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Memorandum M-1505

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Digital Computer Laboratory
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

SUBJECT: GROUP 61 BI-WEEKLY REPORT, May 23, 1952

CLASSIFICATION CHANGED TO:
Auth: PD 254
By: L.L. Everett
Date: 2-1-60

1.0 GENERAL

(C. R. Wieser)

Life insurance is available to cover extra-hazardous conditions not covered by the regular MIT policy. Any people who may have occasion to travel in military aircraft should apply for this insurance by notifying Miss Ballard (M. M. Hubbard's Office, Division 1) 24 hours in advance.

Boehmer, Whelan, Wieser, and Israel visited the Evans Signal Laboratory to discuss the antiaircraft problem. It seems certain that we will supply data on the air situation, and we may supply data for acquisition of targets by gun-laying radars if the positional accuracy and resolution of our data are satisfactory.

The move to the Whittemore Building is scheduled for early June. The space is expected to be ready by June 1, and we will move in as soon as telephones are installed.

2.0 EQUIPMENT ENGINEERING

(E. S. Rich)

L. W. Reid of Engineering Research Associates visited this lab on May 20 and discussed some of the mechanical features of the magnetic drum systems being built for us. In this meeting, agreement was reached on how the drum cabinets will be placed in Room 156, where the air supply and wiring ducts will be located, and how cable connections to the drum circuits will be made. Power switching and indication was also discussed but since Reid is not cognizant of the plans on these points we asked that ERA send us the details of their proposed power control within the drum systems. In the meantime Bob Hunt is planning that portion of the power control for which we are responsible.

(H. J. Kirshner)

The difficulty with the "Time Register", noted in previous bi-weekly reports, has apparently been eliminated. This device is now ready for use.

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2.0 EQUIPMENT ENGINEERING (Continued)

(H. J. Kirshner) (Continued)

S.D.V. data has been recorded using the Ampex twin-track recorder. This data was played back into the SDV terminal equipment and reasonably successful results were obtained. A few "drop-outs" were noticeable, but they did not appear frequently enough to cause trouble. Since the S.D.V. system is one which is amplitude sensitive, persons using the Ampex tape equipment should be careful of playback and record levels.

A P.P.I. for use with S.D.V. was delivered by Group 24, but the P.P.I. is not operating quite right as yet.

(B. Morriss)

An investigation of methods of using some of the storage space on the buffer magnetic drum as buffer storage for relatively slow inputs and outputs is continuing. Because access is sequential rather than random, a complicated selection system is not necessary. Four channels with dual heads are available for handling status marks in a manner similar to that used for the radar groups, and since two channels are necessary for each group, it appears reasonable to provide one group for inputs and one group for outputs. Each of these groups would handle eight external units. Each external unit requires some additional equipment for its control, for temporary storage, and conversion of signals. This equipment consists mainly of a synchronizer and register. The principle restriction placed upon external units is that they must be capable of operating in a line-by-line manner and therefore can not operate in a free-running manner as the radar sets. This is due to the fact that only one group is available for inputs and for outputs, and the computer must be able to operate in the group by stopping all external units feeding the group.

These groups may find possible uses for height-finder information, ground-to-air transmission, ground observer information, etc., as well as for feeding typewriters and receiving information from readers.

(J. H. Newitt)

A survey report with analyses and recommendations regarding the air conditioning requirements for Room #156 and the Barta Building in general has been completed in the past bi-weekly period.

Unfortunately neither Carrier Corp. nor Boston Filter have submitted their equipment recommendations to date. To avoid a disruption of the installation schedule, we have been forced to make our own determination of the air conditioning task to be performed in Room #156. Due to the high unit-volume dissipation of Room #156 a huge air duct was indicated. Packaged requirements of the magnetic drum console also had to be resolved into the overall duct system. To make these considerations compatible with

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2.0 EQUIPMENT ENGINEERING (Continued)

(J. H. Newitt) (Continued)

other installation and maintenance considerations, a special distribution scheme had to be devised. This scheme requires the installation of a primary air duct as one of the first items to go into Room #156. Now that a detailed layout specification of the duct system has been evolved, the equipment decisions on the remainder of the air conditioning system can be made at leisure. All our findings have been approved by Mr. Kember, an engineer of the Carrier Corp.

