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Memorandum M-1678

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Digital Computer Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: GROUP 61 AIR DEFENSE BI-WEEKLY, October 10, 1952

CLASSIFICATION CHANGED TO:
Auth: *DD 254*
By: *R.R. Everett*
Date: *2-1-60*

1.0 GENERAL

(D. R. Israel)

A group consisting of Arnov, Clark, Grandy, Hayase, Israel, Levenson, Rawling and Walquist has been holding daily meetings in connection with the determination of certain requirements for WWII. The group is keeping an informal set of notes which will form the basis for a future report.

The group has formulated a number of flow diagrams and other pictorial information relating to the position and use of WWII in an air defense system. A good deal of effort is presently going into an attempt to provide an analytical basis for selection of a correlation scheme. Six schemes have been found and are undergoing further study.

2.0 EQUIPMENT ENGINEERING

(N. Alperin)

This past bi-weekly period has been spent correcting marginal operation of light gun circuitry. This marginal operation did not show up until the new light gun was tried in Room 222.

(H. J. Kirshner)

The third set of S.D.V. terminal equipment was delivered on October 6. At this writing, it is undergoing final debugging by Group 24. This equipment will replace the Burroughs Test Equipment currently used as an S.D.V. receiver. The changeover between equipments can probably be made without interference with Group 61 computer operations.

We have not yet been able to realize completely dependable performance from the Wilcox V.H.F. equipment at the Lexington Field Station. The most serious difficulty at the moment is inter-channell cross talk caused by the close proximity of the antennae which are used for transmission and reception. Group 22 is attempting to remedy the situation.

Authorization has been received for the standby V.H.F. station at the Whittemore Building. This authorization is effective Nov. 1st and the call sign will be AFLXHS-13. It has been learned that equipment for this installation will not be provided by Group 22 because of more urgent requirements for the originally allocated SCR-624A. In the interest of expediency, it is contemplated that surplus equipment will be purchased by Group 61.

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SECURITY INFORMATION

2.0 EQUIPMENT ENGINEERING (Continued)

(H. J. Kirshner) (Continued)

A "beeper" has been added to a telephone extension in Room 222 in order that interstate voice telephone data may be recorded legally.

A push button synchronizer is to be constructed to facilitate manual insertion of data into any selected flip-flop register of the computer from Room 222.

(B. Morriss)

Most of the period has been spent studying various changes in the Buffer Drum System proposed by ERA, and determining how these changes will affect our use of the equipment.

During the coming period PETR will be modified to operate as follows: PETR will continue to generate program alarms if the unit is selected and a piece of data is sent to IOR before the previous data has been removed by an rd order, but no alarms will be generated after the unit is dismissed even though the unit passes over data. If the unit is dismissed in the middle of a block no alarm is given, and succeeding in-out orders will be performed correctly although in returning to PETR all data which has coasted under the head will be missed.

(J. H. Newitt)

The time during the past bi-weekly period was about equally divided between expediting various critical schedule commitments made by vendors and trying to bring the present schedule to a finally frozen state. It was hoped that a frozen schedule could be produced in the past period but unsettled commitments by vendors prevented this. A final schedule will very definitely be issued within the coming period. A small portion of the past period was devoted to the writing of a simple form of an air conditioning specification for C. Cordeman's room (026) in Barta. Competitive bids for the outline work in 026 will be obtained shortly.

(F. Sandy)

Arlex Mfg. Co. has been installing the basic rack assemblies for Room 156. It is expected that this will be completed by October 22.

Two power supply control panels have been completed. The remaining two will be completed by October 10.

The cabling for the power supply control is being installed so that as little time as possible will be required to connect the panels together.

Row letters have been assigned to the rows of racks in Room 156. The row next to the inside wall is "J", the next out from the wall is "K",

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2.0 EQUIPMENT ENGINEERING (continued)

(F. Sandy) (continued)

the next "L", and the drum bay is "M". The first eight racks in "J" row (J1 through J8) are reserved for power racks. L1 is to be the first rack of mite equipment. L15 is to be the rack for the control of the Auxiliary Drum. The racks are numbered 1 through 15, beginning at the door leading into Room 156.

