys Against Schnorchel U-Boats by Aerial Escort <u>SUPERSEDED BY RR/95</u>	4 Dec 44 SECRET

## ASWORG Reports (continued)

RR No.

83.	L/S Screens for Landing Operations	31 Dec 44 CONFIDENTIAL
84.	Effectiveness of Search Plans Against High Speed U-Boats	19 Jan 45 SECRET
85.	Heat Transformations Associated with Operation of Schnorchel U-Boats	6 Mar 45 SECRET
86.	Sono-Buoy Ranges on Modern U. S. Fleet Submarines at Low Speed	22 Feb 45 CONFIDENTIAL
87.	Sono-Buoy Ranges Based on Operational Data	9 Apr 45 CONFIDENTIAL
88.	Retiring Searches for Lost Contacts Near Shorelines	20 Mar 45 CONFIDENTIAL
89.	Statistical Evaluation of Anti-Submarine Rocket Attacks	23 Mar 45 CONFIDENTIAL
90.	All-Around Air Escort of Large Fast Task Forces	21 Apr 45 CONFIDENTIAL
91.	Results Achieved in Attacks on U-Boats in Atlantic and Mediterranean	30 Mar 45 CONFIDENTIAL
92.	Aircraft Countermeasures to the Type XXI U-Boat	11 May 45 SECRET
93.	Surface Craft Tactical Countermeasures to Type XXI U-Boats	4 May 45 SECRET
94.	Combined Anti-Aircraft and Anti-Submarine Screens for Slow, Crippled Units	12 May 45 CONFIDENTIAL
95.	Aerial Escort Plans for Merchant Convoys	8 Jul 45 CONFIDENTIAL
96.	Aerial Escort Plans for Merchant Convoys (and small Fleet Dispositions) Proceeding at Very Slow Speed	10 Jul 45 CONFIDENTIAL

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ASWORG Reports (continued)

RR No.

- |     |   |                           |
|-----|---|---------------------------|
| 97. | Attacks on U-Boats by U.S. Naval Surface Craft, Atlantic and Mediterranean, 1 March 1944 through 8 May 1945 | 8 Aug 45<br>CONFIDENTIAL  |
| 98. | Statistical Analysis of Aircraft Attacks on U-Boats, March 1944 - May 1945                                  | 28 Aug 45<br>CONFIDENTIAL |

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AIR OPERATIONS RESEARCH GROUP

REPORTS

<u>ARR No.</u>	<u>Title</u>	<u>Date</u> <u>Classification</u>
1.	Effectiveness of Japanese AA in South Pacific Area	11 May 44 CONFIDENTIAL
2.	Analysis of Air-combat Losses in South Pacific Area	17 May 44 CONFIDENTIAL
5.	Force Requirements for Aerial Attacks on Ships	10 Jul 44 SECRET
6.	Analysis of Enemy Air Attacks on Convoys	25 Jul 44 SECRET
7.	Review of Available Literature on Night Fighter Tactics	3 Aug 44 CONFIDENTIAL
8.	Review of U. S. Aircraft Torpedo Attacks in the Pacific	10 Aug 44 CONFIDENTIAL
10.	Summary of Night Fighter Actions in the Pacific	31 Oct 44 CONFIDENTIAL
11.	Effectiveness of Air-bursts of AN/M41 Fragmentation Bomb Against Personnel with Different Degrees of Protection	27 Sep 44 CONFIDENTIAL
12.	Fuzing of Bombs for Aircraft Anti-Shipping and Anti-Submarine Attacks	22 Dec 44 CONFIDENTIAL
13.	Relative Hazards from Automatic AA Weapons Along Various Torpedo Launching Runs	12 Jan 45

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AirORG Reports (continued)

ARK No.

