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MSBLS-GS

MICROWAVE SCANNING BEAM LANDING SYSTEM - GROUND STATION

AIL Project A980

PERFORMANCE TEST REPORT

VOLUME I EXECUTIVE SUMMARY

DRL LINE ITEM NO. 006

DRD NO. SE-257TA

(ENGINEERING REPORT AND TECHNICAL DATA)

20 AUGUST 1977

Prepared for:

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INTRODUCTION

The MSBLS-GS Performance Test Report consists of five volumes as follows:

I Executive Summary
II Performance Test Plan and Procedure
III Test Data Evaluation
IV Test Data
V Reliability, QA and Human Factors Engineering

This volume summarizes the test results and presents conclusions and recommendations.

The MSBLS-GS performance tests were performed utilizing MSBLS-GS serial #001 on runway 17 (Lakebed) at DFRC from July 1976 through January 1977. The tests are described in the following key documents.

MSBLS-GS Performance Test Plan
AIL Document #5-3796 (7 Jan 76)
Performance Testing Implementation Plan
KSC Document #TR1423 (June 76)
Performance Test Procedure for MSBLS-GS
AIL Document #504024 (Rev A

Paragraph 7.0 of the Performance Test Plan outlines the Final Report as follows:

Performance Test Procedure
Test Preparation Sheets
Test Data
Reliability and Maintainability Data
Quality Control Data
Test Data Evaluation
Conclusions
Recommendations

2.0 SCOPE

This final executive summary presents conclusions and recommendations based on data evaluation as developed to date and detailed in Engineering Test Summary Reports (ETSR's).

This report as an executive summary does not provide detail information, e.g. procedures and data. Such items will be found in the basic report.