(A. V. Shortell, Jr.)

There has been a delay in shipment of the Teletalk Inter-communication units due to unavailability of the handsets, which Webster Electric obtains from another supplier. Since these handsets will not be available for at least another three weeks, we have instructed the Webster Electric Company to ship the units without the handsets so that we may install the system as soon as possible. Some difficulty in obtaining Jones strips for the junction boxes has also held up the installation, but all equipment necessary for the installation should be here by the middle of next week.

Some time has been spent working on the scope used with the video mapper equipment. The drift in the vertical amplifier will be minimized using the scheme worked out by D. Neville but there is another difficulty with this scope which must be corrected. The Y amplifier is very sensitive to slight mechanical vibrations and these cause the beam to jump from one semi-stable position to another. This difficulty has not been corrected but I suspect the plate voltage supply is the cause.

(G. A. Young)

Test programs and procedures for testing and trouble-shooting the Auxiliary Drum are in the process of being written.

A study is being made of decimal displays which could be used with the computer.

3.0 BEDFORD EXPERIMENTS

(D. R. Israel)

M-1668, (Considerations Affecting the Choice of Final-Phase Tactics), has been written and will be issued. It discusses the types of final-phase attacks which might be used. A second memo will soon follow with a discussion of the distances and geometry involved in a beam-attack.

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3.0 BEDFORD EXPERIMENT (Continued)

(D. R. Israel)(Continued)

Frank Heart is assuming responsibility for planning execution, and evaluation of our flight test program. He will also be in nominal charge of Room 222.

(A. P. Hill)

Breakdown of Flight Test Time, from October 1 through October 10, 1952

Date	Scheduled Test	Tests Held	Reasons for Change in Schedule
Sept. 26	1400-1800 (Brand & Webster) GROUND OBSERVER (4)	Cancelled (0)	Aircraft not available
Oct. 1	1000-1200 (Knapp) TWO ON ONE INTERCEPTS (6)	As scheduled (6)	
	1400-1600 (Gaudette) JET COVERAGE (4)	Test started but not completed (0)	Aircraft returned to base Ground radio rec. inop.
Oct. 2	1000-1200 (Gaudette) JET INTERCEPTS (4)	Cancelled (0)	Testing programs
Oct. 3	1000-1200 (Gaudette) (4) THREE DIMENSIONAL INTERCEPTS	Cancelled (0)	Weather
Oct. 6	1000-1200 (Gaudette) TWO AIRCRAFT INTERCEPTS (4)	As scheduled (4)	
	1400-1600 (Heart) TAKE-OFF INITIATION (4)	Cancelled (0)	Radar inoperative
Oct. 9	1000-1200 (Arnow) (2) COVERAGE (Rockport & Scituate)	As scheduled (2)	
	1400-1600 (Heart) JET COVERAGE (4)	As scheduled (4)	
Oct. 10	1000-1200 (Knapp) TWO ON ONE INTERCEPTS (6)	Cancelled (0)	Computer installation day
	Total aircraft hours scheduled 42	Total A/C hours flown 16	

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3.0 BEDFORD EXPERIMENT (Continued)

(A. P. Hill) (Continued)

Results of Flight Tests held:

Oct. 1 1000-1200 (Knapp) Two-on-one Intercepts

Two F-51's were used as the interceptors, and a B-17 as the target. Three runs were attempted. One F-51 starting at Alton Bay, N.H., the other from a point over Grenier AFB, N.H. The target flew from a point 20 miles east of Sanford, Me. on a heading of 300°. All three runs were unsuccessful due to errors in program.

Oct. 6 1000-1200 (Gaudette) Two A/C Intercepts

Two runs were made using an F-51 and a B-17
F-51 starting over Grenier Altitude 8,000' IAS 250
B-17 starting 15 miles east of Rockport Altitude 8,500' IAS 190
Run #1 Final separation, F-51 passed one mile ahead of target.
Run #2 F-51 passed 4,000 feet to right of target.

