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# FIRST QUARTERLY DATA REPORT FOR THE RELIABILITY AND MAINTAINABILITY EVALUATION OF THE BASIC WIDE MICROWAVE LANDING SYSTEM AT WALLOPS ISLAND, VIRGINIA

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FEDERAL AVIATION ADMINISTRATION

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DATA REPORT

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Technical Report Documentation Page

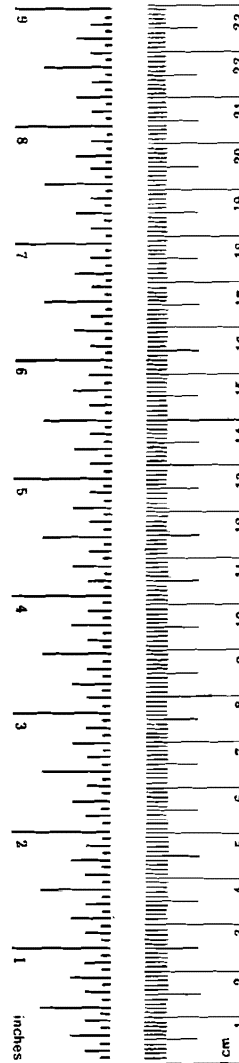
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16. Abstract  This is the first quarterly data report on the reliability and maintainability evaluation of the Basic Wide Microwave Landing System located at Wallops Island, Virginia. Chargeable and nonchargeable failures are defined. Chargeable failures are listed, and calculated reliability values are presented.					
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## METRIC CONVERSION FACTORS

### Approximate Conversions to Metric Measures

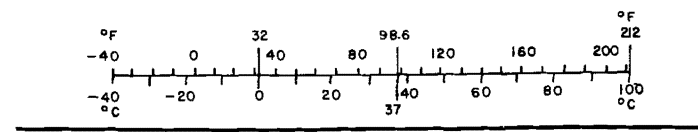
Symbol	When You Know	Multiply by	To Find	Symbol
<b>LENGTH</b>				
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
<b>AREA</b>				
in <sup>2</sup>	square inches	6.5	square centimeters	cm <sup>2</sup>
ft <sup>2</sup>	square feet	0.09	square meters	m <sup>2</sup>
yd <sup>2</sup>	square yards	0.8	square meters	m <sup>2</sup>
mi <sup>2</sup>	square miles	2.6	square kilometers	km <sup>2</sup>
	acres	0.4	hectares	ha
<b>MASS (weight)</b>				
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
<b>VOLUME</b>				
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft <sup>3</sup>	cubic feet	0.03	cubic meters	m <sup>3</sup>
yd <sup>3</sup>	cubic yards	0.76	cubic meters	m <sup>3</sup>
<b>TEMPERATURE (exact)</b>				
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

\*1 in = 2.54 (exact). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price \$2.25, SD Catalog No. C13.10:286.



### Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
<b>LENGTH</b>				
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
<b>AREA</b>				
cm <sup>2</sup>	square centimeters	0.16	square inches	in <sup>2</sup>
m <sup>2</sup>	square meters	1.2	square yards	yd <sup>2</sup>
km <sup>2</sup>	square kilometers	0.4	square miles	mi <sup>2</sup>
ha	hectares (10,000 m <sup>2</sup> )	2.5	acres	
<b>MASS (weight)</b>				
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
<b>VOLUME</b>				
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m <sup>3</sup>	cubic meters	35	cubic feet	ft <sup>3</sup>
m <sup>3</sup>	cubic meters	1.3	cubic yards	yd <sup>3</sup>
<b>TEMPERATURE (exact)</b>				
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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## INTRODUCTION

### PURPOSE.

The purpose of this project is the evaluation of the Microwave Landing System (MLS) Basic Wide System at Wallops Island, Virginia, to determine the operational subsystem and system mean times between failures (MTBF) and mean times to repair (MTTR). Failure rates will be calculated. The calculated values will be compared with the contractor's predicted values. Reliability and maintainability weak points or problem areas will be determined. This data report documents the evaluation data between the dates of May 21 and July 31, 1980.

### BACKGROUND.

A reliability and maintainability project No. 075-725-490, titled "Reliability and Maintainability of Basic Wide MLS at Wallops Island (NASA)," was established at the Federal Aviation Administration (FAA) Technical Center in May 1980 under the Landing Systems Technical Program Document No. 07-115. Reliability Engineering Section (ACT-152) personnel were assigned to support the effort under the technical administrative direction of the program manager (ACT-100E).

After the project manager met with representatives of the program's sponsor from the Landing Systems Branch (ARD-320) in early May 1980 and by mutual agreement with him, the ACT-152 test plan (report No. FAA-CT-80-187) was completed. On May 20, 1980, the FAA Technical Center project manager visited Wallops Island, Virginia, and discussed the required data collection with the site technical personnel (Bendix Company). Data collecting began on May 21, 1980, for the MLS and the Precision Distance Measuring Equipment (PDME) System at the site. The site data collection is continuing.