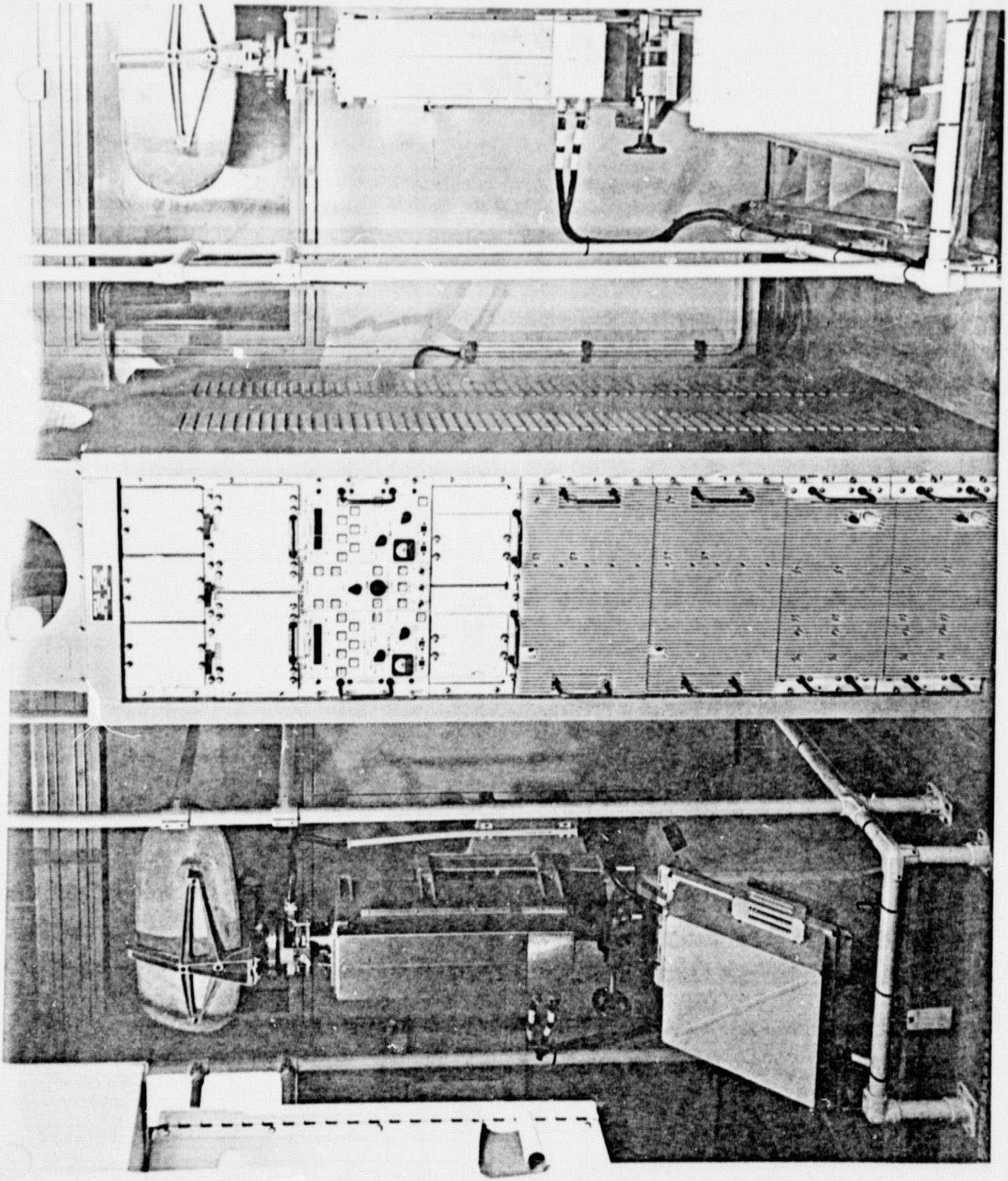
3.0 BACKGROUND INFORMATION

The MSBLS-GS is a redundant system consisting of an Azimuth/DME station (Figure 1) and a Elevation station (Figure 2). The performance tests were run on the lakebed (Runway 17L) at DFRC with the stations 12,950 feet apart on the east side of the runway (Figure 3). Figure 4 shows an aerial view of the approach to the runway while figures 5 and 6 are aerial views of the Elevation and Azimuth/DME stations respectively. System performance was measured utilizing a Precision Laser Tracking System, PLTS, (Figure 7) located 4,000 feet opposite the elevation station as a reference standard. The PLTS tracked the test aircraft (Figure 9) which was outfitted with a retroreflector while the MSBLS-GS position data was recorded on the aircraft (Figure 8) using a Shuttle Nav Set. The resulting positional data of the two systems were compared using specially developed computer programs.

4.0 PERFORMANCE TESTS

The Ground System performance test objectives were:

- Verify performance and compatibility of MSBLS Navset and Ground Station in a realistic dynamic environment
- Determine multipath and siting effects
- Verify monitoring, switchover and shutdown criteria