Close liaison has been maintained with R. Hunt who is formulating equipment installation specifications for Room #156. At present, all major installation difficulties seem to be fairly well resolved and installation work is expected to proceed on schedule.

(A. V. Shortell, Jr.)

In an effort to improve resolution and speed of response, the video mapper equipment was used with a CRT having a P11 phosphor in place of the P7. While this decreased the rise time of the gate output (decay time of the phosphor), the improvement in rise time was not sufficient to give the maximum output change with the present mask. Of course the P11 phosphor has a decided disadvantage from an operator's point of view due to its short persistence.

Some objectionable reflections within the "stovepipe" have been minimized by lining the pipe with a black velvet cloth. This reduction in reflection has increased the output amplitude, but the output change is still only about 80% of the maximum change from maximum light to no light.

Even with the minimum sweep speed, the width of the line on the mask is insufficient to give complete blanking of light. Use of a wider line may necessitate the use of a scope with a larger CRT.

(P. W. Stephan)

I am continuing to make a set of drawings of the proposed in-out system of WWI. Drawing C-51629, block diagram of the in-out element and some external units, is now available.

3.0 BEDFORD EXPERIMENTS

(C. Zraket)

FLIGHT TESTS

Two Final Phase Guidance tests were conducted during the past bi-weekly period. A single run on May 12 resulted in a successful guidance to the offset point. Although subsequent tracking around the turn was poor due

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3.0 BEDFORD EXPERIMENTS (Continued)

(C. Zraket) (Continued)

FLIGHT TESTS (Continued)

to the use of LS, the aircraft was able to reach the final guide point by the "dead-reckon" procedure employed.

Four runs were conducted on May 19, two employing LS, the remaining two using NLS-2c. Run 3 was inconclusive due to spotty radar data. Runs 1, 2, and 4 were successful, the aircraft being guided to the final point in all cases. Data tapes punched out during these tests are being processed by DPO.

The Rockport Height Finder (MPS-4) was tested on May 22. Instructions, namely the R, θ of the target, were given to Rockport by telephone in order that the Height Finder could be put on target. Rockport, in turn, relayed back the altitude of the aircraft by telephone. This sequence took about 15 seconds. Altitude returns from the Height Finder were spotty. The MPS-4 had to be calibrated during the test. However, those returns that were sent back were accurate to within 500 ft. The test was conducted at altitudes ranging from 8,000 - 13,000 feet. The target employed was a B-17 which was subsequently sent back to base because of engine trouble. An F-51 was used for the remainder of the test.

(M. Brand)

During the past two weeks time has been spent on the following projects:

- 1) Writing a flow diagram and program to eliminate the acceptance of a single piece of data as a best fit by two aircraft. This program has not yet been run successfully.
- 2) Writing a flow diagram and program to eliminate the multiple display of beacons when multiple radar returns are present. This program selects the centermost of a multiple beacons response and displays one point only. This program has not yet gone on the computer.

(P. O. Cioffi)

Tape 314-7-4, a 2 a/c tracking program which incorporates the lead angle solution method for an interception computation, was run several times this past period. The results of the tests are sufficiently favorable to indicate a decision to supplant the existing iterative method of solution. To this end, I am rewriting program 1000-5 (formerly 835-6) the present operational interception program.

This new version will be organized as a so-called "Basic 2 a/c Tracking-Interception Program" in which all the important aspects of the

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3.0 BELFORD EXPERIMENTS (Continued)

(P. O. Gioffi) (Continued)

program such as smoothing, selection of best data, displays, etc. will be included as subprograms. This will be a companion program to the "Basic Multiple Tracking Program" mentioned by S. Knapp in the last bi-weekly report.

