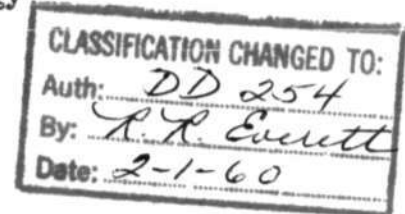


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Digital Computer Laboratory
Massachusetts Institute of Technology
Cambridge 39, Massachusetts



SUBJECT: 6889 AIR DEFENSE BI-WEEKLY February 29, 1952

1.0 GENERAL

(C. R. Wieser)

The first successful interceptions with the automatic ground-to-air link have been held. These tests used the B-25 equipped with the zero-reader to display instructions to the interceptor pilot. During the next bi-weekly period we should have a trial with the B-26, which is equipped to be flown by an autopilot from WWI guidance instructions. (The B-26 system has already been flight tested on manual input data from the ground.)

The Rockport 584 radar and data link are still being tested by Group 24. It is expected that we will feed data from the Rockport radar into WWI during the next bi-weekly period.

(D. R. Israel)

Arrangements have been made to secure a number of Navy training films dealing with fighter direction and control. Several staff members saw these pictures about a year ago and reported that they were very good and were quite worth showing to the whole Air Defense Group staff. Showings of these pictures will be arranged for future staff meetings, the time for which has been set at Thursdays, 3:30 - 5:00 p.m.

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2.0 EQUIPMENT ENGINEERING

(E. S. Rich)

An important factor in speeding up the installation and testing of the new terminal equipment system will be familiarizing the personnel concerned with the details of its operation. Effort is being made to work out diagrams and explanations which are clearer, more concise, and more complete than what is now available. Plans are also being made for a comprehensive instruction program to acquaint interested parties with the functioning of the system, specially the magnetic drums, so that as little time as possible will be lost in debugging the equipment after it is installed.

John Newitt has been assigned to coordinate the constructions of the phone-line terminal equipment and the installation of this equipment and of the magnetic drum systems. Responsibilities for specific phases of this work have been divided among Watt, O'Brien, and myself.

Components for 1700 plug-in units to be used in assembling the phone-line terminal circuits and their connections to the buffer drum and the computer are being ordered. Construction of 100 of these units in our shops will start in the near future. This will provide sufficient units for a mark-up of part of the circuits for one phone line so the proposed methods for making video interconnections using open wires can be tested and evaluated.

(R. Best)

The flip flop designed by Group 24 is still undergoing test. A modified circuit has been tried that is less sensitive to tube deterioration than the original. Both circuits are so insensitive to load that their outputs may be shorted to ground and the circuit still operates.

(F. Heart)

Time has been spent in continued study of current work on In-Out Block Diagrams. Some preliminary consideration has been given to problems of representation of In-Out sequences which are not identical each time used.

(H. J. Kirshner)

Terminal equipment for the Rockport radar is now in operating condition. Flight tests of this radar were conducted on Feb. 26th and 29th and data from the radar was displayed in 224. Cables have been run between room 224 and the computer for the purpose of connecting the Rockport terminal equipment with Whirlwind. It was hoped that a permanent installation

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2.0 EQUIPMENT ENGINEERING (Continued)

(H. J. Kirshner) (Continued)

could be made before initial checks with the computer were made. This does not seem feasible at the moment since the equipment for a permanent installation is not on hand. An interim wiring arrangement will be made which will permit the feeding of Rockport data to the computer. When a more permanent installation can be made, the Rockport terminal equipment will be disconnected from the computer for the period of the installation.

An attempt was made on February 26th to conduct an interception flight test utilizing the digital ground/air link. This test was unsuccessful due to a faulty DC Register Panel in the MEW synchronizing equipment. A successful flight test, using the digital ground/air link, was conducted on February 28th.

One stage of a decoder was breadboard constructed, but proved to be unsatisfactory. An improved design is now being attempted. This decoder is to be used in clutter rejection schemes mentioned in previous bi-weekly reports.