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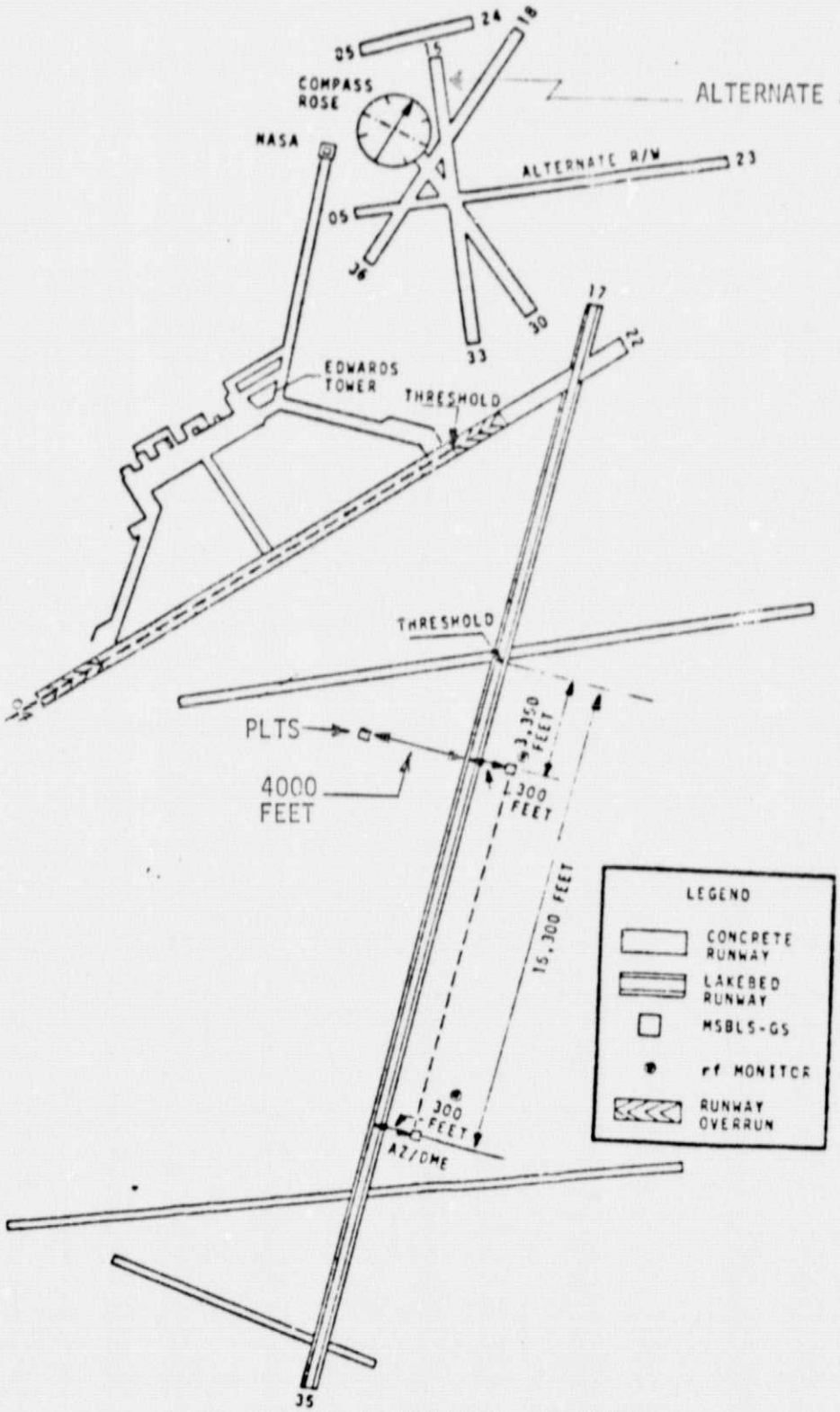
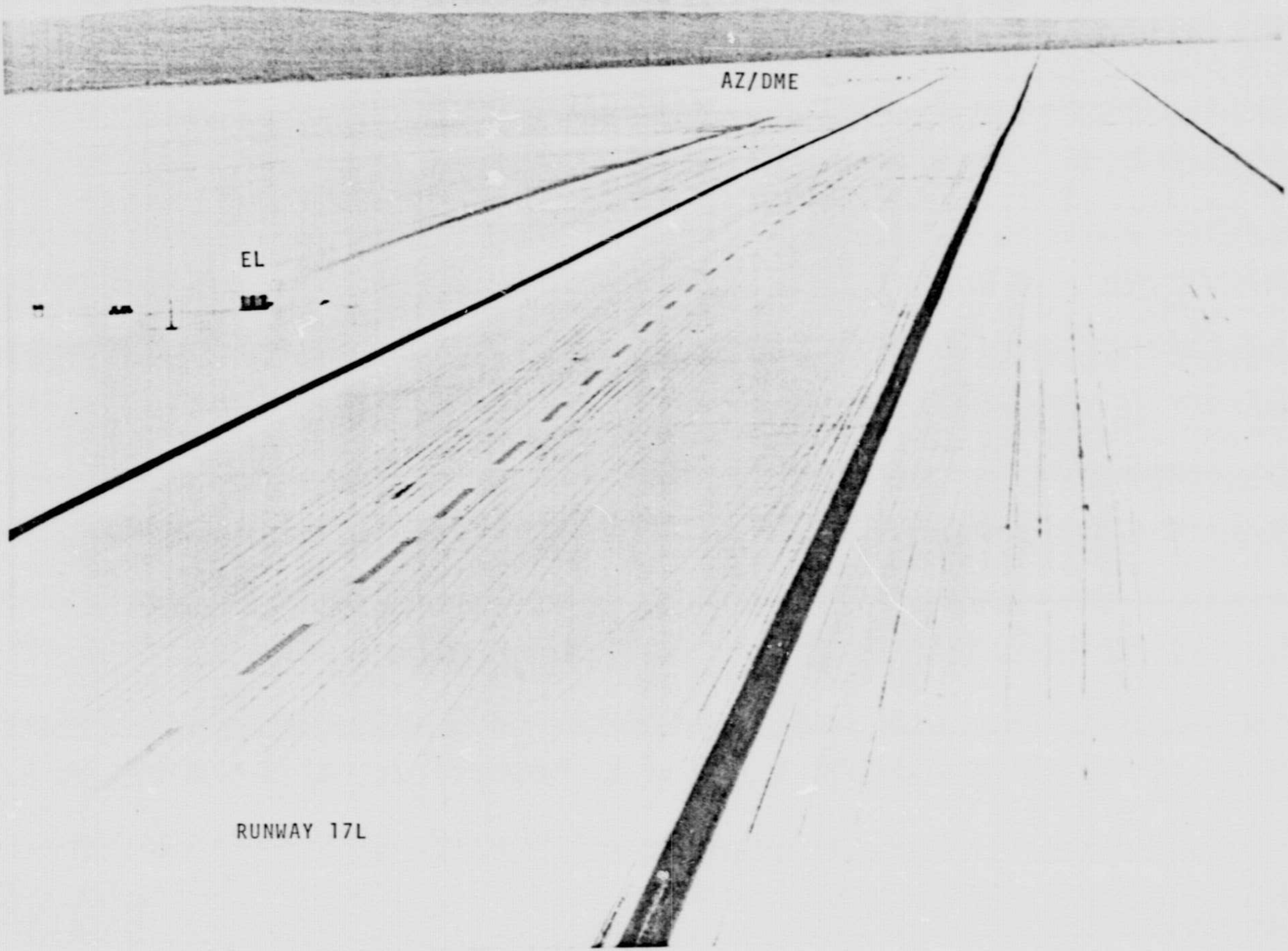