(F. Heart)

When the first attempt at a Beacon Response program was operated (T1083), it was noted that multiple returns from an aircraft with a Beacon Transponder produced an undesirable display. With the assistance of M. Brand, a second Beacon Response program has been written to correct this difficulty (T1257). This program displays a single dotted line between the origin and the target despite possible multiple returns (S-Scope display). This program has not yet been tried.

With further reference to the "wind" question, data from MT123 for a constant velocity, constant heading, constant altitude path was tracked and will be studied.

(S. Knapp)

The Basic Multiple Aircraft Tracking Program is finished and is awaiting trial on the computer. Some thought is being given to a memo to be written describing this program.

Some DPO's have been taken on MT 130 and 133 for the purposes of Analysis. It is planned that DPO will be run with MT 138 and MT 139 in the very near future. These data tapes are being analysed with FWFTT, and will provide a way of knowing just what is going on during interceptions, tracking of high-speed aircraft, etc.

(C. Zraket)

The Final Phase Guidance program was successfully tested during the past bi-weekly period. Both LS and NLS-2c were employed, and, as expected, NLS-2c tracked better during and after the final phase turn. Preliminary study of data punched out during the tests and printed later show that further work can be done on NLS-2c. At present, S. Knapp is taking DPO's on the above data. These will be studied in order to determine whether irregularities are due to faulty smoothing or to the selection of an incorrect piece of data as "best fit".

In addition, the Final Phase Guidance program will be modified as follows:

- 1) "Dead-reckon" time to offset point will be increased from two to four scans.

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3.0 BEDFORD EXPERIMENTS (Continued)

(C. Zraket) (Continued)

- 2) Quantities from which an \tan^{-1} approximation for heading angle is made will be scale-factored to increase accuracy.

It is hoped that these modifications will eliminate discontinuities in the heading angle instructions.

Work with P. Gioffi on the basic two aircraft interception program is continuing as time permits.

4.0 DATA SCREENING

(R. L. Walquist)

Considerable effort has been put into the writing of material on data screening for the Lincoln quarterly report.

Muldar Program #1 has been partially checked by myself, Attridge, Ishihara, and Goldenberg. The remaining part of this program and Bagley's data recording programs will be checked during the coming bi-weekly period. Actual program operation is hoped for in the near future.

(J. Ishihara - W. Attridge)

Muldar Tracking Program #1 has now been checked and should be ready for test during the next period.

(J. Ishihara)

Study has been started on the possibilities and time-storage requirements of programs which would sort tracks (high or low velocity, initiated, "dead"), either by position in a table or by identifying addresses. All considerations are to be made with incorporation in a Muldar program in mind.

(P. R. Bagley)

Muldar Data Recording. As mentioned in previous bi-weeklies, there are three programs involved in the recording on magnetic tape of filtered data from three radars:

1. Clutter Table Construction for Three Radars (T908)
2. Filtered Data Recording (T909)
3. Recorded Data Display (T910)

Now that the computer clock has been checked out, the testing of these programs has begun. Revised copies of the programs and flow diagrams have been made to facilitate trouble-shooting and to aid comprehension by others.

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4.0 DATA SCREENING (Continued)

(P. R. Bagley) (Continued)

Clutter Rejection. The best results to date in stationary clutter rejection have been achieved by collecting for several minutes all data received on alternate scans, storing this data in a non-redundant table, and verifying each entry in the table by requiring that an identical return be received at least twice in the succeeding 16 scans. The present stationary clutter rejection program (T716) was used as the core of a new program (T1255) which has a much greater temporary storage capacity. This new program is being tested; preliminary results are good. Since the new program is in actuality the results of many modifications tacked on the original stationary clutter rejection program written some eight months ago, if the new program is found to give satisfactory results, it will be completely rewritten.

