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Memorandum 6M-4037

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Massachusetts Institute of Technology  
Lexington 73, Massachusetts

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To: Jay W. Forrester

From: Division 6 Staff

Date: 9 December 1955

Approved: J. C. Proctor

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SAGE SYSTEM TEST AND PLANNING

(Group 61, J. F. Jacobs)

MASTER PROGRAM PREPARATION (H. D. Benington)

Utility Programs (C. H. Gaudette)

The major section of the Lincoln Compiler was checked out on XD-1 and took 45 hours, 38 minutes of assigned time, of which 11 hours, 43 minutes were lost (74.3% useful time). The recompiling and sub-routine insertion section will be incorporated into the program by 15 December.

A set of output (printing) and input routines are being prepared and will be available for use in the coding of other utility programs.

A rough draft of the coding specifications for the Checker has been completed and the coding of the program is underway.

Publications (P. R. Bagley)

Memorandum GM-3964, The Program Input Process: A Manual on the Use of the Compiler and Read-In Programs, was completed and distributed. This memorandum has "controlled distribution," i.e., a record of the distribution is kept in the Document Room so that supplements will reach all holders of the original memo.

A draft of GM-3994, Lincoln Checker: Operational Specifications is two-thirds rewritten.

OPERATIONAL SPECIFICATIONS FOR SAGE SYSTEM (C. A. Zraket)

Air Surveillance (E. W. Wolf)

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The following memoranda were issued:

GM-3928, Comparison of Track Sorting Methods for The Correlation Program in an AN/FSQ-7 (XD-1) Air Defense Program.

GM-3774-1, Correction 1, Operational Specifications for SAGE System Radar Data Inputs.

GM-4013 (First Draft), Mathematical Specifications for Track Detection and Initiation in the SAGE System.

GM-3953 (First Draft), Mathematical Specifications for Automatic Tracking in the SAGE System.

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OPERATIONAL SPECIFICATIONS FOR SAGE SYSTEM (continued)Identification, Manual Inputs, T.B.S.  
(J. Bryan, F. Garth, S. Hauser)

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Revisions to 6M-3780-1, "Operational Specifications for the Identification Function in SAGE," will be made to accommodate recent changes in ADC regulation 55-12 pertaining to the identification function.

Detailing of the mathematical specifications and recommendations from the Master Program Preparation Section will result in additional revisions to both the Identification and Manual Input operational specifications. All such revisions, however, are in areas which do not affect the operational doctrine of the functions and are expected to receive concurrence at the same meeting scheduled for discussion of the mathematical specifications.

Resolution of problem areas in T.B.S. (reference last biweekly report on this topic) has been achieved by a logical separation of the functions of simulation status determination and simulation data association. Corrections to 6M-3899, "Interim Operational Specifications for Training and Battle Simulation Function in SAGE," will reflect recommendations resulting from a meeting with C. A. Zraket and J. Ishihara and a previous meeting with 4620th Wing. Another concurrence meeting with ADC at Lincoln will be necessary to incorporate changes in the operational specifications.

Standby Computer (A. Heineck)

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The standby machine reconstructs the air defense situation when the active machine fails. The reconstruction is made from safe track data provided by the active machine before failure. A rough analysis indicates that safe track data can age 45 seconds without causing tracking trouble when the standby machine reconstructs the air situation. To permit a transfer control to the standby machine within 30 seconds after a failure of the active machine, error detection methods, switchover criteria (to decrease decision time), and startover procedures are being developed. This would mean that safe track data need be received only every 15 seconds by the standby machine, to keep within the 45 second age period previously mentioned. Between these transfers of information every 15 seconds, the standby machine would uninterruptedly perform maintenance programs for 14 seconds.

It has been proposed that the storage tables be organized with the safe track data in a group of as few registers as possible. This would minimize the time required by the active machine to assemble the safe track data and the time required by the standby machine to reconstruct the air defense situation from the safe track data.

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OPERATIONAL SPECIFICATIONS FOR SAGE SYSTEM (continued)Standby Computer (continued)

It has also been proposed that all maintenance programs which check the standby computer's auxiliary memory drums restore all the permanently stored information to the drums when maintenance is complete. Thus, in many cases, when the standby machine has to assume the air defense load no startover time will be required to rewind tapes and read in information from tapes.

ESS Shakedown Planning (C. C. Grandy)

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A preliminary statement of requirements for writing operational procedures for the external sites has been issued as an interoffice memorandum. This information will be made available to Group 23 after comments are received. A preliminary inventory of tasks to be accomplished in preparation of ESS operation has been completed and issued as an interoffice memorandum. Preliminaries will be established for the various work items and attention given during the coming weeks to those of top priority.

A proposal for the ESS Shakedown has been written and will be circulated for comments during the week of 5 December. Art Lozeau has been assigned to display duty in this area and is preparing specifications for simulated background traffic to be issued during the ESS Shakedown exercises.

DATA SIMULATION AND ANALYSIS (W. S. Attridge)Simulation (R. Collmer)

A study has been completed of the errors resulting from approximating vectors in one projection plane with the same vectors in other type projection planes.

COMPUTER OPERATION TIME, XD-1 (P. L. Guinard)

Program Checkout (Utility Assembly)		24:59
Downtime		
In/Out Equipment	4:00	
Computer Malfunction	3:25	7:25
Returned to IBM		<u>12:36</u>
	TOTAL ASSIGNED TIME	45:00

CARD PREPARATION ROOM (H. Newhall)

Plans for a new punched card and magnetic tape installation have been completed and space for the installation requested in the basement of Building "A". All possible steps are being taken to expedite the construction of this installation to have it ready for use by 15 January, when delivery of the first of the magnetic tape equipment is scheduled.

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FSQ-7 PROTOTYPE DESIGN AND INSTALLATION

(Group 62, N. H. Taylor)

XD-1 INSTALLATION (J. A. O'Brien)Schedules (N. L. Daggett and H. F. Mercer)

We are assembling data to revise ESS schedules. Daggett will be responsible for Test Team activity and Mercer for the incomplete areas in Bldg. F.

Acceptance Tests (J. D. Crane)

Noise and interference tests on XD-1 are in progress. Results of the acceptance tests on the display system and the GFI element are contained in memorandum 6M-4019.

Lighting Test (R. H. Gould)

The rearrangement of the Charactron setup in the experimental lighting room, Bldg. B-034, has been completed and has greatly speeded up the testing of Charactron legibility.