Oct. 9 1000-1200 (Arnow) Coverage (Rockport & Scituate)

See report by J. Arnow.

1400-1600 (Heart) Jet Coverage

Two F-80's were used, one flying north, the other in the south-east sector. Blip scan ratios are being made and from them a graph will be drawn giving a summary of single engine aircraft coverage results.

(M. Brand)

One A/C Printing Analysis

This program was completely rewritten in this bi-weekly period to lend itself more to the aided tracking analysis. It is now operative. I expect that during this bi-weekly period I shall have quite a bit of printed results from it from which to assess the efficacy of aided tracking.

Aided Tracking

As mentioned above, this type of smoothing is being analysed by the one A/C printing analysis program. I have written an aided tracking smoothing parameter for the final phase guidance program. If the results of the printing analysis are encouraging I will test this parameter with the guidance program, first on tape, then, I hope, on a live flight test. If these tests are successful I will include the method in an interception program.

(F. M. Garth)

A rewrite was done by Charlie Gaudette of the Basic Two Aircraft Program. This meant that my fighter automatic initiation program also had to be rewritten. In doing so several elaborations were included.

3.0 BEDFORD EXPERIMENT (Continued)

(F. M. Garth)(Continued)

Two registers are now provided in the Basic Two Aircraft Program to store the status of the target or the fighter. After either aircraft has been manually initiated upon, my program will store a value in the proper status register to indicate tracking. In the case of the fighter's automatic initiation a similar storing will be done as well as indicating of "airborne" at Grenier or "standby" at Grenier.

At present the first two switch positions of the light gun IOR are being used for fighter and target initiation. However, my program introduces the third and fourth positions -- the third to indicate cessation of target tracking and the fourth cessation of fighter tracking.

Last week my original automatic initiation program was tried on the computer at two different times. No good data were available for takeoffs at Grenier, so the program could not be checked out as fully automatic. It is hoped better data will be available next week.

(C. H. Gaudette)

The new basic two aircraft tracking and interception program is now complete. The program has just been rewritten to provide additional facilities for future programmers i.e, computed results that may be needed in other programs are saved and additional subprograms are now available. In addition the program has two parameters. Parameter 1 uses magnetic tape as delayed storage for printing the velocities, position and heading of the aircraft on each scan. Parameter 2 replaces the 5 x 3 point display program by a 7 x 4 point display. The program is now being checked out.

(C. C. Grandy)

C. Zraket and I spent some early morning hours trying to check out the final phase interception program after it was combined with the standard two-aircraft tracking program. Results were very unsatisfactory and the cause has not been located definitely. (It was either programming errors, tape errors, or we were just too sleepy!)

(F. Heart)

1. Single Pair

Continued effort was spent on the single-pair interception program. This work is directed at combining into 1024 registers as many sophistications of the basic program as is possible.

a) The automatic initiation section, being studied by F. Garth, is proceeding as fast as possible. So far, one of the main troubles has been a lack of good take-off data. Attempts are being made to acquire some new data. This section of the program will also interrogate 60c-box switches to determine interceptor status.

3.0 BEDFORD EXPERIMENT (Continued)

(F. Heart)(Continued)

b) The height finder program, written by J. Cahill, is being tested and modified. It is expected that it will be operative as soon as the brand-new main program is checked out by Gaudette and Zraket.

c. Other modifications, such as beacon AA, and various displays are being written, tested and modified. Generally these programs are being written independently by various people, but enough coordination is present to allow combination when various parts are ready.

2. 16 A/C

During the last bi-weekly period only a minor amount of time was spent on this program.

3. 4 Pair

Study was started on the requirements for a four-pair interception program.

(S. Knapp)

A flight test held on October 1 using the "Two on One" Interception Program showed that the program was extremely difficult to monitor, due to lack of scope displays. In conjunction with Ann Ward, I have worked on putting into the program displays of heading angles and interception points on the scope, plus continuous displays of target and interceptors. The program is now ready to be tested again.