14.	Analysis of Rocket Accuracy in Operational Training Units	15 Feb 45 CONFIDENTIAL
15.	Bombing Accuracy of SBD and F4U	9 Jan 45 CONFIDENTIAL
16.	Tables of Probabilities of at Least m Successes in N trials	9 Jan 45 (Unclassified)
17.	Disposition of Combat-Type Aircraft within the Japanese Air Force <u>WITHDRAWN</u>	6 Feb 45 SECRET
18.	Analysis of U. S. Air Effort and Damage to the Japanese Fleet in the Battle for Leyte Gulf	13 Feb 45 SECRET
19.	Interim Report - Electronics Bomb sight Project	23 Mar 45 CONFIDENTIAL
20.	Dive and Glide Bombing Accuracy Achieved on Marcus Island Strike of May 19 and 20 1944	2 Apr 45 CONFIDENTIAL
21.	The Effect of Altitude of Release on the Fleak Hazard to a Dive or Glide Bomber	Apr 45 CONFIDENTIAL
24.	Review of Aircraft Torpedo Attacks in the Pacific from May through October 1944	19 May 45 CONFIDENTIAL
25.	Estimates of Standard Deviations of Circular Normal Distribution from Knowledge of Radial Distribution	9 Mar 45 RESTRICTED
26.	The Role of Radar Fire Control in Japanese Anti-aircraft Defenses	6 Jul 45 SECRET
27.	Notes on Probability and Its Application to Bombing Problems	7 Jul 45 RESTRICTED
28.	Probability of Obtaining One or More Hits with Airborne Rockets	29 Aug 45 RESTRICTED
29.	Optimum Angle of Glide for Minimum Altitude Attacks on Merchant Vessels	18 Aug 45 CONFIDENTIAL

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AirORG Reports (continued)

ARR No.

30. Analysis of Air Anti-Shipping Attacks,  
May through October 1944, (Exclusive  
of 24-26 October 1944)

25 Sep 45  
CONFIDENTIAL

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OPERATIONS RESEARCH GROUP

MEMORANDA

<u>ORG</u> <u>Memo No.</u>	<u>Title</u>	<u>Date</u> <u>Classification</u>
1.	Preliminary Report on the Submarine Search Problem	1 May 42 CONFIDENTIAL
2.	Statistical Research into Anti-Submarine Operations	6 Jul 42 CONFIDENTIAL
3.	The Use of Weighted 300-Pound Depth Charges in Anti-Submarine Attacks	16 Jun 42 CONFIDENTIAL
4.	Memorandum on Anti-Submarine Warfare Data for May 1942	5 Jun 42 CONFIDENTIAL
5.	Supplement to ORG Report on Aerial Escort of Convoys <u>SUPERSEDED BY HR/19</u>	17 Jun 42 CONFIDENTIAL
6.	Radar Equipment for ASW Use in Aircraft	22 Jun 42 SECRET
7.	Analysis of Attack Teacher Runs made by Experienced Teams	18 Jul 42 CONFIDENTIAL
8.	Sighting Index for Radar Patrols	24 Jun 42 CONFIDENTIAL
9.	Operational Data Relating to Anti-Submarine Warfare in the Western Atlantic, June 1942	16 Jul 42 CONFIDENTIAL
10.	Effect of Pattern and Spacing in "Mousetrap" Contact Charges Barrages on the Probability of a Successful Anti-Submarine Attack	27 Jul 42 CONFIDENTIAL
11.	Aircraft Attacks on Submarines	2 Aug 42 CONFIDENTIAL
12.	Operational Data Relating to Anti-Submarine Warfare in the Western Atlantic, July 1942	18 Aug 42 CONFIDENTIAL

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ORG Memos (continued)