MEMORY TEST COMPUTER (W. A. Hosier)Magnetic Tape Installation

There is nothing new on the IBM tape drive units and tape adapter frame; apparently IBM will deliver the Adapter Frame and at least two Drive Units by 1 February on a loan basis of 5 or 6 months; PCO is making a request of the Air Force to provide these units (including a third tape drive unit) as part of the SAGE exhibit so that they may be retained more or less permanently. With regard to the tape drive unit power supply, it now seems probable that we will tap the necessary voltages off bleeders and drop resistors from our own MTC supplies.

Tom Stockebrand has gone to Poughkeepsie for eight weeks to attend IBM's classes on the tape drive units and associated circuitry.

New Control

Ziegler, Gates, and Olsen have assembled the five FF's and 32 diode gates with cathode followers which constitutes the basic instruction switch, and have cycled the switch through its paces at 2.0 mc. with a load of 8 gate tubes (about 150  $\mu$ f) on each cf. The switch performs as intended: rise of 1/4 sec., fall to cutoff (-15v.) in 1/4  $\mu$ sec. Ziegler has been experimenting with 100-ohm lumped constant delay lines for various special control cycles. These lines have the decided advantage over the usual high impedance distributed-constant lines of being able to drive more load without interlarding of buffers.

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MEMORY TEST COMPUTER (continued)

Display

The new camera scope enjoyed a successful, if brief, trial on 25 November: a line of 256 dots was nicely resolvable even by eye, and the pattern was solid as a rock. Unfortunately, however, the CR, tube, a Dumont K1187P11, proved to be a lemon by breaking down internally below rated voltage. Dumont has brought out a replacement for this tube, the K1354P11, which has a bigger neck and base and higher rated voltages; we have ordered some of these and should have the camera scope in business again in a week or two.

Ferranti Reader

The modified reader performed famously on the bench, even with rejected 5965's. An inexplicable shift of one of the levels occurred when it was installed on the computer, which returned to normal after a bit of twiddling on the bench. We will let it run for a couple of days more on the bench, and then try it again in the computer.

Computer Operation

The only new note added to MTC applications has been a proposal by Chan Watt and Company to use Werlin's program to make tapes to check the GE ground-to-air VHF data-link. This is not much different from the current use of the program to check LRI equipment.

Performance has generally been satisfactory at about the same level as the past month. The usual biweekly figures on machine time and component failures are missing this period because the persons responsible for gathering them have been absent, but they will be included in the next report.

DISPLAY DEVELOPMENT (C. Corderman)

I accompanied members from IBM and Hazeltine in a visit to the Hughes Aircraft Co. and Stromberg Carlson for discussions of a large controlled-persistence display tube and a small Charactron for use in the projection system. The latter will probably have a 7" flat-face and a double lens optical system similar to the tube planned for the XD-1 projection system. Further conferences on the controlled-persistence tube are scheduled at Capehart-Farnsworth and CBS during the week of 5 December.

Experiments are in progress to determine the fastest settling time which can be obtained with a magnetic yoke when the excursion is limited to 1/8" or less.

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BASIC CIRCUITS (R. L. Best)

High Speed Flip-Flop (MTC) (N. J. Ockene)

Test data is being taken and will be incorporated into a final report on the high speed MTC flip-flop.

Centralized Probe System (A. Hingston, W. F. Santelmann)

All follower circuits now operate well and provide rise and fall times of about 20 nsec, with very small distortion through 227 feet of RG-11h/U to screen of the Tektronix 541 scope.

The old three-tube circuit using 6197's seems larger than necessary. The only advantage of the subminiature four-tube cathanode is its high output which permits an overall 20:1 attenuation ratio. The simple two-tube subminiature follower with its 50:1 ratio seems to be the best compromise.

Surprisingly, there is little risetime degradation produced by an eight-foot "cold probe" damped with a resistance center wire when it is used to drive any of the follower circuits. Several sizes of resistance wire have been procured for experimental determination of the best size for damping "cold probe" ringing.

Charactron Vector Intensity Decoder (R. B. Paddock)

Much of the p.r.f. sensitivity seemed to be present in the output stage and has been improved by use of a low-impedance voltage divider for selecting the cathode potential. Fall and rise times are still somewhat outside specifications at full load.

Half Amplitude Driver (Production Plane Tester) (D. Shansky)

This driver has been modified so that it will be more acceptable as a piece of special purpose test equipment. It will now furnish currents variable in amplitude from approximately 300 ma to 1 amp. The maximum back voltage the driver may withstand is a function of current amplitude and at maximum current (1 amp), the maximum back voltage is 5 volts.

Gap-Filler Sweep Circuit (B. W. Barrett)

The gap-filler sweep circuit is explained in Memorandum GM-4027 which is now being distributed.

Display Line Driver (J. Kriensky)

Linearity measurements have been taken on this amplifier and show that it is linear to within 0.1 % throughout its operating range for 1000 and 500-ohm loads.

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BASIC CIRCUITS (continued)Digital Data Receiver (E. B. Glover)

With all major problems behind us, we have left the problem of getting the DDR to work satisfactorily with 326-bit message. As far as I have been able to determine, the units requiring this message length will be built by G. E. and will not be interchangeable with the DDR's for Bldg. F. Since the range of 52 to 326 bits per message places very strenuous requirements on the AGC circuits, we plan to end up with our circuit designed for the range of 52 to 92 bits per message and another circuit designed for a 326 bit message. It is anticipated that the difference between these two circuits will be on the order of a change in value of two of three components. If there are any objections to this proposal, I will appreciate being notified as soon as possible.

Digital - Analog Decoder (J. I. Wolf, H. E. Zieman)

An M-note (GM-3971) has been released on the component circuits for digital-to-analog decoder as used in XD-1. The note discusses the theory and operational specifications of the four basic circuits used in the decoders.

A trip to the Instrumentation Conference of the IRE has revealed several interesting techniques which might be useful to Lincoln. A more detailed report will be issued as an M-note.

Charactron Shields (J. I. Wolf, H. E. Zieman)

A chemical analysis of the Charactron's shields has shown no correlation between the nickel content of the shields and the eddy currents set up in them. These eddy currents are causing problems in magnetic deflection and attempts are being made to find some material which will reduce these currents. Resistivity measurements are now being made on three shield materials which have widely varying eddy current effects. It is hoped that some useful correlation will be found.

Typotron Collector Surface (J. I. Wolf, H. E. Zieman)

A system for scouring the collector surface of a typotron is now complete, and will be put to use as soon as a slave display is completed.