(N. S. Potter)

The indoctrination problem has finally been completed. An analysis of muldar data (two radar tracking) has shown that, by use of elementary theory of small corrections, coordinate conversion may be accomplished by a method requiring one third the processing time and considerably less storage than that of the standard procedure. Unfortunately though, it introduces a correlation problem which has, as yet, not been considered.

(D. Goldenberg)

During the past week, I have received an orientation to the Muldar Tracking Problem, particularly the work being conducted by W. S. Attridge, J. Ishihara and P. Bagley on a three radar system. About seven hours were spent in conference with the aforementioned, the conference consisting of reading and checking the coded programs of J. Ishihara on Initiation and Correlation and of P. Bagley on Clutter Rejection and Data Recording on Magnetic Tape.

5.0 TRACKING AND CONTROL

(J. Arnow)

The major portion of the time during the period was devoted to writing a portion of the Lincoln Quarterly Report.

The commutator at Rockport has been in a state of disrepair and the data has been less than desirable as a result. This will probably be fixed in the near future and useful data recorded for later operation.

The terminal equipment for the Scituate site probably will not be here for another few weeks so that operation will be restricted to the Rockport radar during that period.

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5.0 TRACKING AND CONTROL (Continued)

(M. Frazier)

The progress of the present group of programs has been seriously impeded in the past bi-weekly period by lack of computer time and tape preparation difficulties. A subtle and rare error in polysmooth continues to give trouble. To round out the smoothing study programs for use with simulated data, a new program - polysmooth annex - is being written. These two tapes embody nearly all of the methods of data combination for two radars under serious consideration at present. The new Bedford-Rockport tracking program has been written, but not yet run. Some time has been spent in investigating very quick and very dirty approximation methods. A sin-cos routine nearly as fast as the present table methods, but with far less storage, shows considerable promise. Suggested by Perlis is the approximation $\sqrt{x^2+y^2} \approx 0.96|x|+0.4|y|$ ($|x| \geq |y|$) good to 4%.

(W. Lone)

A modification was made on TRASACT FF (first fit) so that the velocity when translated into miles per hour for printing would take into consideration the fact that smoothing was done every 14 secs. rather than 15 secs. The program will be run with various data tapes and a comparison made with the other TRASACT methods.

A program is being completed which predicts a single position with an associated time throughout an interval for correlation with both radars. At the smoothing time, which is at the end of the latest of the two search sectors, observed positions and times are averaged. On the basis of existing velocities the predicted position is moved from its associated time up, or back, to the averaged time of observation and deviations from the averaged observed position noted to be used in the smoothing equations. It is hoped that the program will be tested in the coming bi-weekly period.

(B. Stahl)

Most of this period was spent on the Indoctrination Problem.

I have also been familiarizing myself with some of the two-radar single aircraft tracking programs written by A. Mathiasen and W. Lone.

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6.0 AIR DEFENSE CENTER OPERATIONS

(D.R. Israel)

A trip to the Manchester Filter Center was made on May 10 with Bob Wieser. At that time tentative arrangements were made for the installation of a telephone line from that center to the Barta Building. With this line, we shall be able to monitor those observer reports from the area generally used in our flight tests. Technical details and arrangements will be made as soon as possible.

Visits from Mr. Slattery, chief of the Radar Branch at Evans Signal Corps Lab, and Colonels Hahn and Pamplin, Liaison Officers at Lincoln, have been very successful and it appears that active coordination with operational anti-aircraft units in the Boston Area will be forthcoming. A trip to Evans Signal Corps Laboratory on May 6 and 7 was extremely beneficial, and gave us a better idea of anti-aircraft problems. Further meetings with the group at Evans will be held to see if agreement on the characteristics of the TSA-8 telephone data link can be reached.

(M.I. Brand)

1. The indoctrination single-aircraft problem was modified to rid it of some errors found while on the computer. This modified program has not yet been tested.