INSTRUMENTATION LOCATION AT EAFB

FIGURE 3



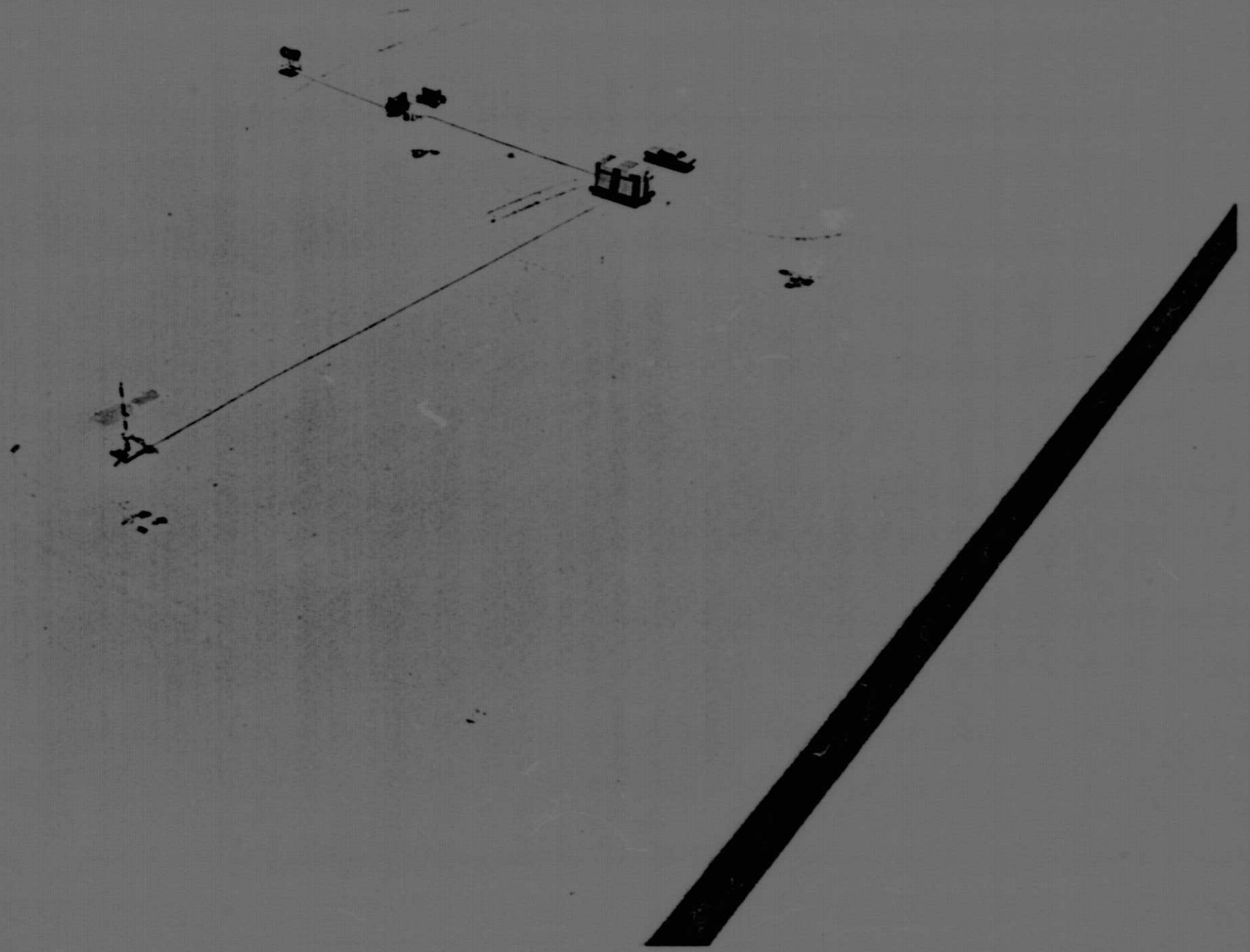


FIGURE 5 - AERIAL VIEW OF ELEVATION STATION

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FIGURE 7 - PRECISION LASER TRACKING SYSTEM (PLTS)