A two channel magnetic tape recorder has been ordered from the Ampex Electric Company. Ordering of the fourteen channel recorder will be delayed until experiments can be performed on either the two channel recorder now on order or a similar machine in Building 22.

(A. V. Shortell, Jr.)

The past bi-weekly period was spent on the frequency multiplexing system for a tape recorder. The U.T.C. High-Q toroidal coils mentioned in a previous bi-weekly were received at the beginning of the period and were tested in the filters for which they were ordered. The 3kc low-pass filter gives excellent results. Its response is flat within 1 db from 20 cps to 3300 cps dropping off sharply above this frequency. Its attenuation is greater than 60 db from 3900 to 5500 cps and above 5500 remains greater than 30 db.

The results given by the 4-7kc band-pass filter were not as good as had been expected. The attenuation below the lower cutoff frequency was very satisfactory but the response curve dropped too slowly above the upper cutoff frequency.

Both filters showed that these High-Q coils will meet our rather stringent requirements. The difficulty with the band-pass filter is that it is practically impossible to design using integral values of inductance available from U.T.C. stock.

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2.0 EQUIPMENT ENGINEERING (Continued)

(A. V. Shortell, Jr.) (Continued)

Word is expected this coming week from Graybar Electric concerning characteristics and availability of Western Electric band-pass filters used in carrier telephone systems. Some of these filters, if suitable to our needs, would probably be the fastest and most economical solution to our need for band-pass filters.

Meanwhile I shall continue working on other components in the proposed system and shall continue to try to build a workable band-pass filter.

3.0 BEDFORD EXPERIMENTS

(D. R. Israel)

As noted, successful flight tests using the B-25, the Zero reader, and the automatic data link have been held. Tests next week will involve the use of the B-26 and its auto-pilot.

Plans are being drawn up for an Air Defense Group collection of subroutines. Walter Attridge and Charlie Gaudette will coordinate the work on this subject.

Arrangements have been made for an additional scope intensification order. (See Inter-office Memo of February 18.) This will be a modification of the present qs order. This new display will be more fully explained in an inter-office memo to be issued next week.

A good deal of computer time has been used during the past bi-weekly period in the analysis of various malfunctions of the interception program and its related modifications. By the end of the bi-weekly period, all difficulties had been uncovered, and the latest version of the interception program, mentioned in the previous bi-weekly, is now ready for use.

(C. Zraket)

Flight Tests

A 2 a/c interception to test the automatic transmission link was attempted on the morning of February 26 using a C-47 as the target and a B-25 as the interceptor. The test was inconclusive due to faulty computer operation and questionable operation De-Multiplexer Equipment. The ground-air data link operated satisfactorily. It was later ascertained that a faulty synchronizer flip-flop in Room 224 caused faulty data transmission to FF4.

3.0 BEDFORD EXPERIMENTS (Continued)

(C. Zraket) (Continued)

Flight Tests (Continued)

A flight test on February 28 proved highly successful in testing the automatic transmission link. Three interceptions were run using a B-17 as the target and a B-25 as the interceptor. Data namely the heading angle, was transmitted to the interceptor via FFL. The first run, an "S" shaped course, resulted in a separation of 100 yards. The last two runs resulted in separations of 25 and 50 yards respectively.

(P. R. Bagley)

The last two runs of the single-radar Clutter Rejection and Verification program (T-716) proved to be failures. In the first of the two runs, the program operation was exceptionally good, but the photographs did not come out due to camera maladjustments. In the second, a tape copying error in modification caused the program operation to be unsatisfactory. A magnetic tape (MT-124) has been earmarked for the next trial of the program. It is hoped that photographs can be made of the filtered and unfiltered displays, and that the clutter table may be punched out from storage for future reference.

Work on the High-Speed Data Display program (T-746) and on the Radar Data Counting program (T-826) has been suspended.

(P. O. Cioffi)

Tape errors due to improper conversion were discovered on the Interception Test Program tape 832. This and other tape preparation difficulties have been most effective in delaying the results of this program. These errors are corrected now and it is expected that the program will be checked out shortly according to computer availability.