SYSTEMS OFFICE (H. E. Anderson)

Drawing E-58233-11, Second Floor Layout of Building F, is being changed to bring it up to date.

A set of notebooks containing all concurred with specifications for



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SYSTEMS OFFICE (continued)

the AN/FSQ-7 production machine has been assembled. These and the AN/FSQ-7 (XD-1) specifications notebooks are available in B-209 to all interested personnel.

Our brief numbering system is still undergoing a change to a coded decimal system which will enable us to file properly all air defense material.

Teletype Inputs

BTL were visited to look at the teletype systems under development there.

A manual selective-call system has been developed which uses the Model 28 KSR (keyboard send-receive) teletypewriter. The #28 KSR, made with a stunt box, is all that is required in this system.

An automatic remote-transmitter-start, selective-call system uses automatic equipment at the station designated as the central control to poll each transmitter in turn. Provision has been made to include a priority rating which is established at each station. The first characters in a message transmitted are call directing codes (CDC) which select the receivers. This system was designed to work primarily with ASR (automatic send-receive) machines. This system, 83B1, with a few minor changes, seems to be the answer to the needs of an automatic teletype input.

Talos Reply Back

The report on the Talos reply back message transmission system study will be issued during the next biweekly period.

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ADVANCE DEVELOPMENT

(Group 63, D. R. Brown)

MAGNETIC MATERIALS (J. B. Goodenough)Memory Core Production

Approximately 220,000 D397 memory cores were fired during the past biweekly period. One hundred thousand of these have been sent to the testing section and the remaining 120,000 are being held for further heat treatment. (J. J. Sacco)

Memory Core Testing

Double-tested to date:	2,076,000
Single-tested and on Final Test:	112,000
On hand for test:	<u>40,000</u>
Total	<u>2,228,000</u>

Chemistry

The determination of the oxidation states of the various heavy metals and the accurate estimation of lithium are still major problems to be solved. (D. L. Brown, D. Wickham)

Cobalt-substituted manganese-ferrite boules are being oriented and cut for window frame experiments. Microscopic and X-ray examination will reveal the quality of these supposed single crystals. (W. J. Croft)

The motion picture film showing the motion of domain walls in polycrystalline ferrites is being improved and provided with titles. (F. Maddocks)

Some compositions represented by the formula  $[(Li_{0.5}Fe_{2.5}O_4)_{0.6}(ZnFe_2O_4)_{0.4}]_{1-\alpha} [NiFe_2O_4]_{\alpha}$  have been prepared in the search for new materials for switch cores. The composition for which  $\alpha = 0.3$  appears promising. Preliminary measurements have given  $R_s = 0.71$ ,  $H_{c,sat} = 0.9$  oersteds,  $B_s = 3200$  gauss. The coercivity remains 50 per cent too high. (D. L. Brown)

PhysicsInstrumentation

The vibrator unit of the vibrating-coil magnetometer has been assembled in the magnet and found to require slight modification which should be done within a few days. The auxiliary mechanical apparatus designed

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MAGNETIC MATERIALS (continued)

for sample manipulation (i.e., heating, cooling, positioning, and rotating) has arrived and is now being assembled. The electrical testing of the system is in the initial stage and should proceed rapidly upon the return of the vibrator unit. (D. Smith)

The DC fluxmeter was in operation for part of this biweekly period, and the DC hysteresis loops of several cores were obtained. However, the X-y recorder used in conjunction with the fluxmeter has developed a noisy potentiometer in the y-axis. Further operation will be suspended until this is repaired. (R. A. Pacl)

A fast-rise-time current-pulse generator has been built on a bread-board and is now being tested. The generator will produce a current pulse of 4 amperes amplitude and will have a rise time of 0.04  $\mu$ sec at 2 amperes. This generator is expected to become a standard test equipment unit. It is therefore suggested that potential users of this unit contact J. D. Childress or R. C. Zopatti so that an estimate can be made of the quantity to be built. (J. D. Childress, R. C. Zopatti)

Theory

For experiments to be conducted on ferrite single crystals, two window frame cutters have been constructed. One will cut out a crystal in which the domain wall lies in the crystalline (110) plane, and the other will give rise to a domain wall in the (11 $\bar{2}$ ) plane. In order to interpret experimental results, a comparison of the dynamic behavior of the walls in these planes is required. A calculation of the anisotropy energy and the exchange energy of a domain wall in the (11 $\bar{2}$ ) plane has been completed, and the result indicates that for a given external field, wall motion in this plane is 30 per cent faster than a wall in the (110) plane. A calculation has also been made of the output voltage due to wall motion in the (11 $\bar{2}$ ) plane. Despite the more complicated geometry involved in this type of motion, the output voltage will be constant to within 3 per cent for most materials. (N. Menyuk)

NEW COMPONENTS AND CIRCUITS (D. J. Eckl for T. Meisling)SBT Life Tests

The unshielded 8-digit shift register made an error after 1800 hours by picking up an extra one in the pattern. This error occurred on the eve of a battery change and so the supply voltage was low, probably affecting the margins. It has been running error-free for 237 hours since the mistake.

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The shielded register continues to run without error and has now reached 4232 hours since its last mistake. It has been on test a total of 5538 hours.

The Burroughs test equipment control for our original life test flip-flops has been replaced by a transistor control, thus eliminating all vacuum tubes from our life test setup.

Power Transistor Curve Plotter (R. Burke)

The original relay-operated curve plotter, designed for point-contact transistors, has been reworked to present grounded-emitter characteristic curves for power transistors. Currents of the order of 1 ampere will be displayed.

Transistor Circuits Series

The fifth M-note in the series, "The Thermal Stability of Transistors," is being typed and should be available shortly after this Biweekly appears. The sixth note will discuss transistor types and the seventh the basic grounded-emitter transistor switch.

Transistor Procurement (P. Fergus)

Approximately 1200 SBT's have been measured for TX-0 delivery. The over-all yield runs about 67 per cent. This results from the fact that commercial SB-100's have been ordered and then tested to certain switching specifications. The new L-5122 units should meet these "on" and "off" switching specifications.

Transistor procurement in the group has increased from a maximum of 200 units per month in 1954 to an all-time high of 1300 for the month of August, 1955.

MEMORY (J. L. Mitchell)

Experimental Switch and Plane

The magnetic core switch is now operating satisfactorily. A program has been outlined for an intensive investigation of the 256<sup>2</sup> sense winding characteristics.