- |     |  |                           |
|-----|--|---------------------------|
| 13. | Index to British Intelligence Reports C.B.<br>4051 - Interrogation of U/Boat Survivors;<br>and Summary of U/Boat Tactics | 8 Sep 42<br>CONFIDENTIAL  |
| 14. | An Analysis of Anti-Submarine Aircraft<br>Patrolling by the First Bomber Command<br>for the Period May, June, July, 1942 | 12 Sep 42<br>CONFIDENTIAL |
| 15. | Operational Data Relating to Anti-Submarine<br>Warfare in the Western Atlantic, August<br>1942                           | 16 Sep 42<br>CONFIDENTIAL |
| 16. | A Study of the Killer Group Search Tactics   | Nov 42<br>CONFIDENTIAL    |
| 17. | Statistical Report of Operational Data<br>Relating to Anti-Submarine Warfare in<br>the Western Atlantic, September 1942  | 16 Oct 42<br>CONFIDENTIAL |
| 18. | Frequency of Attacks on Convoys in Relation<br>to U/Boat Predictions   | 18 Nov 42<br>CONFIDENTIAL |
| 19. | Statistical Report of Operational Data<br>Relating to Anti-Submarine Warfare in<br>the Western Atlantic, October 1942    | 18 Nov 42<br>CONFIDENTIAL |
| 20. | Analysis of U. S. Aircraft Attacks on<br>U/Boats<br><u>SUPERSEDED BY ORG MEMO #35</u>                                    | 7 Dec 42<br>CONFIDENTIAL  |
| 21. | Statistical Report of Operational Data<br>Relating to Anti-Submarine Warfare in<br>the Western Atlantic, November 1942   | 19 Dec 42<br>CONFIDENTIAL |
| 22. | Convoy Escort Plans for Small Planes<br><u>SUPERSEDED BY LATER ESCORT PLANS. SEE RR/72</u>                               | 20 Feb 43<br>CONFIDENTIAL |
| 23. | Statistical Report of Operational Data<br>Relating to Anti-Submarine Warfare in<br>the Western Atlantic, December 1942   | 23 Jan 43<br>CONFIDENTIAL |
| 24. | Statistical Report of Operational Data<br>Relating to Anti-Submarine Warfare in<br>the Western Atlantic, January 1943    | 24 Feb 43<br>CONFIDENTIAL |
| 25. | A Probability Study of COMINT Daily<br>Submarine Estimate  | 27 Feb 43<br>SECRET       |

## ORG Memos (continued)

26.	Statistical Report of Operational Data Relating to Anti-Submarine Warfare in the Western Atlantic, February 1943	25 Mar 43 CONFIDENTIAL
27.	Probability of Success in Aircraft Attacks on U/Boats	29 Mar 43 CONFIDENTIAL
28.	Statistical Report of Operational Data Relating to Anti-Submarine Warfare in the Western Atlantic	29 Mar 43 CONFIDENTIAL
29.	Convoy Escort Plans for the Civil Air Patrol	28 Apr 43 RESTRICTED
30.	A Graphic Analysis of Aerial Escort Plans <u>SUPERSEDED BY LATER ESCORT PLANS</u>	21 May 43 CONFIDENTIAL
31.	Table of Aircraft Anti-Submarine Bombing Probabilities	24 May 43 CONFIDENTIAL
32.	Optimum Load for Anti-Submarine Aircraft	25 May 43 CONFIDENTIAL
33.	Statistical Report of Operational Data Relating to Anti-Submarine Warfare in the Western Atlantic April 1943	1 Jun 43 CONFIDENTIAL
34.	Anti-Submarine Attacks by Surface Craft U. S. Strategic Area, Atlantic Ocean, Jul-Dec 42	24 Jun 43 CONFIDENTIAL
35.	Statistical Analysis of Aircraft Attacks in U-boats	16 Jul 43 CONFIDENTIAL
36.	Convoy Formations and the Stationing of Surface Escorts	26 Jul 43 CONFIDENTIAL
37.	Listening Gear Aboard U/Boats <u>WITHDRAWN</u>	18 Aug 43 CONFIDENTIAL
38.	Theoretical U/Boat Listening Ranges <u>SUPERSEDED BY RR/60</u>	20 Aug 43 CONFIDENTIAL

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ORG Memos (continued)

39.	Evaluation of Shipborne Anti-Submarine Weapons	30 Jun 43 CONFIDENTIAL
40.	Errors in Attack Teacher Depth Charge Attacks	2 Jun 43 CONFIDENTIAL
41.	Statistical Analysis of Aircraft Attacks on U/Boats, U. S. Forces, Atlantic Ocean and Mediterranean Sea. See #20 and #35	Jan-Jul 43 CONFIDENTIAL
42.	Countermeasures to the Acoustic Torpedo	20 Nov 43 SECRET
43.	Anti-Submarine Attacks by Surface Craft July 1942 through July 1943	18 Nov 43 CONFIDENTIAL
44.	An Analysis of U. S. Coastal Trade Convoys	13 Dec 43 SECRET
45.	Aircraft Requirements for Anti-Submarine Air Coverage of Shipping in the Eastern Gulf and Caribbean Sea Frontiers	2 Feb 44 CONFIDENTIAL
46.	Probability of Success of Shipborne A/S Ordnance	1 Jan 45 SECRET
47.	Number of Rounds Required to Hit Small Targets	26 Mar 45 CONFIDENTIAL
48.	Number of Rounds Required to Hit Small Vertical Targets at Short Ranges	10 May 45 CONFIDENTIAL
49.	Anti-Aircraft Action in the Philippines Campaign	17 Oct 44 to 13 Jan 45 SECRET
50.	A Summary War History of the Submarine Operations Research Group	1 Oct 45 SECRET