The Multiple Aircraft Tracking program is still causing trouble as far as automatic initiation is concerned. The program has been modified to use an azimuth examiner and the new dm order, which have caused considerable number of registers to be saved. It is hoped that use of an azimuth examiner instead of an azimuth counter will clear up a rather elusive trouble in the automatic initiation section.

(A. B. Ward)

A subroutine to display letters and numbers on a scope has been written and will be tried out on the computer when time is available.

A modification was written for the Two on One Interception Program which will display at North the heading angle for one interceptor and at South the heading angle for the other. It will also display continuously the tracks of the three aircraft.

(C. A. Zraket)

Further tests of the new 2 A/C Interception and Display Program (T-2061-9) were made using recorded interceptions for data. The operation of the program is now satisfactory in all respects; as soon

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3.0 BEDFORD EXPERIMENT (Continued)

(C. A. Zraket) (Continued)

as "Height Finder" calculations are incorporated in the program, it will be used in all 2 A/C Interception Flight Tests.

A rewritten version of the above programs (T-2104) is in the process of being checked out. It was written with the intent of conserving storage space and for use as the basis of the Single Pair Intercept Program discussed by F. Heart in the last bi-weekly.

A Final-Phase Interception Program was written for purposes of study and tried once on the computer. Although the tracking and display sections operated satisfactorily, no check could be made on the offset-point calculations due to tape errors. It is hoped that the program can be checked out before the scheduled Flight Test of October 17.

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4.0 DATA SCREENING

(R. L. Walquist)

The rough draft of a memo on automatic monitoring of the Data Screening Program for the Cape Cod system has been finished; it will be issued shortly as an M-Note.

Considerable time has been spent on the WWII committee meetings, discussing many of the problems of correlation. Initial work has been started on a memo describing the problem of correlation, the various solutions possible, and the effect of certain system parameters on the various correlation methods.

All of the major decisions for MTP #2 have been made and the basic programming completed. The remaining work on programming will be to fit the program into the available ES storage. To accomplish this, the program is being written in several sections, all of these sections being stored on magnetic tape. A master program will then read in each section of the Data Screening Program as it is needed; the various sections are as follows:

1. Sorting of tracks by quadrants of one particular radar set;
2. Correlation of returns from this radar set with targets seen by this radar set;
3. Display and/or printing routines;
4. Smoothing and predicting of target trajectories.

Steps 1 and 2 must be carried out for each radar set every scan. Steps 3 and 4 are carried out only once per scan of the radar sets.

(W. S. Attridge, Jr.)

Coding of the tracking section of MTP #2 is almost complete. A rough estimate indicates that for this section alone more than 20% in storage and in orders duration could be saved if a B-box were available.

Several decisions on scope displays for MTP #2 have been made with P. Bagley and R. L. Walquist. Letters and numbers will be displayed on the scopes when a track is initiated, ceased, and transformed from one type of tracking to another. These displays may make it unnecessary to do the large amount of printing done in MTP #1.

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4.0 DATA SCREENING (continued)

(P. R. Bagley)

I have drawn the flow diagrams for and coded in preliminary form the positional tracking and display control sections of the Muldar Tracking Program #2.

(D. Goldenberg)

The editing of the rough draft of the memo on the time analyses of various methods of sorting is almost completed. It will be ready for typing of the final copy in a day or two.

Two subroutines have been completed and submitted to W. Lone for issuance. These subroutine combine into a single subroutine the computation of the radius vector and the azimuth angle from the rectangular coordinates. They employ the same method of approximation but differ in accuracy and number of orders. One of them has a minimum accuracy in range of 0.75% and 0.9 of an azimuth unit in azimuth and requires 27 orders. The other has a minimum accuracy of 0.20% in range and 0.2 degrees in azimuth and requires 33 orders. These methods make a saving in the time of operation over the existing subroutines of at least 50%.

(J. Ishihara)

Work continues on coding a satisfactory correlation section for MTP #2. The program will be split into a track-sort and a correlation section due to ES storage limitations.