2. Time was spent indoctrinating myself in the past and present work of the group working on G.O.C.

(C. Gaudette)

All of the data between the hours of 1100 and 1300 of the December 1, 1951 Test Exercise at the White Plains Filter Center has been plotted and tracked. During the next period statistics on this data will be compiled.

The Ground Observer Corps Data Display Test Program operates satisfactorily. Some of the techniques used in this program will be standardized for future Ground Observer Corps programs.

A memo describing one method of storing the (x,y) coordinates of the observation posts in the White Plains Filter Center is being written.

(F.A. Webster)

A memorandum has been written on the methods and problems of tracking aircraft with the use of ground observer data. An appendix on the analysis of data plotted in Rm. 157 will be added. All data on aircraft reported to the west board of the White Plains Filter Center between 1100 and 1300 on December 1 has now been processed, and will be used in the development and evaluation of a tracking program.

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7.0 ASSOCIATED STUDIES

(P.R. Bagley)

Magnetic Tape. The magnetic tape block recording and reading subroutines listed in the previous biweekly were extensively revised once again, this time to effect a significant saving in storage.

A subroutine to record a Flexowriter character on magnetic tape (for later printing out on the magnetic tape output typewriter) was run successfully. This subroutine, and outlines for others, have been turned over to Ed Kopley of the Math Group, together with a verbal summary of my experience with magnetic tape programs.

Orientation. A small amount of time was devoted to studying block diagrams and principles of logical design.

(G. Cooper)

A rough draft of the memo M-1492, "Limit-Mean Smoothing" is about 75% complete.

An attempt to extend the method of recursive smoothing to the case of filtering with a delay has run into a snag analogous to one which was encountered in the case of prediction. However, the solution found for the predicting filter does not appear to be applicable here -- or rather, its use will give a filter whose performance seems to be worse than that of a filter with zero delay, contrary to intuition. I feel confident that this problem does have a satisfactory solution, and I am continuing to search for one.

(F. Heart)

A Master's Thesis entitled "Applications of Self-Checking and Self-Correcting Codes to Digital Computers" was submitted, and copies are available in Barta Library as #1813.

Time was spent in writing an outline of descriptive material on the operation of the present interim WWI Input-Output Equipment. This outline is partially based on a previous indoctrination lecture, and is directed partially towards indoctrination efforts in the immediate future. After a certain amount of revision this material will be issued as an M-note.

(D.R. Israel)

The majority of the past bi-weekly period has been spent in preparing material for the Lincoln Summary Report. The remainder of the time has been devoted to matters in connection with the Orientation Course of the Laboratory and the Indoctrination Program of Group 61.

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7.0 ASSOCIATED STUDIES (Continued)

(D.R. Israel) (Continued)

An Advisory Committee on Programming Techniques has been set up to consider, for Group 61 as a whole, matters pertinent to the programming for and the utilization of the computer. The members of this group are J. Arnow, W. Attridge, Jr., C. Gaudette, D. Israel, A. Perlis, and R. Walquist.

(A.J. Perlis)

1. Investigation of methods for simplifying programming procedures for air defense personnel is underway. Parameter, block assembly, and sub-routine handling techniques developed by the applications group will probably be employed.

2. Several new differential correction procedures for the interception problem are being examined.

(H.R.J. Grosch)

Memorandum M-1496 on signed ternary arithmetic is being typed. Memoranda on WWII word structure and operation list, and on multiplexing for reliability, are being revised and extended, and should be issued next month.

I attended a meeting on mathematical tables at the Bureau of Standards, May 15, and visited at the Bell Labs, May 16.

8.0 COMPUTER OPERATION

(J. Arnow)

The following is a summary of the time used on the computer by Group 61:

Data Screening	6.75
Tracking & Smoothing	19.00
Aircraft Control	3.00
Ground Observer Exp.	0.75
Miscellaneous	3.25
Flight Tests	3.25
Equipment Checking	1.00
Set up & Calibration	0.75
Lost due to computer	10.75
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	48.50
Not used*	14.50
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	63.00

* The time not used was during scheduled time from midnight to 4.00 a.m. The major part of this was used by the math group.