I have continued reading D. Israel's thesis in preparation for my expected visit to the Air Traffic Control Center in Boston.

(C. H. Gaudette)

NLS-2b Smoothing has been slightly modified. In NLS-2b we count the number of times, n , the magnitude of the difference between the predicted position and the observed position is less than the break point. When the magnitude of the difference is larger than the break point, the large value of Δ is divided by n , and this result multiplied by the difference is used as the velocity correction. Then the register containing n is reset to one. This new modification resets this counter

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3.0 BEDFORD EXPERIMENTS (Continued)

(C. H. Gaudette) (Continued)

to $1/2 n$ instead of one. In order to distinguish between results obtained with each method, the new method has been called NLS-2B.

Additional data using NLS-2c and NLS-2B have been obtained with Sue Knapp's PWTFT Program and will be plotted as soon as possible. Preliminary analysis of these results indicate that:

1. NLS-2c is better than NLS-2.
2. In the steady state NLS-2B is better than NLS-2c or linear.
3. All three methods (Linear, NLS-2c, and NLS-2B) require approximately the same number of scans to get within 10% of the true velocity and 5 azimuth units of the true heading.
4. As the tolerances in 3 become larger, NLS-2c and NLS-2B fall within the tolerance limits at a faster rate than linear smoothing.

(E. Heart)

Some time has been spent in writing and debugging various modifications to the basic Interception Display program. With C. Zrakat, a combination was made of the main Interception Display program (835-6), the special R-scope display of Bearing Angle, Heading Angle, and Velocity Vectors (971-1), and the use of NLS-2c (974); this combination has been given the tape number 1000. This program is not yet operating reliably.

A very short tape was prepared which, if used, eliminates the D-Scope display of the "picked" Target and Interceptor points, in any of the programs based on T835-6.

(S. Knapp)

PWTFT for x, y smoothing has been modified to eliminate all unnecessary printing, such as initial zeros, unnecessary + and - signs, etc. This has shortened the time it takes for getting the data from the computer and duplicating it later. The program is now being changed so that it will read in the whole data tape at the beginning instead of printing after each observation in read in. This will make it possible for the photo-electric reader to be used, instead of the Flexowriter reader. Most of the straight-line path Simradata Tapes have been analysed with this program and the R, Θ PWTFT. This work will continue, using tapes with various turns.

Some time has been spent in rechecking the 3 a/c Tracking and Interception Program. This program has not been tried on the computer, but it will be run in the near future.

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3.0 BEDFORD EXPERIMENTS (Continued)

(C. Zraket)

Due to a succession of tape preparation errors, both in the main tape and in the modifications, which were not discovered until a print-out was obtained, most of the time spent in running the Interception Test Program (T-832) has been wasted. A new tape has been made up correcting all tape preparation errors and a program error discovered in the print-out, and it is hoped that some conclusive results can be obtained on the next run.

T-1000-2, the Interception Program using NLS-2c and the additional display of heading angle, bearing angle, and velocity vectors, was run successfully. No quantitative analysis was made of NLS-2c.

All wind and interceptor velocity tapes are now listed under "T-1000 Parameters".

As soon as time permits, a flow diagram of the Interception Program, T-1000, will be drawn up.

4.0 DATA SCREENING

(R. L. Walquist)

Study is being made of the problems associated with automatic initiation by sector only. Sector initiation for the Cape Cod Muldar System would consist of initiating tracking only on targets falling in the fringe area of radar coverage and flying into the system. Identification of newly initiated targets by Flight Plan correlation is also being studied.

(P. R. Bagley)

The program for Clutter Rejection Table Construction for N Radars (T-908) has been run twice but failed due to both tape and program errors. Debugging will continue.

A flow diagram was prepared some time ago for a program (T-909) to record on magnetic tape data from N Radars (less stationary clutter and zero ranges). The coding of this program is awaiting the assistance of N.S. Potter.

(J. Ishihara)

Preliminary drafts for various sections of the "Three Stage" correlation program have been written. Since parts of this process are highly repetitive, a careful study will have to be made of the various alternatives to determine which one will conserve the most time.