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APPENDIX B  
TABULATION OF THE  
ASSIGNMENTS OF PERSONNEL

Name	Latest Degree
Morse, P.M.	PhD. Physics
Craig, A.T.	PhD. Math.
McCarthy, P.J.	M.A. Math.
Kip, A.F.	PhD. Physics
Bell, M.E.	PhD. Physics
Rinehart, R.F.	PhD. Math.
Shockley, W.B.	PhD. Physics
Ambrose, W.A.	PhD. Math.
Thorndike, A.	B.S. Physics
Tyson, J.K.	B.S. Physics
Pellam, J.R.	B.S. Physics
Votaw, D.F.	M.A. Math.
Neuendorffer, J.A.	M.S. Physics
DeVries, W.L.	B.A. Math.
Hennington, H.H.	B.A. Math.
Kimball, G.E.	PhD. Chemistry
Thorndike, A.M.	M.A. Physics
Brown, A.W.	B.A. Math.
Ennis, M.E.	M.A. Physics
Reed, S.C.	PhD. Biology
Beatty, R.E.	B.S. Math.
Brooks, F.L.	PhD. Math.
MacCornack, D.A.	M.Arch Arch.
Brown, A.A.	PhD. Math.
Olshen, A.C.	PhD. Math.
Hauter, J.A.	B.S. Chemistry
Steinhardt, J.	PhD. Chemistry
Cody, D.D.	B.S. Math.
Seeber, R.R.	B.A. Math.
Shellard, G.D.	B.S. Civ. Eng.

	1941	1942	1943	1944	1945
	A	J	M	A	J
	J	A	S	O	N
	Washington Office				
Morse, P.M.	B				
Craig, A.T.	B				
McCarthy, P.J.	B				
Kip, A.F.	B	Miami	M	London	
Bell, M.E.	B	Boston	S	Langley	
Rinehart, R.F.					
Shockley, W.B.					
Ambrose, W.A.					
Thorndike, A.					
Tyson, J.K.		Boston	L	B	Quonset FL
Pellam, J.R.	B	ESP	London	Casa Blanca	
Votaw, D.F.					
Neuendorffer, J.A.					
DeVries, W.L.					
Hennington, H.H.					
Kimball, G.E.					
Thorndike, A.M.					
Brown, A.W.					
Ennis, M.E.					
Reed, S.C.					
Beatty, R.E.					
Brooks, F.L.					
MacCornack, D.A.					
Brown, A.A.					
Olshen, A.C.					
Hauter, J.A.					
Steinhardt, J.					
Cody, D.D.					
Seeber, R.R.					
Shellard, G.D.					

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Name	Latest Degree
Little, J.L.	B.S. Physics
Traber, R.E.	M.A. Math.
Gardner, E.B.	M.A. Math.
Holloway, L.A.	B.S. Civ. Eng.
Sternhell, C.M.	B.S. Math.
Horvath, W.J.	PhD. Physics
Kittel, C.	PhD. Physics
Squire, C.F.	PhD. Physics
Jones, N.F.	B.A. Math.
Pomerat, G.R.	PhD. Biology
Uehling, E.A.	PhD. Physics
Elliott, R.M.	PhD. Physics
Lathrop, J.B.	B.A. Math.
Lamar, E.S.	PhD. Physics
Albertson, W.E.	PhD. Physics
Holsten, F.H.	M.E.E. Elec. Eng.
Thimann, K.V.	PhD. Biology
Boormeester, J.M.	B.A. Physics
Thiesmeyer, L.R.	PhD. Geology
Coyle, J.P.	B.S. Chemistry
Dobbie, J.M.	PhD. Math.
Dutka, J.	PhD. Math.
Thompson, C.E.	B.A. Math.
Jones, R.J.	B.S. Math.
Lewis, M.	B.S. Chemistry
Koopman, B. O.	PhD. Math.
Best, R.J.	M.S. Chemistry
Peaslee, D.C.	B.S. Physics
Livingston, M.S.	PhD. Physics
Allendorfer, C.B.	PhD. Math.