Cooling and Supplies

The installation of the ceiling in the basement of Building A is underway. The delivery of the Westinghouse air conditioning units is still indefinite. The manufacturers are starting to ship the power supplies, and most of the supplies should be here in the next few weeks.

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MEMORY (continued)256<sup>2</sup> Construction

Sixty-six 64 x 64 memory plane modules have been accepted. The construction of the small memory plane tester is underway, and the first model should be available in two weeks. The first results from the improved plane-wiring procedure look good. More information is needed before a final evaluation can be made.

The three-bay rack is complete and now undergoing a few minor modifications. The Assembly Shop has completed the PIU digit-plane driver and PIU switch-driver input-amplifier prototypes. Construction of the balance of the units is underway. The design of the memory stall is complete except for one panel. Construction of some of the parts of the memory stall is underway.

Advanced Development

The sense amplifier circuit has been altered in an attempt to raise the input impedance. This new circuit was tested on the 256 x 256 plane and the results were good. The one remaining problem is the delay through the amplifier. Various transformers are being tried in an attempt to reduce the delay.

Work on the transistor memory driver is being concentrated on increasing the speed of the amplifier preceding the driver. A conference was held at Philco and the memory-driving transistor was discussed. Philco seems to be making progress on this unit.

LOGICAL DESIGN (W. A. Clark)

The detailed logical design of the TX-0 control is essentially complete. Most notable of the many last-minute changes is the elimination of the time level distributor (the 6-bit high-speed counter in which difficulty in start-stop synchronization was anticipated) and the substitution of a delay-line chain to supply time pulses directly. The number of time pulses has been increased from 6 to 8 to insure that the memory will be able to run at its maximum rate if it turns out that the MAR can be set up during the write operation.

The photoelectric tape reader control is now designed to permit reading of either one line or three lines at a time. This facility simplifies the problem of stopping the computer in the read-in mode of operation.

SYSTEM DESIGN (J. Fadiman for K. H. Olsen)TX-0 Circuits

During the past two weeks, we have been experimenting with SBT cir-

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SYSTEM DESIGN (continued)

cuitry using a combination of the grounded-base and emitter-follower configurations. It appears that such circuitry will give greater tolerance to hole-storage and  $\beta$  than does the common inverter. Consequently, we intend to use these configurations whenever possible in TX-O logical circuits in order to gain the advantages of greater speed and greater tolerance to transistor parameters. The flip-flop is being reworked in order to gain greater speed.

TX-O Packaging

Models of the various types of plug-in units for TX-O circuits have been made.

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AN/FSQ-7 AND CAPE COD DIRECTION CENTER

(Group 64, S. H. Dodd, Jr., E. S. Rich)

SYSTEM TEST PLANNING AND COORDINATION (K. E. McVicar) **CONFIDENTIAL**EPSCOM (R. P. Mayer)

It has been decided to hold a meeting of EPSCOM programmers once a week on Wednesday mornings beginning 14 December. The hour and place will be announced. On alternate weeks, this Wednesday meeting will be combined with the present "biweekly" meeting.

F. Irish reports that console T20 will be the only console with voice radio facilities until next April. All programs that require radio communication with aircraft should make use of this fact.

A chart showing the organization of the EPSCOM programmers and indicating the reported status of their work, together with a more detailed description of tracking program activity is available in Room B-111 as interoffice memorandum PL-BJ-29.

G/A Data Link Tests (C. Watt, I. Aronson)

During the past two weeks the output buffer drum has been used as a message source for G/A data link messages several times. The information on the buffer drum has been transmitted both to Prospect Hill where it was transmitted by UHF link to Building B, and to the Barta Building where it was recorded on the 14-channel Ampex recorder. In Building B, the information was used to operate a mock-up of the instrument panel that will be put in the F86D airplanes. The data transmitted from the buffer drum still contains some errors which are being tracked down, but the method of using the buffer drum as a message source seems to be satisfactory.

A schedule will be set up and maintained by C. E. Ellingson of WE for the use of the buffer drum and the tape equipment at the Barta Building as message sources for both ground and flight tests of G/A data link equipment. Group 311 expects to be running daily tests of the data link equipment both on the bench and in the airplanes and it will therefore be necessary to have adequate signals available every day. Ellingson will coordinate the requirements of Group 311 with the availability of the buffer drum and the tapes so that there never need be a time when the equipment test is held up for a lack of test signals.

Tests will be run in the near future to evaluate quantitatively the reliability of the 14-channel Ampex recorder as a message source when the reel of tape is repeatedly rewound and replayed. These tests will be run with MTC.

In addition to Ellingson, who will handle the scheduling and the planning of the magnetic tape tests, Arnold Bailey of BTL will spend some time with Group 311 learning the ins and outs of the ground-based data link equipment, and Lou Broccoli of WE will work with Group 311 learning the airborne equipment.

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Teletype (C. W. Watt)

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Two ADES people, Burgess and Rose, are currently studying the teletype outputs of XD-1 and the teletype requirements in the Experimental Subsector preparatory to doing some planning for teletype tests.

Duplex Switching Study (A. J. Roberts)

I have been investigating the possibilities of using the "standby" computer for testing and maintenance of external equipment. A study of the available switching configuration indicates that equipment to be checked may have to be removed from the "active" computer to avoid complex switching sequences. It may be necessary to check all output equipment with the "active" computer. The results of this investigation will be reported in a memorandum.

Crosstelling (C. W. Watt)

On Friday, 2 December, an attempt was made to crosstell arbitrary messages from WWI to XD-1. Both computers were scheduled at the same time, WWI to send messages, XD-1 to receive them, reject any messages with bad parities or missing busy bits and send them back to the Barata Building, where the returned message would be checked against the message transmitted. Several things blocked successful accomplishment of the first attempt to run this test. The XD-1 program had some defects in it. There were certain unexplained parity alarms in both the input and output systems and there was difficulty in diagnosing the troubles that did appear at the input because of unsatisfactory instrumentation. A meeting will be held on Monday, 5 December, to discuss the troubles encountered in this first test and a second attempt will be made on Wednesday, 7 December. Computer time for this testing activity has been scheduled during the same hours on WWI and XD-1 twice each week during December.

Two ADES people have been assigned to this crosstelling effort and they will participate in the forthcoming tests. These are K. Myers of BTL and C. E. Ellingson of Western Electric.