Time was spent on the Indoctrination Problem, since more programming and computer operation "experience" will be of value in the above job.

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5.0 TRACKING AND CONTROL (Continued)

(J. A. Arnow)

A program has been written in order to give instructions to a tracking 584 radar. The modifications necessary to use a height finder in place of the 584 are reasonably trivial.

The data link for the Rockport radar will be tied in to the computer during the early part of the next bi-weekly period. A few flight tests were observed during the past period. The results were semi-satisfactory. More data can be taken after the system is tied into Whirlwind.

An inter-office memo summarizing a conference on Special computing machines at the Aberdeen Proving Grounds was written. The conference was mainly concerned with methods of determining the effectiveness of various types of missiles, projectiles, etc. but contained nothing of direct interest to this project.

(N. S. Potter)

The coding of the statistical muldar tracking program is nearly done and should be ready for a test with simulated data early next week. At present it is undergoing continuous revision in an effort to reduce the processing time.

Preliminary studies have also been made in connection with the magnetic tape recording of filtered muldar data problem mentioned by Phil Bagley in the preceding bi-weekly.

(P. R. Bagley)

The study, which was begun some months ago, of the philosophical and technical details of Automatic Initiation of targets into the Muldar system is being renewed.

(A. Mathiasen)

The difficulties encountered in the test portions of TRASACT such as the handling of simulated data and printing seem at last to have been eliminated. The program was run with encouraging results although not with complete success. The velocity was reached in four to five scans. Since nine scans was the limit for which the program tracked, it may very well be that incorrect values of the smoothing parameters were used. However, it may also be possible that a three-quarter second wide search sector may be too small. Another flaw was that while each radar tracked when it was the initiating radar, the two did not track together.

(A. Mathiasen) (continued)

A print-out of the constants involved showed that the coordinates of both radars were the same. Whether this was due to tape error or some program error has not yet been determined. Other parts of the program appear to be working correctly.

A little time was spent on the indoctrination problem for new staff members.

(M. Frazier)

Polysmooth has not yet been run due to tape preparation difficulties.

The Three Radar Display program has been checked out.

Slowed-Down Video-Data Analysis II is still suffering from program errors, tape preparation errors, and lack of computer time.

A program is being written to track a single aircraft from the Rockport and Bedford Radars (TRASACT-BR.). It will use the separate tracking and velocity averaging method of data combination.

(Bill Lone)

The program for printing out of double length numbers has operated successfully. The factor which converts the given two register number from an integer to a fraction is also contained in two registers and the product in three, rounded off. The addition of 1×2^{-45} to the converted fraction makes for ten decimal digit accuracy, and this apparently independent of the given number.

A flow diagram for one of the staff indoctrination problems has been written and I will begin writing the program next week.

The remainder of the bi-weekly period was spent considering the two radar, single aircraft tracking program.

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6.0 (AIR DEFENSE CENTER OPERATIONS)

(D. R. Israel)

A second visit has been made to the Boston Air Route Traffic Control Center. Details of this visit are described in an inter-office memo of February 21. A letter has also been written to Mr. Millea, Chief Controller, suggesting that for the next several months, one or two of our staff members be permitted to make regular visits to the Center. The purpose of these visits would be: a) attain familiarity with the methods and procedures, and b) to keep us up-to-date on the latest AMIS procedures.

Together with Dick Whelan of Group 22 a trip was made on February 25 and 26 to the Evans Signal Corps Laboratory at Belmar, New Jersey. Two seminars were held on these dates, one dealing with the 414B system under study by General Electric, the other with the 414C system under study by Sperry Gyroscope (see inter-office memo of February 27). A description of these two projects will be made as soon as my notes are mailed from Evans.

While at Evans, arrangements were made to initiate coordination between the Cape Cod Groups and the appropriate personnel at Evans interested in anti-aircraft problems. Several people from Evans have been invited to visit us in the near future.

It was most evident during the trip to Evans that Project Lincoln can and should make a very substantial contribution to air defense by means of coordinating counter-measures and passive detection devices. An effort will be made in the near future to contact people who can give us information on these subjects.