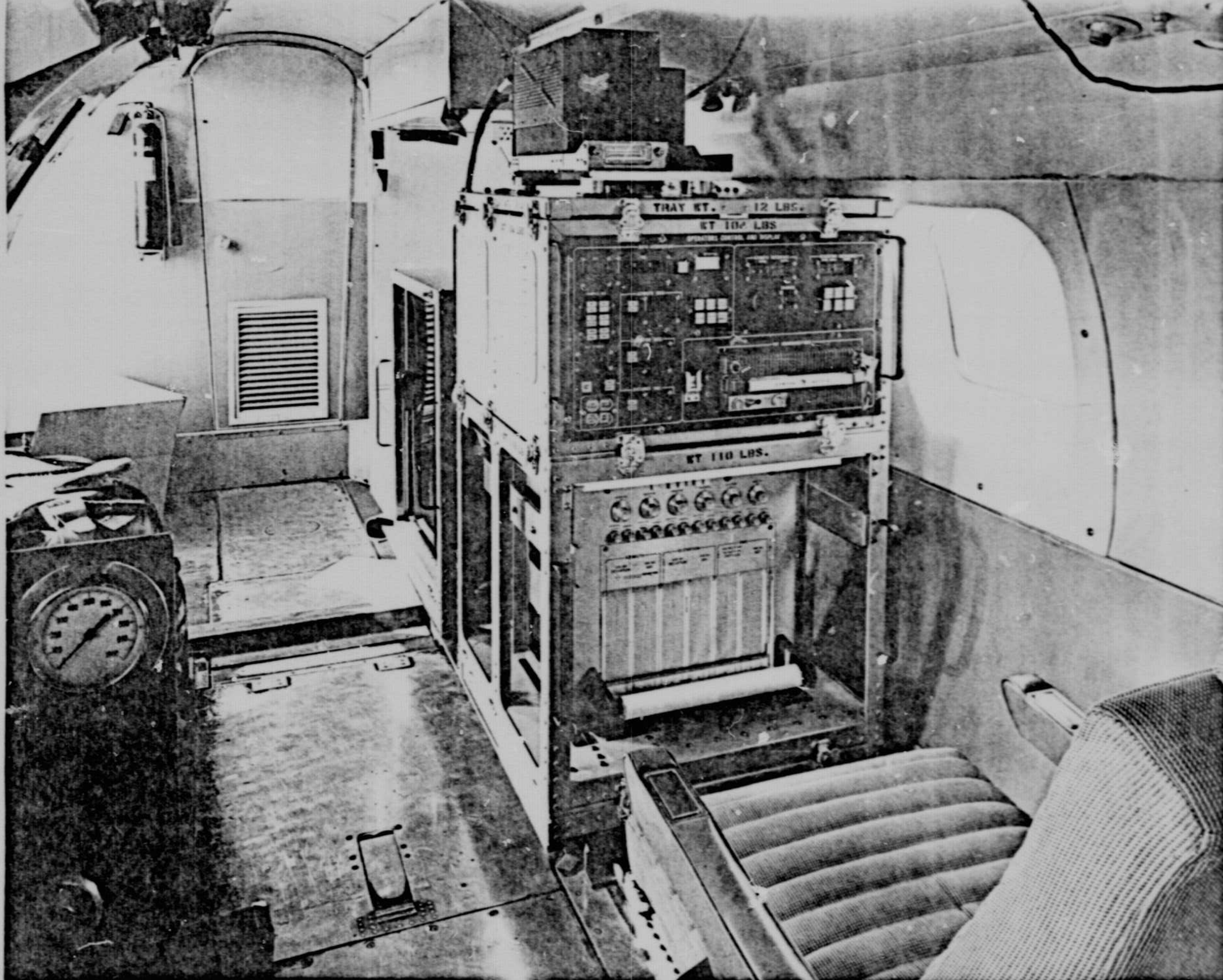

FIGURE 8 - MSBLS-GS RECORDING EQUIPMENT

FIGURE 9 - JETSTAR AIRCRAFT USED FOR FLIGHT TESTS

- o Verify setup alignment, checkout, and maintenance procedures
- o Obtain test results early enough to correct problems before ALT
- o Obtain data base for ALT and possible future anomalies.

The Performance Tests were conducted in accordance with the approved Performance Test Procedure (AIL document #504024). The tests are grouped into Ground Probe Tests (section 4.1), Field Monitor Tests (section 4.2), Flight Tests (section 4.3) including test with 2 Nav Sets, and Temperature Tests (section 4.4). Table I presents a listing of the tests and the dates performed. Day numbers, e.g. DAY 252, are derived using January 1, 1976 as day number 1.

After the completion of ground probe testing, seasonal rains at EAFB caused the complete flooding of the runway 17 area. Test operations continued, however, when access to the ground stations became available via the use of an All Terrain Vehicle, and the employment of speical safety procedures for the motor generators.

Three tests were not performed by mutual NASA/AIL agreement. The tests were 4.1.3 Accuracy Data Base, 4.3.6 STA Shuttle Trajectory and 4.4 Temperature Tests. The decisions to delete these tests were based on both practical and technical reasons. The Accuracy Data Base was a ground probe test which required a precisely boresighted system and an accurate ground measurement data collection procedure. It was decided to use available flight test data as a substitute. The Temperature Test was deleted because it was beyond the program requirements and might have overstressed the hardware. In addition, confidence