CAPE COD ENGINEERING (L. L. Holmes)WWI Computer Operation

Scheduled Computer Hours:	329.25
Interrupting Incidents:	27.00
Hours Lost:	12:70
Percent Good Time:	96.20
Mean Time Between Failures in Hours:	11.70

Several types of failure contributed to the 12.7 hours of downtime:

1. An accidental erasure of the mark track on the auxiliary drum

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made rerecording of the mark pulse necessary. The mark pulse is used to synchronize the drum with its electronic control equipment whenever power is returned to the drum system. The original pulse was recorded at the factory and in our rerecording it was necessary to exercise several precautions.

Four hours were required to locate and correct the trouble. To reduce the possibility of a recurrence of the trouble, the drum head connector and others of similar importance have been painted red and tagged.

2. Twelve interrupting incidents have resulted from what appears to be an intermittent auxiliary drum control system fault. The computer stoppage results from the lack of a drum operation-completion pulse. The failure also causes writing between the slots in several tracks of the selected group. Three hours downtime has been charged to the unlocated fault. We believe that the source of trouble will be located during our maintenance period on Saturday, 3 December 1955.

3. The discovery of three unrelated, dangerously low margins during daily marginal checking periods, necessitated our using 2.5 hours of assigned applications time to cure the troubles.

4. A faulty cathode follower tube in the arithmetic element's B register caused several computer stoppages and incidents of programmers' obtaining inconsistent results. The tube was not located with our marginal checking program but by applying margins to the arithmetic element while running a library subroutine.

#### XD-1 and WWI Crosstelling

A two-hour crosstelling test, involving both computers, was conducted 1 December. During the subsystem test, XD-1 was slaved to WWI. The XD-1 input drum apparently failed to record any of our messages. The actual reason for the failure wasn't determined, but during the test we reconnected our input system to our output system to serve as a monitor and it appeared to us that the structure of the outgoing message was proper.

Prior to the next test requiring both computers, attempts will be made to operate the WWI to XD-1 lines using the WWI subsystem test program, WWI phone line, and the Building F demodulator. The run will be made to determine the legitimacy of the structure of the transmitted message.

#### Training Program

A program consisting of lectures and on-the-computer training has been formulated by C. S. Lin, A. N. Blumenthal, and O. C. Wheeler. The purpose of the program is to improve the efficiency and increase the versatility of the Group 64 staff and technicians who maintain

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WWI. The training will emphasize learning the fundamental logic of WWI and improving the personnel's system-maintenance philosophy. Each lecture and on-the-computer training session will last one and three hours, respectively.

Marginal Checking Programming

Art Curtiss has been acquainted with the fundamentals of programming. He will work with Don Morrison in revising our marginal checking programs. His initial assignment is to integrate into the existing display system marginal checking program a routine that will check the vector and character displays.

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VACUUM TUBES

(Group 65, P. Youtz)

TUBE TECHNIQUES (J. S. Palermo)

Several bariated-nickel cathode study tubes were processed and dissected for analysis. The results obtained from this program indicated a need for a modification of the pressing techniques used in the fabrication of these cathodes since it was observed that an inadequate bond existed between the emitting and base metal layers. Three cathodes incorporating these modifications have been prepared and are presently being assembled into triodes for processing and evaluation. These latest cathodes have been sintered in a more controlled atmosphere as a result of the installation of an activated alumina drying cylinder: Lectrodryer.

Work is also in progress for the preparation of components for further studies of electroluminescent storage devices for Group 25. The necessary "masks" were procured and chemically processed. They have been used for the evaporating of an aluminum pattern on glass plates.

Components were fabricated and assembled for another 5-inch projection Charactron tube. This tube will be processed the week of 12 December 1955.

RECEIVER TUBES (S. Twicken)

The IBM Tube Group, P. Youtz and I attended a meeting at G.E., Owensboro, Kentucky. G.E. presented a first draft of a proposed MIL specification for the 0528. After considerable discussion, the situation now stands as follows:

1. Characteristic limits remain unchanged.
2. G.E. proposed lengthening life tests from 500 to 1000 hours (with 500-hour release) and will reconsider its original rejection of 2000 hours with 1000-hour release.
3. G.E. will reconsider its rejection of the 2000-hour materials change evaluation test.
4. G.E. has proposed a design maximum, rather than absolute maximum rating system. We shall take this under advisement.
5. G.E. will reconsider its rejection of a 0.65% AQL for intermittent shorts in favor of 1.5% AQL.

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RECEIVER TUBES (continued)

6. Several AQL's remain to be firmly established after reconsideration.

G.E. has had considerable production difficulties during the past several months and feels that many limits and AQL's as well as 2000-hour life test end points may be tightened after six months or so of stable production. The tubes in production are now using the passive P-50 cathode alloy. Large enough quantities for complete evaluation have not yet been produced. The SAGE movie was shown to G.E. management and all production personnel concerned.

COMMERCIAL TUBES (T. F. Clough)

On 21 November a meeting was held at the Sylvania executive office in New York City to discuss the current shortage of type 2420 tubes. This shortage results from manufacturing difficulties at the Emporium plant. The present demand was reviewed and compared with probable tube availability. A committee, chaired by ADES, will survey all uses, determine requirements, and allocate the quantity of tubes available.

I attended a progress meeting at the Bendix Red Bank Division in Eatontown, New Jersey, on 28 November 1955 with E. J. Breiding of the IBM Kingston Tube Group. Bendix is the subcontractor for a second source of the AN/FSQ-7 gate pentode. Tooling is practically complete and several lots of tubes are now being made with parts of their design to adjust mount geometry to the required characteristics. Their hooded mount-bench design and some of the other measures they are taking to reduce lint and intermittent defects were discussed. The SAGE Film was shown to their personnel to acquaint them with the importance of the tube's application.

Members of the IBM Tube Group and I met with Tung-Sol at their plant in Boomfield, New Jersey, on 1 December to review their progress in producing the DT-438 twin triode for AN/FSQ-7. Tubes are now being produced using the improved design parts. Present yield is low because of plate current troubles. They are seeking to ascertain the cause of the difficulty. The Westinghouse strike has cut off their supply of bases but various expedients will permit them to continue basing tubes for a minimum of three weeks.

CHARACTRONS AND TYPOTRONS (P. C. Tandy)

Four MIT 19-inch tubes and six Convair Charactron tubes have completed between 574 and 7174 hours on life test. Convair 0174 was rejected for low pulse matrix current after 2940 hours. The helical-accelerator resistance of the six Charactrons during the first 550 hours has not shown any appreciable changes.