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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. "Group 61 Bi-Weekly Report, May 9, 1952," M-1488, pp. 1-14.

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2. "WWII Block Diagrams Meeting of May 1, 1952," Hosier, W.A., M-1481, May 8, 1952, pp. 1-4.

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3. "WWII Block Diagrams Meetings of May 6 & 8, 1952," Hosier, W.A., M-1486, pp. 1-4.

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TECHNICAL REPORTS

1. "Quarterly Progress Report," Project Lacrosse, Cornell Aeronautical Laboratory, Inc., Buffalo 21, New York, October-December, 1951, Lib. No. 248/S.

SECRET

2. "Sky Brightness Measuring Instrument," A.F. Project MX-775, Report GM-561, Northrop Aircraft Inc., Northrop Field, Hawthorne, California, October, 1951, previously listed in M-1488, reclassified SECRET, Lib. No. 249/S.

SECRET

3. "Design and Construction of Continuously Wound Delay Lines," Parsons, J.R., Combined Research Group, Naval Research Laboratory, Washington, D.C., September 26, 1945, Lib. No. 251/S.

SECRET

4. "Integrated Fire Control System for Terrier," Monthly Progress Report, RCA Victor Division, Radio Corporation of America, Camden, N.J., March 1952, Lib. No. 1487.

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5. "Bimonthly Progress Report, Number 4," August-September, 1951, Advisory Board on Simulation for the Control Systems Dynamic Analysis Facility, University of Chicago, Lib. No. 1534.

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(M.R. Susskind) (Continued)

6. "Thermodynamics of Resistors," Interim Engineering Report No. 2, March 1, 1951 to May 31, 1951 under contract No. AF-33(038)-18417 between The U.S. Air Force, Wright-Patterson Base, Dayton, Ohio, and The University of Pennsylvania, Philadelphia, Pennsylvania, May 31, 1951, Lib. No. 1842.
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7. "Progress Report (April), Pulse Transformers," Warren, C.E., Kirschbaum, H.S., The Ohio State University Research Foundation, Columbus 10, Ohio, May 10, 1947, Lib. No. 1843.
RESTRICTED
8. "Preliminary Investigation of Soviet Electronic Components," Intelligence Department, Headquarters Air Materiel Command, Wright Patterson Air Force Base, Dayton, Ohio, September 6, 1950, Lib. No. 1844.
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9. "Welded Germanium Crystals," Final Report, North, H.Q., separate sections by Hennelly, E.F., Alessandrini, E.I., Hahn, W.C., General Electric, Contract OEMsr-262, Order No. DIC-178554, September 20, 1945, Lib. No. 1845.
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10. "Sparrow II Guidance Investigation (Kinematics)," Project Cyclone, contractor: Douglas Aircraft Corporation and Bendix Aviation Corporation; Reeves Instrument Corporation, 215 East 91st St., New York, N.Y., April 17, 1952, Lib. No. 1846.
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11. "Simulation of Amphibious Dynamics," Project Cyclone, contractor: Mr. Edward S. Gilfillan, Jr., Committee on Amphibious Operations, National Research Council, Reeves Instrument Corporation, 215 E. 91st St., New York, N.Y., March 19, 1952, Lib. No. 1847.
RESTRICTED
12. "PTV Defense Missile Analysis," Project Cyclone, contractor: Bureau of Aeronautics, Reeves Instrument Corporation 215 E. 91st St., New York, N.Y., March 31, 1952, Lib. No. 1848.
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13. "Survey of Department of Defense Computer Program," Final Report, draft, Ad Hoc Committee on Scientific and Synthetic Analysis, Appendix I, Research and Development Board, Washington 25, D.C., November 1, 1949, Lib. No. 1849.
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