(J. Levenson)

In the short periods not spent with the WWII Study Group, I have completed a correlation program for MTP #2 with the specifications listed by Ishihara in the last bi-weekly. This involved considerable evaluation of programming schemes for savings in storage at the expense of increasing the time.

(H. Peterson)

I have written a program that is independent of where it is put, except for three registers in flip-flop storage, which will read any part of storage desired and store it on magnetic tape. In addition, I have been investigating effects of altitude on correlation and

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4.0 DATA SCREENING (continued)

(H. Peterson) (continued)

working on a display program to associate a number 1 to 99 with any point, displaying the number above or below the point at will.

(N. S. Potter)

The programs under consideration are as follows:

- a) Numerical Display
- b) Data Display with Grid and Camera Index
- c) Magnetic Tape Record of a Block with Sum Check
- d) Magnetic Tape Transfer to ES with Sum Check
- e) Bar Graph Display

The displays should be in correct working form shortly; but the tests of the others will have to wait for the appropriate equipment.

(H. H. Seward)

Methods of selecting tracks associated with each radar set and the subsequent sorting of these tracks within a table according to quadrants and high or low velocities were examined with J. Ishihara.

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5.0 MULDAR TRACKING AND CONTROL

(M. Frazier)

Due to lack of computer time the rewritten SDV test programs have not yet been checked out. The Bedford-Rockport Tracking Program nears completion.

(J. Hayase)

Schemes for tracking a single aircraft with two radars have been considered, but no conclusions have been reached.

(W. Lone)

The Two Radar Tracking Program which averages times of returns and positions observed is operating successfully. During a flight test Thursday, October 9, 1952, an aircraft flying between Rockport and Scituate was tracked for about thirty minutes with data from these radar sites. To go with this program a display at the radar sites to indicate whether an aircraft was seen or out of range is being written. This, together with a display of a plus for the track, should aid in the analysis of the tracking and eliminate some of the existing confusion.

The simulated version of the above program still awaits testing.

(A. Mathiasen)

Since computer time at last became available, testing of two tracking programs was undertaken. The One Radar Tracking Program was successful in the various printing control combinations and in stationary tracking (on a test pattern). Complete testing of other built-in variations awaits further time. A Two Radar Tracking Program (TRASACT -3PAD) had some minor program errors and revealed also that the dm order was not being handled by the Conversion Program at that time.

An improved version of SYMULDATA is being written.

(B. Stahl)

T-2015 was finally run on the computer for the first time since revision for the in-out system. A few slight modifications were necessary, however, in order for the program to operate satisfactorily, and these have since been made. The performance of this program also suggested modification of another radar-data-checking program which still has not been checked out. This modification has also been written and is now awaiting computer time for testing.

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6.0 AIR DEFENSE CENTER OPERATIONS

(M. Brand)

GOC: I have written a memo describing the method used in GOCSACT, the Single Aircraft Tracking Program using GOC data. This program has not yet been on the computer.

(J. J. Cahill, Jr.)

A simplified AA Guidance and Height Finder Program, for use with the Single Pair Interception Program (T 2104-M1) has been written, as T 2115-M1. It has not been checked out as yet. The Height Finder Program, T 2083, has been rewritten as T 2116, so it will fit with T 2061-M9. This program has also not been checked out, though T 2083 was in operation before it was obsoleted.

No AA Guidance tests were performed during this period, as the battery used is still not available.

(P. O. Cioffi)

Arrangements were completed for my status as visitor-observer at the Boston Air Traffic Control Center. I have spent five mornings and one afternoon there becoming familiar with the personnel, the equipment and observing the control procedure.

Most of my time otherwise has been spent in the direction of a complete definition of the air traffic problem and its transformation into a form usable to the air defense system.

(F. Heart)

Work has started on coordination of flight test efforts. This work will proceed along three main lines:

1. Consideration of maintenance, modification and procurement of 222 equipment.
2. Study of record-keeping procedures.
3. Consideration of flight test (and pre-flight test) procedures.