1942	1944	1945
J.F.M.A.M.J.J.A.S.O.N.D.	J.F.M.A.M.J.J.A.S.O.N.D.	J.F.M.A.M.J.J.A.S.O.N.
Washington Office 3		
Trinidad	Trinidad	SORG Pac
Miami		Quonset
Quonset	SORG Pac	Ft. Laud.
London		London
Quonset		London
Langley	Quonset	London
		OpDev Flor
Quonset		
Trinidad	Recife	Recife
London		
ComAirLant		
	SORG Pac	
London		
		SORG Pac
	Quonset	
	Q R.L.	
	SORG Pac	
	Ft. L.	
	SORG Pac	
	London	

UNCLASSIFIED

Name	Latest Degree
Jastram, R.W.	B.A. Economics
Farley, J.	B.A. Economics
Wilson, R.E.	PhD. Astronomy
Fine, R.	M.S. Ed. & Math.
Ficken, F.A.	PhD. Math.
Steenrod, N.E.	PhD. Math.
Steinberg, A.G.	PhD. Zoology
Forbush, S.E.	B.S. Physics
Picardi, E.	Civ. Eng.
Wehausen, J.V.	PhD. Math.
Hemmeldinger, H.	PhD. Astronomy
Petrauskas, A.A.	PhD. Physics
Davidson, H.R.	B.S. Physics
Howland, T.G.	Abitur
Singleton, H.E.	M.S. Elec.Eng.
Humphry, J.A.	B.S. Lib. Sci.
Read, W. F.	PhD. Geology
Rutemiller, H.C.	B.S. Physics
Klein, M.J.	M.A. Physics
Tyler, A.R.	A.B. Biology
Trimble, H.C.	PhD. Math.
Fullerton, R.E.	PhD. Math.
Steeves, H.A.	B.S. Lib. Sci.
Reade, M.O.	PhD. Math.
Phipps, T.E.	A.B. Elec.Phys.
Sawyer, H.E.	Physics

Washington Office 4

Quonset R

London

R

**UNCLASSIFIED**

APPENDIX C  
OFFICIAL CORRESPONDENCE  
CONCERNING THE  
ASSIGNMENT OF THE GROUP



~~CONFIDENTIAL~~  
**UNCLASSIFIED**

UNITED STATES ATLANTIC FLEET  
ANTI-SUBMARINE WARFARE UNIT  
150 Causeway Street  
Boston, Massachusetts

March 16, 1942

A16-3  
(abv/jm)  
Serial 046

**UNCLASSIFIED**

From: Atlantic Fleet Anti-Submarine Warfare Officer.  
To: Coordinator of Research and Development  
(Secretary's Office).

Subject: Records and analyses of anti-submarine warfare.

1. Much information has been contained concerning the conduct of anti-submarine warfare from various British Admiralty and Royal Air Force Coastal Command publications and letters. The amount and scope of the records kept by the British, and the analyses which have been made from these data, are quite impressive. This information from British sources has been most useful and the benefits of obtaining and studying it have been invaluable so far in expediting our preparations.

2. Records of the activities of our own forces are of course being kept but, as yet, such information has not become available in form comparable to that of the British and scientific analyses of the results of our own endeavors have not been published.

3. While doubtless presented to us in good faith, the advisability of accepting such analyses and conclusions from foreign sources without an opportunity to evaluate the data and appraise its value through similar processes carried out by comparable American agencies is questioned. The National Defense Research Council, as presently conceived, is concerned primarily with development of material and has no facilities for operational analysis. As now organized, such functioning of the N.D.R.C. would be impossible even if it were desirable.