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CHARACTRONS AND TYPOTRONS (continued)

Fourteen cathode study tubes have completed between 3377 and 4757 hours on life test. Six of these tubes did not give 50- $\mu$ a beam current, the end-of-life criterion, at the last testing period; three of the failures are questionable since some difficulty has been encountered with the curve tracer. A more detailed evaluation of these tubes will be made at the next testing period.

Nine bariated-nickel cathode study tubes and eight Typotrons continue to operate on life test satisfactorily.

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PRODUCTION COORDINATION OFFICE

(Group 66, B. E. Morriss)

PCWER (J. J. Gano)

Memo 6M-4029 "Drift Studies - XD-1 DC Power Supplies," Coffin, reports on the investigation of the excessive drift (as high as 8%) on the output voltage of these supplies. On some of the supplies, the variations are due to poor load regulation, and on others they originate within the supply, possibly due to drifting of germanium diodes or magnetic amplifiers. The use of one major feedback loop instead of several parallel minor loops would have been more effective in minimizing drift. IBM has been requested to investigate the production supplies which have a different design.

Coffin is investigating design revisions in the control sections, not only because of drift but because of low reliability. A test using a quickly-contrived push-pull vacuum tube amplifier indicates that regulation can be considerably improved. Revised magnetic amplifier circuits as well as transistor circuits will be investigated.

We have received IBM's "XD-1 Systems Test Procedures for Power Equipment" with minor modifications we suggested. Piantoni is determining specific tests to be conducted for acceptance.

MTC (R. C. Jahn)

Jahn has investigated the auxiliary power system necessary to supply the magnetic tape adapter and tape drive frames. Rather than install an entire new set of voltage units, because of the non-standard voltage, it is recommended that bleeder voltage dividers or small rectifier units, superimposed on the present supplies, be used because of higher reliability and economy.

TX-0 (J. D. Clarke)

Clark is designing a vacuum tube regulator for the amplidyne to be used as the variable voltage source in the marginal-checking system.

OPERATIONS: (H. J. Kirshner)

Coordination in release of Operational Specifications by T.I.R. is proceeding slowly, due primarily to the length of the specifications and the careful checking of technical content by those reviewing the specifications. The first T.I.R. will probably be issued during the coming biweekly period.

A T.I.R. covering the recently issued ADES Direction Center communications plans will be issued during the coming biweekly period.

A T.I.R. covering 6M-3975, Functions and Responsibilities of the C

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OPERATIONS (continued)

and E Duty Officer, is being coordinated.

Indications are that additional magnetic tape units for XD-1 may not be available until June or July 1956.

COMMUNICATIONS (F. E. Irish)

Installation checkout tests prepared by Carlin and Doyle of the Communications Test Team are being reviewed by members of the team.

Permission has been granted by Hq. ADC for installation of Experimental Subsector circuits on TT-2. The question of compatibility between Air Force and Telephone Co. equipment has not yet been resolved.

Permission has not yet been granted by the CAA for installation of circuits at the New York and Boston ARTCC's. A meeting between CAA and Lincoln will be held (probably at Washington) to resolve this problem.

FACILITIES AND EQUIPMENT (W. H. Ayer)

The Bell Telephone Laboratories' test equipment list for WE-ADES guidance in preparing their SAGE subsystem acceptance tests has been reviewed by Lincoln and released on T.I.R. #1-115. A request for contractual coverage and an Engineering Change Proposal for three Long Range Radar Input Monitors for XD-1 has also been issued on T.I.R. #1-113. In addition, a new Master Reference List with changes in the Combat Center lighting and the Sector Command Post was released by T.I.R. #1-111. As with all other T.I.R.'s, these items will now enter our regular follow-up procedure to make sure they do not fall by the wayside.

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ADMINISTRATION AND SERVICES

(Group 60, J. C. Proctor)

PERSONNEL

F. E. Vinal has terminated his employment with Lincoln and is now working with R.C.A. on ferrites.

ENGINEERING (A. R. Smith)Kelvin & Hughes

Packaging design of the power supply and associate equipment is slowing down slightly; our problem being one of getting data to complete design from equipment that is in use. The revised estimate is now two more weeks before fabrication can begin.

Memory Plane Testing

Redesign of the mat and test jig is complete and 12 units are in process of fabrication. The redesign minimizes the previous difficulties experienced in removing a defective core from a completed assembly. Now it is possible to test and detect inferior cores in the matrix, remove the same, all prior to the assembly of the mat to the frame which is the final assembly step before storage or installation.

Status Boards XD-1

Tests have been performed which indicate that a dimmable daylight may be acceptable. We have used a Variac-controlled slim-line white lamp that produces no obvious light in the plexiglass board, yet illuminates four different colors. Dick Mitchell of Group 38 has viewed these tests conducted in the command post and was pleased with the results.

TEST EQUIPMENT COMMITTEE (L. Sutro)

For the first time in more than a year the committee has accepted a new piece of standard test equipment. This is the 15-volt, 1-ampere power supply designed by R. Hughes with output variable from 1.3 to 15 volts. The rectifiers are silicon diodes. The series regulators are six 2N57 or 2N141 transistors. The feedback amplifier employs a 2N43, a 2N95 and an H2 transistor. Ripple voltage is less than 0.005 volt, voltage regulation 0.3%.

The committee has approved purchase of a Simpson Model 269 Multimeter for S. Coffin and a Leeds and Northrup Model 9835A DC indicating amplifier for D. Buck.