On Thursday, February 28, Col. Robert Gould of the EADF visited the Laboratory. Col. Gould is the officer in charge of Ground Observer Corps developments in this area. Our conversations with him were extremely fruitful, and we shall make efforts to undertake experiments with Ground Observer Corps data in the very near future. At first it appears that we will use recorded telephone line data to be

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6.0 (AIR DEFENSE CENTER OPERATIONS) (Continued)

(D. R. Israel) (Continued)

obtained at the White Plains (New York) filter center. Within a period of four or five months, the renovation of the Manchester (New Hampshire) Center should permit us to use both recorded and direct data from that source.

(F. A. Webster)

Work has been continued on the use of auxiliary, non-radar data, chiefly G.O.C. (Ground Observer Corps). The use of such data may introduce problems somewhat different from those involved in the use of radar data alone. For example, without special reporting equipment and special telephone-line arrangements, both the delays in reporting and the indicated times of observation may vary up to several minutes. Considerable variability is also possible in reports of position and height.

In certain respects the data from radars and G.O.C. tend to be complementary. Thus, with decreasing target altitude, G.O.C. reporting tends to increase in accuracy and reliability, while radar indications tend to be lost. Furthermore, while G.O.C. data is chiefly vulnerable to conditions of poor visibility, radar data is liable to interference by jamming, local clutter and injury to its communication linkages. Finally, ground observers give one piece of data not directly available by radar: namely, direction of flight at the time of observation.

Such consideration suggests that the two sources of data need somewhat different weightings and treatment. Some time has been given to the principles of computation devices and methods specially designed to deal with problems of data variability and the use of differential weightings.

7.0 ASSOCIATED STUDIES

(R. L. Walquist)

Ishihara's solutions to the indoctrination problems of January 24, 1952, have been proofed and corrected. They are now in the hands of the typist and should be finished shortly.

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7.0 (ASSOCIATED STUDIES) (Continued)

(W. S. Attridge, Jr.)

Little work has been accomplished on the Air Defense Subprogram Library. It has been decided to keep this work separate but parallel to the Math Group's Subroutine Library. We hope that more people will cooperate and contribute any subprograms or ideas so that we can progress futher. In particular we would like to see some ideas on inverse trig functions.

The automatic cease track subprogram has been written using the method mentioned in the last bi-weekly.

The Simulated Tridar Data program is in working form. Programming for the analysis of this data is contemplated.

(G. Cooper and A. Katz)

During the past bi-weekly period data was taken on two, three, and four-element statistical predictors using ESP-1. The results may be summarized as follows.

	Average Error	Standard Deviation	Mean Sq. Error	Percent of Samples having less than 1° Error	Max. Error
Two-element	0.326°	0.804°	0.750 deg ²	75%	2.46°
Three-element	0.238°	0.735°	05.98 deg ²	79%	2.57°
Four-element	0.229°	0.660°	0.434 deg ²	89%	2.50°

These results are based on 210 samples for each case. It should be noted that there is a distinct improvement as the number of elements is increased.

A new program has been written (GESP-1, Generalized version of ESP-1) which incorporates a section to handle the discontinuity in angular data mentioned in the previous bi-weekly. We were unable to obtain any results with this program because of a tape preparation error.

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7.0 ASSOCIATED STUDIES (continued)

(P. R. Bagley)

The single-aircraft tracking program assigned as an indoctrination problem has been written. After the program has been checked, it will be turned over to Attridge for approval before a tape is prepared.

A program (T-985) for testing the magnetic tape block recording and reading subroutines written by Walquist (T-988, T-989) is ready to be run on the computer, but will be delayed until the installation of the cycle left order.

The data input section of the Interceptor Assignment Demonstration has been modified to fit in Bank B. It has been checked out and will now be combined with the remaining sections written by Knapp and Zracket to form a new Interceptor Assignment Demonstration program (T-948).