4. The Atlantic Fleet Anti-Submarine Warfare Unit has been in existence only a brief time. It has already become

evident, that while the analysis of any one single attack upon an enemy submarine is a relatively simple matter for officers who are thoroughly conversant with the problem (provided reports obtainable of that attack are sufficiently accurate and complete), however, not only are present records apt to be inadequate but the mathematical training and number of present personnel are inadequate to handle complex scientific analyses and maintain the necessary records as thoroughly as is now apparently necessary.

5. It is considered to be not only desirable, but also necessary that this Unit be in a position to inform the Commander in Chief at any time concerning the following, as well as of many other aspects of our anti-submarine warfare:

- Hours flown on patrol.
- Hours flown on escort duty.
- Hours flown to and from patrol or escort stations.
- Number of submarines sighted.
- Number of submarines attacked.
- Possibility of success in attack.
- Number of submarines sighted in various localities.
- Number of ships sunk by submarines in various localities.
- Predicted future operating theatres of submarines based on various factors, such as: daily submarine situation, percentage of success of U-boats, density of patrols possible and other considerations having a bearing.
- Hours surface vessels steamed on patrol, miles steamed, etc.
- Similar data on sighting, attacks and sinkings, as listed above for aircraft.
- Average days in port, proportional effect upon upkeep, etc.
- Sea water temperature gradient effect.

The Anti-Submarine Warfare Unit is not now in a position to furnish such information nor is it in a position properly to evaluate the probable effectiveness of suggested weapons, developments and procedures based upon mathematical studies or on records available. Neither is it in a position to maintain the extensive records which will be required in a form useable for this purpose.

6. The following quotation, from a RAF Coastal Command memorandum on the subject, expresses clearly what is desired and intended.

"Experience over many parts of our war efforts has shown that such analysis can be of the utmost value, and the lack of such analysis can be disastrous. Probably the main reason why this is so, is that very many war operations involve considerations with which scientists are specially trained to compete, and in which serving officers are in general not trained. This is especially the case with all those aspects of operations into which probability considerations and the theory of errors enter. Serving officers of the highest caliber are necessarily employed in important executive posts, and are, therefore, not available for detailed analytic work".

This is further elaborated upon in the following quotation also from the same memorandum.

"A considerable fraction of the Staff of an Operational Research Section should be of the very highest standing in science, and many of them should be drawn from those who have had experience at the Service Technical Establishments. Others should be chosen for analytic ability, e.g., gifted mathematicians, ~~lawyers~~, chess players, etc. An O.R.S. which contents itself with the routine production of statistical reports and narratives will be of very limited value. The atmosphere required is that of a first class pure scientific research institution, and the calibre of the personnel should match this. All members of an O.R.S. should spend part of their time at operational stations in close touch with the flying personnel, and where possible should occasionally go on operational or training flights".

The foregoing is written from the viewpoint of the RAF but the need for the surface forces is the same. The British have long had such O.R.S.'s in operation.

7. Based upon recent studies it is believed that this organization should consist of two primary sections:

- (a) Statistical - five men.
- (b) Analytical - five men.

The statistical section is envisioned as consisting of four subsections as follows:

- (1) Aircraft operations.
- (2) Surface Craft Operations.
- (3) Combat records.
- (4) Dissemination of information and Preparation of reports.

The organization of the analytical group cannot be so well foreseen at this time but it must necessarily be separated from the purely statistical section for the main purpose of preserving the atmosphere of scientific research which is vital for this type of work. Men for the statistical section should be carefully selected individuals, highly trained and experienced in their type of work. Men for the analytical section should be outstanding men of reputation with broad vision and receptive minds, able quickly to comprehend the needs and problems with which we are confronted, and experienced in utilizing the abstract as well as the material tools of science in solving such problems.

8. It is regarded as obvious that such records and analyses are urgently required and it is therefore proposed to immediately commence the organization of such a service. The Coordinator of Research and Development is therefore requested to take the necessary action toward the formation of such an analytic and statistical organization as is described above, using the facilities of the National Defense Research Committee, in the selection of individuals having the necessary qualifications.

(signed) W. D. BAKER

Copies to:

CominCh .  
Cinclant.