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STUDIES IN PROCESS

<u>Study</u>	<u>Responsibility of</u>
<u>GROUP 61</u>	
Digital Data Display Program Specs	H. Briscoe
In-Out Program Specs	A. Shoolman, A. Ginsberg
Radar Input OPS Specs	F. Brooks
Situation Display Program	A. Schwartz
Switch Interpretation	R. Olsen
Table Storage Requirements	L. B. Collins
Track Scan	F. Ogg, P. Strait
XD-1 Inactivity Alarm Proposal	M. Feldstein, P. Vance
XD-1 Startover Program OPS Specs	P. R. Vance
Lectures, AD Programming Course	A. R. Shoolman
OPS Specifications	A. R. Shoolman
<u>Mathematical Specifications</u>	
Antiaircraft	J, J. Cahill
Intercept Direction	6M-3982, first draft to be issued 5 Dec 55
Weapons Assignment	2nd rough draft) expected week " " " ) of 5 Dec 55
Raid Forming	6M-3973 (Dan Ladd), final issue expected week of 5 Dec 55
<u>Operational Specifications</u>	
Weapons Assignment	6M-3744-1, Corr.) rough drafts
Intercept Direction	6M-3786-1, Corr.) ready 5 Dec 55
Interim Antiaircraft	6M-3739-1, Corr 1 comments on 1st draft recd. 2nd draft to be issued next period.
<u>Combat Center</u>	
Guide to CC Operation	W. Lone
	rough draft ready 12 Dec 55
<u>ESS Planning (over-all)</u>	
Task inventory	C. Grandy
Test program requirements	T. Callahan
Operating procedure requirements	R. Lusher
	A. Thomas
<u>Staff Training</u>	
AD Indoctrination Lectures	A. P. Hill
Data Analysis	J. Slagle

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STUDIES IN PROCESS (continued)

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GROUP 62

Memory Test Computer	W. A. Hosier
Card and Symbolic Address Assy.	B. G. Farley
Flight Test Analysis (for Grp 22)	G. Harris, C. Uskavitch
Pattern Recognition (for Grp 24, 34)	G. Dineen, O. Selfridge et al
Simulation (for Grp 22)	H. Neumann, B. Stahl et al
New Control Design, MTC	E. Gates, H. Ziegler
High-Speed Punch Installation, MTC	A. D. Hughes

Return-to-base Air Navigational Systems C. Corderman

GROUP 63

<u>New Components and Circuits</u>	E. U. Cohler
Emitter-Follower-Coupled Flip-Flops (Philco subcontract)	
Silicon Diode Avalanche Noise	
$\alpha$ vs Emitter Current in Transistors	
Hole Storage in SBT's	

GROUP 66

Power Generation, CC-DC Installation	J. J. Gano
Filament Cycling, Thermistor Application	G. F. Sandy
XD-1 Power System Debugging	G. L. Piantoni
TX-O Power System Design	J. D. Clarke
Memo on Air Conditioning System, WWI	R. C. Jahn

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GLOSSARY

AA	antiaircraft
AAOC	AA Operation Center
AD	Air Defense
ADC	AD Command
ADES	AD Engineering Service
AEW	Airborn Early Warning
AF	Air Force
AFB	AF Base
AFCRC	AF Cambridge Research Center
AFIRO	AF Installation Requirements Office
AGC	automatic gain control
AMC	Air Materiel Command
ARDC	Air Research and Development Command
ASC	Air Situation Coordinator
ASO	Air Surveillance Officer
ASR	automatic send-receive
AST	Air Surveillance Technician
ATC	Air Training Command
ATCF	ATC Facility
BTL	Bell Telephone Laboratories
BSO	Battle Simulation Officer
CAA	Civil Aeronautics Administration
CBS	Columbia Broadcasting System
CC	combat center
CCDC	Cape Cod Direction Center
CDC	call direction code
CAT	category
CCS	Cape Cod System
CER	change evaluation request
CHT	Charactron tube
CP	Command Post
CPO	command pulse output
CRT	cathode ray tube
C&E	communications and electronics
DAB	display assignment bit
DC	direction center
DD	digital display
DDG	DD generator
DDR	digital data receiver
DDT	digital data transmitter

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EADF	Eastern Air Defense Force
ECM	electronic counter measure
ECP	engineering change procedure
EMAR	experimental memory address
EPSCOM	Equipment Program Services Committee
ESS	experimental SAGE subsector
FF	flip-flop
FGD	fine grain data
FM	frequency modulation
FORX	FGD orientation with Raydist and calibrated Mark X
G/A	ground to air
GFI	gap filler input
GSR	group selection register
HEC	Hazeltine Electronics Corp.
IBM	International Business Machines Corp.
INS	interceptor simulator
IRE	Institute of Radio Engineers
JETEC	Joint Electron Tube Engineering Council
KSR	keyboard send-receive
LPO	Lincoln Project Office
LRI	long-range radar input
LTFS	Lincoln Tube Process Specification
MAR	memory address register
MEL	minimum equipment list
M-G	motor-generator
MIL	Military
MISP	Manned Interceptor Simulation Program
MITE	multiple input terminal equipment
MTC	Memory Test Computer
NAS	Naval Air Station
NET&T	New England Telephone and Telegraph Co.
NRL	Naval Research Office
OB	output buffer
OPS	operations
OT	Overlap Technician

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PCO	Production Coordination Office
PIUMP	plug-in unit mounting panel
PPI	planned position indicator
PRF	pulse repetition frequency
PT	Plotting Technician
RAFD	Rome Air Force Depot
RAND	Research and Development Corp.
RC	register containing
RD	radar data
ROTR	receive-only typing reperforator
S&EC	Scientific and Engineering Computation
SAGE	Semiautomatic Ground Environment
SBT	surface barrier transistor
SAR	storage address register
SD	situation display
SDG	SD generator
SDV	slowed down video
SIF	selective identification feature
SC	Signal Corps
SCEL	SC Engineering Laboratory
SOP	standing operating procedure
SO	Systems Office
STP	System Training Program
TBS	training and battle simulation
TD	track data
TIR	Technical Information Release
TT	Texas Tower
UHF	ultra high frequency
VHF	very high frequency
WE	Western Electric Co.
WISE	Whirlwind I SAGE Evaluation
WWI	Whirlwind I
XT	crosstell

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(Frances Christopher)

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<b>ADMINISTRATION &amp; SERVICES (Group 60)</b>			
4014	Div. 6 Staff	Biweekly Report for 18 November 1955	C
<b>SAGE SYSTEM TEST &amp; PLANNING (Group 61)</b>			
3922	H. D. Benington	Number of XD-1 Tape Units Required by Group 61	C
3964	P. R. Bagley	The Program Input Process: A Manual on the Use of the Lincoln Compiler and Read-in Programs	U
3986	Gr. 61 Sage T. O.	Results of Survey of XD-1 Operator Requirements	S
4002	H. D. Benington	XD-1 Time and Equipment Required by Group 61 5 Dec. 1955-2 April 1956	U
4003	D. L. Bailey A. R. Shoolman	Description of Coding Specifications for an Individual Program Which is Part of a System Program	U
4004	H. D. Benington	Unified Coding Specifications for the Sage Programming Effort	U
4006	R. R. Reed	Proposal for Change to 6M-3728 "Category and Display Assignment for Sage Situation Display Consoles".	C
4015	A. Heineck	Minutes of a Meeting on the Standby Computer Activity	C
4018	W. F. Harris	Preparation of Coding Specifications for the Direction Center Active (DCA) Program	U
<b>FSQ-7 PROTOTYPE DESIGN &amp; INSTALLATION (Group 62)</b>			
3629	A. D. Hughes	Study of Probability of Storage for IRI	C
3958	L. L. Sutro	Test Equipment Committee Meeting of 14 October 1955	U
3971	H. E. Ziemann	Component Circuits for Digital-to-Analog Decoders	U
3974	B. G. Farley	Proposed MTC In-Out Block Transfer	U
3978	F. R. Durgin	Auxiliary Data Processing Equipment	U
4000	J. Giordano	Minutes of the Experimental Sage Sub-sector Planning Approval Committee Meeting 14 November 1955	C