(H.R.J. Grosch)

I continued to work on a report advocating the use of signed ternary arithmetic. On February 19 and 20, I squired Smith and Hopkins of the University of Rochester (Dean of the Graduate School and Professor of Physics, respectively) around Cambridge computing centers, and on February 29, gave a seminar talk on the SSEC and its uses in optical design at Harvard Observatory.

(J.H. Newitt)

First week of the subject period was devoted to work on assigned indoctrination problems.

Second week of the subject period was devoted to the following work:

1. Investigation and write-up of recommendations for improving the effectiveness of the indoctrination program.
2. Preparation of a sample summary of a bi-weekly report streamlined to fit the needs of Project Lincoln personnel.
3. Study of material relating to newly proposed terminal equipment.

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8.0 COMPUTER OPERATION

(J. Arnow)

Radar and Relay Link	1.25 hours
Clutter Rejection	1.25 hours
Tracking Programs	3.00 hours
Smoothing Studies	7.00 hours
Aircraft Control	6.00 hours
Miscellaneous	1.00 hours
Calibration	0.25 hours
Flight Tests	3.25 hours
Time Used	<u>23.00 hours</u>
Time Lost	5.00 hours
Total (Time Assigned)	<u>28.00 hours</u>

9.0 PUBLICATIONS

(M.R. Susskind)

The following material has been received in the Library, Rm. 217, and is available to Laboratory personnel:

LABORATORY REPORTS

1. "Whirlwind II Meeting Of February 1, 1952," Taylor, N.H., M-1397, February 6, 1952, pp. 1-2.

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2. "Whirlwind II Meeting Of February 8, 1952," Taylor, N.H., M-1402, February 18, 1952, pp. 1-2.

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TECHNICAL REPORTS

1. "The Development of AN/AKT-11(XN-5) Telemetering Transmitter Systems," Report No. 9479-4, Hazeltine Electronics Corporation, 1 September to November 1951, Lib. No. 1438.

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2. "Bimonthly Progress Report No. 3," Advisory Board On Simulation for the Control Systems Dynamic Analysis Facility, The University of Chicago, Museum of Science and Industry, Chicago 37, Illinois, June-July 1951, Lib. No. 1534.

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3. "Radar Interceptor," Monthly Newsletter, Research and Development Laboratories, Hughes Aircraft Company, February 1, 1952, Lib. No. 1525.

CONFIDENTIAL

4. "Time-Dependent Probabilities," Beck, Hugo M., Naval Research Laboratory, Washington, D.C., December 29, 1951, Lib. No. 1705.

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5. "Synchro-Data Quantizer and Digital Servo, Gridley, D.H., Poland, W.B., Jr., Operational Research Branch, Radio Division III, Naval Research Laboratory, Washington, D.C., January 4, 1952, Lib. No. 1706.

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6. "Coding Processes For Bandwidth Reduction In Picture Transmission," Laemmel, A.E., Microwave Research Institute, Polytechnic Institute of Brooklyn, August 30, 1951, Lib. No. 1707.

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9.0 PUBLICATIONS (cont'd.)

(M.R. Susskind)

7. "Characteristics Of Communication Systems," Laemmel, A. E.,
Microwave Research Institute, Polytechnic Institute of Brooklyn,
June 18, 1951, Lib. No. 1708

UNCLASSIFIED

8. "Operations Evaluation Group Study No. 375, Effect of Programmed
Evasion on Air-to-Air Firing," Operations Evaluation Group, Navy
Department, Office of the Chief of Naval Operations, Washington, D.C.,
March 17, 1949, Lib. No. 1709.

CONFIDENTIAL

9. "Operations Evaluation Group Study No. 368, Visual Detection in
Air Interception," Operations Evaluation Group, Navy Department,
Office of the Chief of Naval Operations, Washington, D.C.,
November 24, 1948, Lib. No. 1710.

CONFIDENTIAL

10. "Operations Evaluation Group Study No. 354, Paths of Intercepting
Aircraft," Operations Evaluation Group, Navy Department, Office of
the Chief of Naval Operations, Washington, D.C., April 19, 1948,
Lib. No. 1711.

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