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6.0 AIR DEFENSE CENTER OPERATIONS (continued)

(F. A. Webster)

Most simply-installable systems designed to supplement (and possibly replace) the ground observer system are likely to include the property of irregular spacing of detection (input) points. The chief reason for such irregularity is dependence upon telephone and/or power lines, which, of course, do not conform to any regular grid. In the case of ground observers, conversion of position to a rough georef coordinate designation gives an approximation in conformity with the basic inaccuracies of observation, and hence this conversion does not introduce serious additional error in time-position-velocity relations. In the case of non-human detection devices, the situation might be quite different, for more precise use of time and space might be required to give position-velocity-altitude relations compatible with the potentialities of the system.

Question arises as to what is the most economical means of computing track data with such a system. It seems unlikely that any single central program could handle the situation economically; and that preliminary decentralized computation devices would have to be interposed between detection and central "report". Work is continuing on some of the theory of such a system.

7.0 ASSOCIATED STUDIES

(W. A. Clark)

Committee meetings have consumed a large amount of time during the past bi-weekly period. These have essentially been devoted to the further presentation and discussion of the concepts and parameters involved in the WWII requirements problem.

(F. Heart)

I have continued to assist with the Group 61 Indoctrination Program, and with the General Laboratory One-Week Indoctrination Program.

(J. Hayase)

Participated in conferences and assisted George Rawling and Charles Grandy in the preparation of flow diagrams for the over-all air defense system and correlation schemes.

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7.0 ASSOCIATED STUDIES

(G. Rawling)

Overall functions and flow diagrams for WWII Air Defense Center Operations were drawn and distributed.

(C. C. Grandy)

Most of my time this past bi-weekly period has been spent meeting with the committee studying WWII. I have read most of the available memos concerning WWII planning for some background information. Some time has also been spent writing up results of committee meetings for the use of the members.

(W. I. Wells)

Work has progressed to the point where some simple examples of the more general problems of noisy data may be solved rigorously. This particular scheme is adaptable to all types of noise, including multiple returns, and also to the case of varying velocities. As yet the work is concerned only with single dimensional problems, however, the ideas are general and may be expanded.

8.0 COMPUTER OPERATION

(C. Gaudette)

During the last bi-weekly period (Sept. 29 to Oct. 12, 1952) the assigned computer time was used as follows:

Equipment Characteristics	0.25 hrs.
MEW Tracking and Control	8.08 "
Data Screening	4.00 "
Multiple Radar Tracking and Control	4.00 "
Air Defense Center Operations	0.58 "
Indoctrination Programs	3.17 "
Miscellaneous	1.75 "
Sub Total	- 21.83 "

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8.0 COMPUTER OPERATION (continued)

(C. Gaudette) (continued)

Flight Tests	2.00 hrs.
Calibration	0.25 "
Equipment	1.67 "
Time Lost	7.42 "
Time not used	21.83 "
Total Assigned Time -	<u>55.00</u> "

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9.0 PUBLICATIONS

(M.R. Susskind)

The following material has been received in the Library, Whittemore Building, and is available to Laboratory personnel:

LABORATORY REPORTS

1. "Data Screening; Division 6 Quarterly Report of August, 1952," R.L. Walquist, E-486, September 30, 1952, pp. 1-14.
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2. "Notes on the Logical Design of the IBM 701 Computer," R.P. Mayer, E-487, October 8, 1952, pp. 1-24. (For Internal Distribution Only)
CONFIDENTIAL
3. "Group 61 Air Defense Bi-Weekly, September 26, 1952," M-1660, pp. 1-24.
CONFIDENTIAL
4. "Schedule of Design Objectives, WWII," A.P. Kromer, M-1661, October 2, 1952.
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5. "Flight Test Schedule for Month of October," C. Gaudette, A. Hill, C. Zraket, M-1656, September 30, 1952.
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TECHNICAL REPORTS

1. "Instrumentation Laboratory Bibliography, Project RR-3 (Tracking Control Research), Project MX885D (Fighter Fire Control), Project MX885B (F-94 Installation)," Instrumentation Laboratory, M.I.T., Lib. No. 2089.
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