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4016	J. Giordano	Minutes of the ESS Planning Approval Committee Meeting of 21 October 55	C
4016 C#1	J. Giordano	Same title	U
4017	R. Callahan L. L. Sutro	Specifications for Utilizing the Kelvin & Hughes Rapid Processing Photographic Projector System in the XD-1 Command Post	U
PRODUCTION AN/FSQ-7 & CAPE COD DIRECTION CENTER (Group 64)			
3975	C. W. Watt	Functions and Responsibilities of the C & E Duty Officer in the Sage System	U
VACUUM TUBES (Group 65)			
3895	D. Lynch J. Palermo	Surface Processing of Vacuum Tube Components	U
PRODUCTION COORDINATION OFFICE (Group 66)			
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3198-2	E. L. Smiley	Master Reference List, Lincoln Laboratory Requirements for Combined Direction Center - Combat Center Buildings	U
3946	Jackson & Moreland per J. J. Gano	Transient Analysis of Direction Center Power Supply Without Motor-Generator Sets	U
3947	S. T. Coffin	Effect of Power Transients on Computer Reliability	U
3988	E. L. Smiley	Notes on Air Conditioning Responsibilities Meeting at WE-ADES on November 1, 1955	U
3998	E. D. Lundberg	Sage System Meeting 14 November 55	C
4011	E. D. Lundberg	Sage System Meeting 21 November 55	C
4023	E. D. Lundberg	Sage System Meeting 28 November 55	C
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4012	A. Wright	Cape Cod System Weekly Operations Schedule	U
4025	A. Wright	Cape Cod System Weekly Operations Schedule	U
5058	J. Uskavitch	Air Traffic Observed by Gap-Filler	C
5084	M. Curran	Test Specification: Intercept Track- ing Accuracy Test Maneuvering Courses	C

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858	P. Cutler	D-C Biasing of Filament Voltage	U
859	H. L. Kurkjian	XD-1 System Testing for Acceptance Phase I	U
860	H. Hayden	Marginal Checking Breakdowns by	
	M. Kupris	Equipment Group for AN/FSQ-7 (XD-2)	U
861	-----	Progress Report AN/FSQ-7 & AN/FSQ-8	C
862	W. A. Jackson	Project High Engineering Report -- Card Assembly Report (Duplex Special Circuits)	U
863	-----	Central Reference Room Bulletin #105	U
864	-----	Theory of Programming	C
865	-----	Display System -- Theory of Operation	C
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867	-----	Theory of Operation AN/FSQ-7 (XD-1, XD-2) Combat Direction Central Input System	C
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873	-----	Maintenance -- AN/FSQ-7 (XD-1, XD-2) Combat Direction Central -- Input System	C
874	-----	Theory of Operation AN/FSQ-7 (XD-1, XD-2) Combat Direction Central -- Central Computer System	U
875	-----	Theory of Operation AN/FSQ-7 (XD-1, XD-2) Combat Direction Central Drum System	U
876	-----	Theory of Operation AN/FSQ-7 (XD-1, XD-2) Combat Direction Central -- Power Supply and Marginal Checking System	U
877	-----	Maintenance -- AN/FSQ-7 (XD-1, XD-2) Combat Direction Central -- Drum System	U
878	-----	Maintenance -- AN/FSQ-7 (XD-1, XD-2) Combat Direction Central -- Central Computer System Vol. 1	U
879	-----	Maintenance -- AN/FSQ-7 (XD-1, XD-2) Combat Direction Central -- Central Computer System Vol. 2	U

LL-DR DOCUMENTS ISSUED

519	R. C. Marden	Concurrence on Master Reference List of Equipment Specifications for XD-1. P-228-1	U
520	R. C. Marden	Concurrence on Proposal for the Add- ition of Switches to the Maintenance Console of XD-1. P-240	U
521	P. Longo	Proposal for the Adding of Switches to the Maintenance Console of XD-1 and XD-2 P-240	U

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DOCUMENTS ISSUED  
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NO.	AUTHOR	TITLE	CLS.
LL-DR Documents Issued (Continued)			
522	P. Longo	Proposal for the Addition of two More Tape Drive Units to XD-1 P-234	U
523	P. Longo	Proposal for Placing the Spare Amplidyne of XD-1 in a Standby Status P-235	U
524	N. H. Decker	Proposed Expansion of the Marginal Check System for the Tape Element P-222	U
525	L. V. Ruffino	Addition to Duplex Input MCD Specifications. D-62-2	U
526	P. Longo	Concurrence on P-233 entitled "LR Monitor Consoles for XD-1".	U
527	BTL Memo	Test Equipment List for Sage Sub-Systems	U
528	L. V. Ruffino	Supplement to Maintenance Furniture & Miscellaneous Non-Expendable Items for Duplex Central D-89-1	U
529	H. VanAllen	Specifications for Signal Capabilities of "See All Display" Patchboard Units D-68-1	U
530	W. Squire	Concurrence on Signal Capabilities of "See All Display" Patchboard Unit Specifications D-68-1	U
531	W. Squire	Addition to Duplex Input MCD Specifications. D-62-2	U
532	H. Van Allen	Display Console Specifications for AN/FSQ-7. D-25-6	U
533	W. Squire	Concurrence on Changes to the Display Console Specifications for AN/FSQ-7. D-25-6	U
534	H. Van Allen	AN/FSQ-7 Auxiliary Console Specifications. D-65-9	U
535	W. Squire	Concurrence on Changes to the AN/FSQ-7 Auxiliary Console Specifications D-65-9	U
536	R. J. Paddock	Proposal for Concurrence on IRI Parity Rate Counter, P-229-1	U