Office for Emergency Management  
OFFICE OF SCIENTIFIC RESEARCH AND DEVELOPMENT  
1530 P Street, N. W.  
Washington, D. C.

Vannevar Bush  
Director

July 7, 1943

DIRECTIVE TO  
THE ANTI-SUBMARINE WARFARE OPERATIONAL RESEARCH GROUP

1. In view of the fact that the Commander in Chief, United States Fleet, is responsible for all anti-submarine operations, in the interests of centralized control and elimination or reduction in duplication of effort, the Anti-Submarine Warfare Operational Research Group organization will hereafter be considered as a part of the Tenth Fleet and responsible to the Commander thereof.
2. The intent of this transfer of authority is that all matters for which the Anti-Submarine Warfare Operational Research Group may be responsible shall be processed through the organization of the Tenth Fleet Command to the end that proper security may be maintained and that there shall be no wasted and conflicting efforts resulting from wide, direct dissemination of anti-submarine information which has not been checked through the Tenth Fleet.
3. This is not intended to prevent the exchange of inter-office memoranda on subjects, the investigation of which has already been approved by the Tenth Fleet.
4. The Anti-Submarine Warfare Operational Research Group will continue to serve the interests of the research and development laboratories of the Office of Scientific Research and Development in providing them, as may be authorized by the Commander, Tenth Fleet, with such information as will assist those laboratories in the wise direction of their activities.

(signed) JOHN T. TATE  
Chief, Div. 6, NDRC

Approved: 9 July 1943

(signed) E. J. KING  
Commander in Chief, United States Fleet.

UNITED STATES FLEET  
Headquarters of the Commander in Chief  
NAVY DEPARTMENT  
Washington 25, D.C.

CONF **UNCLASSIFIED**

FF1/A3-1  
Serial: 03421

7 Oct 1944

MEMORANDUM TO DIRECTOR, ANTI-SUBMARINE WARFARE OPERATIONS  
RESEARCH GROUP.

Subject: Operations Research Group.

Reference: (a) Directive to ASWORG, from Dr. J. T. Tate,  
approved by Admiral E. J. King, 7 July 1943.

1. Reference (a) is hereby cancelled.

2. In view of the decrease in enemy submarine activity and the increase in operations research requirements on subjects other than anti-submarine measures, by agreement with the Office of Scientific Research and Development, the Anti-Submarine Warfare Operations Research Group is hereby transferred from the TENTH Fleet to the Readiness Division of the Headquarters of Commander in Chief, United States Fleet. This group is hereby reconstituted as the Operations Research Group, Headquarters of Commander in Chief, United States Fleet (short title ORG).

3. Upon request the Assistant Chief of Staff (Readiness) will make available the services of members, or groups of members, of the Operations Research Group to other Divisions of the Headquarters of Commander in Chief, to the Offices of the Navy Department, or to the Fleets. Such assignments already made by the Commander, TENTH Fleet, will not be affected by this transfer, and the group at present engaged in anti-submarine research is hereby reassigned to the TENTH Fleet to maintain the services previously rendered by the Anti-Submarine Warfare Operations Research Group until such time as their services are no longer required in this field.

APPENDIX C  
**UNCLASSIFIED**

Subject: Operations Research Group.  
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4. The Operations Research Group will continue to serve the interests of the research and development laboratories of the Office of Scientific Research and Development in providing them, as may be authorized by the Assistant Chief of Staff (Readiness), with such information as will assist those laboratories in the wise direction of their activities.

(Signed) E. J. KING

E. J. KING,  
Admiral, U. S. Navy,  
Commander in Chief, United States Fleet  
and  
Chief of Naval Operations.

Copy to:  
All bureaus and offices, Navy Dept.  
CinCLant  
CinCPac  
ComTWELFTHFlt  
ComSEVENTHFlt  
OSRD

7 October 1944

OPERATIONS RESEARCH GROUP

1. General Organization

The Operations Research Group is a group of scientists lent to the U. S. Navy by the Office of Field Service of the Office of Scientific Research and Development (Project No. OFS, Nr 2) to carry on operations research for the Navy. The central unit, assigned to the Readiness Division of the Staff of the Commander in Chief, U. S. Fleet, will be known as the Operations Research Center (ORC). The units on loan to various divisions of CominCh or OpNav, or to various fleet commanders, will be known as ORG Sub-Groups (ASWORG, SORG, AIRORG, etc.). The Director, Operations Research Group (DORG) is the head of ORC and consulting supervisor of the sub-groups.