TAB I

MSBLS-GS PERFORMANCE TESTS EAFB 1976 - S/N 001 PER AIL DOC #504024

TEST NUMBER AND TITLE		DATE(S) PERFORMED
-GROUND PROBE TESTS-		
4.1.1 BORESIGHTING ACCURACY		ELEVATION: 7/29-7/31 '76 AZIMUTH: 8/5-8-7 '76
4.1.2 ANTENNA INTERCHANGEABILITY		QUICK BORESIGHTING TESTS WEEK OF 24 JAN 77
4.1.3 ACCURACY DATA BASE		NOT PERFORMED
4.1.4 VERTICAL LOBING		SEE 4.1.5
4.1.5 LOBING REDUCTION		SCREEN PLACEMENT FLIGHTS: DAY 252, DAY 308
4.1.6 RUNWAY COVERAGE		8/10/76
-FIELD MONITOR TESTS-		
4.2.1 LINK MARGIN		7/9/76
4.2.2 BIAS STABILITY		7/12-7/26 '76
4.2.3 MULTIPATH AND SIGNAL SHADOWING		ELEVATION: 7/15/76 AZIMUTH: 7/19/76
4.2.4 TIME TO ALARM		ELEVATION: 7/19/76 AZIMUTH: 7/16/76
4.2.5 RESPONSES TO TRANSIENT ERRORS		7/21/76
-FLIGHT TESTS -		
4.3.1A RADIAL APPROACH SET	1000 FT PRI	DAY 230, DAY 253, DAY 280, DAY 343
B	1000 FT B/U	DAY 226, DAY 231, DAY 344(2)
C	5000 FT PRI	DAY 337
D	5000 FT B/U	DAY 341(1)
E	10000 FT PRI	DAY 341(2)
F TWO NAVSETS	10000 FT B/U	DAY 342(1)
G	15000 FT PRI	DAY 342(2)
H	15000 FT B/U	DAY 344(1)
J	500 FT PRI	DAY 351
K	500 FT B/U	DAY 352
L	100 FT PRI	DAY 275 PARTIAL DAY 253
M	100 FT B/U	DAY 275
N ORBITAL PATTERNS - PRI & B/U		DAY 288: PRIMARY BACKUP: DAY 322
P CROSSCUT PATTERN PRIMARY		DAY 338(1)
Q CROSSCUT PATTERN BACKUP		DAY 338(2)
4.3.2 ACCURACY AT LOW ELEVATION ANGLES		DAY 345
4.3.3 AGC TRACKING		DAY 323
4.3.4 ACQUISITION AND SWITCHOVER (MANUAL)		DAY 327
4.3.4X ACQUISITION AND SWITCHOVER (AUTO)		DAY 350
4.3.5 RUNWAY OFFSETS AND RUNWAY COVERAGE		DAY 229
4.3.6 STA SHUTTLE TRAJECTORY		STA SUPPORT ACTIVITIES
4.4 TEMPERATURE TESTS		NOT PERFORMED