2. Duties

The ORC will carry on operations research under the general control of the Head of the Readiness Division of CominCh. Requests for work to be done by the ORC can be made by other divisions of CominCh and OpNav, and studies can be initiated by ORC without formal request from the staff, but the relative priority of the work will be determined by the head of the Readiness Division, CominCh. If at any time the magnitude of work requested of ORC by some other Division or Fleet is sufficiently large, arrangements can be made to organize another sub-group (similar to SORG, etc.) which will be lent to, and will be under the control of, the other Division. These sub-groups have the right to consult with the DORG on the scientific aspects of their problems. ORC will maintain IBM services and general reference facilities for the use of all the sub-groups. Distribution of Reports and Memoranda embodying the results of the work of ORC will be controlled by the head of the Readiness Division, CominCh; Reports and Memoranda from each sub-group will be controlled by the Division, or Fleet, to which it is lent.

3. Procurement and Training of Personnel

Personnel for the ORC, or for any of the sub-groups, will be obtained from the Office of Field Service, OSRD. The ORC will arrange for the clearance and general training of such personnel.

4. Coordination with other Research

The Coordinator of Research and Development of the Navy (SONRD) is to be kept informed of the general progress of the Operations Research Group, in order that operations research may be coordinated with other research of interest to the Navy.

W. S. DeLANY,  
Assistant Chief of Staff (Readiness)

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**UNCLASSIFIED**

UNITED STATES FLEET  
Headquarters of the Commander in Chief  
NAVY DEPARTMENT  
Washington 25, D.C.

FF1/A3-1

19 August 1945

Serial: 6565

RES **UNCLASSIFIED**

From: Commander in Chief, United States Fleet and  
Chief of Naval Operations  
To: The Secretary of the Navy  
Subject: Continuation of Operations Research Group,  
Provisions for.

1. Since April 1942 the Operations Research Group has been of service to the Navy as a scientific advisory group to the forces afloat and to the Commander in Chief, United States Fleet and Chief of Naval Operations, dealing with naval scientific evaluation from the point of view of the operational user of naval equipment. This group has been of active assistance in:

- (a) The evaluation of new equipment to meet military requirements.
- (b) The evaluation of specific phases of operations, i.e., gun support, AA Fire, from studies of action reports.
- (c) The evaluation and analysis of tactical problems to measure the operational behavior of new material.
- (d) The development of new tactical doctrines to meet specific requirements, i.e., A/S screens, screens for slow moving damaged ships, etc.
- (e) The technical aspect of strategic planning.
- (f) The liaison for the Fleets with the development and research laboratories, naval and extra-naval.

2. The Group carrying out this work consists of civilian scientific personnel under individual contract with the Office of Field Service of the Office of Scientific Research and Development, assigned to and responsible to the Commander in Chief, United States Fleet and Chief of Naval Operations. Previous to the formation of the Office of Field Service, the Group was provided through an OSRD contract with Columbia University. The Group at present consists of about seventy scientists with a current annual operating budget of approximately \$800,000.

APPENDIX C  
**UNCLASSIFIED**

FF1/A3-1

Serial: 6565

RE: **UNCLASSIFIED**

Subject: Continuation of Operations Research Group,  
Provisions for.

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3. This group does not concern itself primarily with the technical and scientific problems of research and development of new material. As the name implies, these personnel are scientific evaluators who concern themselves with the operational problems (material and tactical) of the Fleet. Their functions therefore, are properly a part of the seagoing command.

4. I feel that an uninterrupted continuation of this service into peacetime is necessary. Action should be taken at this time in order to preclude any discontinuity upon cessation of hostilities.

5. I therefore recommend that suitable provisions be made to continue this Group into peacetime at approximately twenty-five percent of its present size.

E. J. KING

Approved: Aug 21 1945 .

/s/ Forrestall  
Secretary of the Navy.