NOTE: DAY 341(1) REPRESENTS FLIGHT 1 ON DAY 341

DAY 341(2) REPRESENTS FLIGHT 2 ON DAY 341

in the shelter climate control system was developed by its performance during the test program. The STA Shuttle Trajectory was not performed because of a scheduling imcompatability with other STA aircraft usage. This test was not considered critical to performance test evaluation. It would provide engineering information ot both the STA and MSBLS-GS programs and, as such, can be scheduled at some future date.

Performance testing accomplished with and aided by the early delivery of MSBLS-GS Serial No. 001 provided time and experience to refine operating procedures and techniques. Performance testing utilized the same procedures, software and test hardware as are to be used during the commissioning of each MSBLS-GS. Some anomalies discovered, corrected, and carified by Performance Tests were:

1. DME IF noise
2. Beam pulse density error, corrected by encoder and clock change.
3. Signal dropout due to multipath-RF fences installed and verified.
4. Field Monitor RF source redesigned.
5. PLTS east-west tilt calibration required additional target, more frequent calibrations and the installation of a sun shade.
6. Instrumentation Van configuration-design and procedures were modified.
7. Defective radome - discovered and replaced with test procedures changed accordingly.
8. Operating time on system helped wring out design and quality problems.

A number of open items have evolved during the test program. These included anomalies of azimuth slope error which appear at the lateral edges of azimuth coverage due to azimuth antenna flexure, field monitor shadowing effects and an MSBLS-GS Azimuth cross-polarization

attitude-correlated error. Questions concerning the Precision Laser Tracking System (PLTS), i.e., its calibration, software and configuration have developed. The computer software used for data reduction has been updated and revised. All these open items are being worked with the objective of closing them prior to the completion of commissioning.

Engineering Test Summary Reports (ETSR's) have been prepared on each of the Ground Probe tests 4.1.1, 4.1.2, 4.1.4, 4.1.5 and 4.1.6, Field Monitor tests 4.2.1 through 4.2.5, and Flight tests 4.3.2 through 4.3.5. In addition four ETSR's on accuracy, coverage, signal strength, and two Nav Sets cover the data under 4.3.1A through 4.3.1Q. These ETSR's are found in volume III.

A standard data package exists for each flight, and are included in the test data portion of this final report, volume IV.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The objectives of performance testing were fulfilled. The test program demonstrated the readiness of the MSBLS-GS for ALT commissioning. The accuracy of the system has been demonstrated. The site requirements have been established and identified in the Interface Data Document (IDD). Computer software for commissioning is available. Procedures for commissioning and operation have been prepared. Reliability, Quality Control, Human Factors, Configuration Control, and Safety Requirements were satisfied. The open items affect isolated, off-nominal regions and do not significantly impact overall performance.

It is recommended the commissioning of MSBLS-GS system 001 at runway 17 be initiated. In parellel, the open items should be studied further and resolved.