## DISCUSSION.

Failure and maintenance data as well as changes in operational status have been entered on a standard log form (Facility Maintenance Log, FAA form 6030-1) by the site technical personnel. This information includes a complete and comprehensive history of every hardware failure regardless of whether or not such failure resulted in a degradation of system performance.

This information has been reported on a 2-week basis and supplied by the site technical personnel to ARD-320 which, in turn, provided copies to ACT-152. ACT-152 processed and analyzed the data from May 21 through July 31, 1980. The preliminary data are presented in this report with a preliminary analysis for ARD-320.

The criteria for chargeability are as follows:

1. The failure is independent; that is, it did not occur as a result of a related failure or hardware modification.
2. The failure causes a loss or degradation of performance beyond specified or acceptable limits of the equipment unit (reliability element) in which it occurred.
3. The failure requires actual maintenance effort to correct rather than being a transient outage which can be reset or master-cleared.

Each failure was analyzed independently and included coordination with the site maintenance personnel to resolve questions of chargeability, actual maintenance time expended, and any other questions concerning the failure that arose during the course of this preliminary analysis. At the element and enclosure level all failures which met the above chargeable criteria were used in the data calculations. In

computing subsystem and system values, because of equipment designed graceful degradation, the Bendix Corporation's reliability model definition of chargeable failures is utilized.

The failure rates ( $\lambda$ ), MTBF's, and MTRR's for the analyses were determined by finding the total uptime (U), the total number of chargeable failures (N), and the total corrective maintenance or repair time (C) for each subsystem or system. The values U and C are expressed in terms of subsystem hours. An exponential (constant failure rate) statistical distribution was assumed for the failure and repair rates. The following formulas were used for each subsystem:

$$\lambda = \frac{N \times (10)^6}{U} \text{ failures per million hours}$$
$$\text{MTBF} = \frac{U}{N} \text{ hours}$$
$$\text{MTRR} = \frac{C}{N} \text{ hours}$$

The chargeable failure test data are shown in tables 1 through 4, progressing downward from system level in table 1 through the equipment level in table 4. Appendix A is a chargeable failures list including the date, definition, and explanation.

Failures occurred which did not meet all the criteria for being counted as chargeable failures. All of these caused the subsystem or system to not transmit. The azimuth subsystem had 5, and the elevation subsystem had 13

nonchargeable failures. The PDME system had no nonchargeable failures. Most of the downtimes of the respective subsystems were related to these nonchargeable failures. Most of the chargeable and nonchargeable combined downtime amounts were attributed to the technician's not being on duty (nights or weekends).

The air-conditioners' performance was included for consideration in the preliminary data analysis since the MLS and PDME are in field operation and environmentally controlled by these air-conditioners. No special air-conditioner input power or local environment temperature and humidity sensing and recording exist with this system. This precludes the possibility of any time-related data recording on these units during the test period. No recording of these important factors is expected for the test period. Only the air-conditioners' number of chargeable failures can be and is reported.

There were four main base power outages varying in duration from 0.25 hour to 1.17 hours. The total time lost because of this problem was 2.17 hours. The total MLS azimuth subsystem downtime attributed to preventive maintenance was 4.17 hours during this reporting period. The MLS elevation subsystem had 3.25 hours of downtime due to preventive maintenance and an additional 3.25 hours of downtime due exclusively to the preventive maintenance on the MLS azimuth subsystem. No preventive maintenance was done on the PDME system.

TABLE 1. MLS AND PDME SYSTEMS FAILURES AND MAINTENANCE (MAY 21 TO JULY 31, 1980)

<u>Item No.</u>	<u>System</u>	<u>Total Uptime (Hours)*</u>	<u>No. of Chargeable Failures</u>	<u>Total Repair Time (Hours)</u>	<u>Failure Rate (Per Million Hours)</u>	<u>MTBF (Hours)</u>	<u>MTRR (Hours)</u>
1	MLS (azimuth and elevation)	1,451.54	3	9.33	2,066.77	483.85	3.11
2	MLS (azimuth only)	1,646.41	2	8.58	1,214.76	823.21	4.29
3	PDME	1,486.58	1	12.5	672.68	1,486.58	12.5

\*The test data do not include accurate downtime or accurate repair time for the air-conditioners in the operational systems. Thus, the air-conditioner units' test data are not included in this table.

3

TABLE 2. MLS SUBSYSTEMS FAILURES AND MAINTENANCE (MAY 21 TO JULY 31, 1980)

<u>Item No.</u>	<u>Subsystem</u>	<u>Total Uptime (Hours)*</u>	<u>No. of Chargeable Failures</u>	<u>Total Repair Time (Hours)</u>	<u>Failure Rate (Per Million Hours)</u>	<u>MTBF (Hours)</u>	<u>MTRR (Hours)</u>
1	Azimuth	1,646.41	2	8.58	1,214.76	823.21	4.29
2	Elevation	1,451.54	1	0.75	688.92	1,451.54	0.75

\*The test data do not include accurate downtime or accurate repair time for the air-conditioners in the subsystems. Thus, the air-conditioner units' test data are not included in this table.

TABLE 3. MLS SUBSYSTEMS' ENCLOSURES, FAILURES, AND MAINTENANCE (MAY 21 TO JULY 31, 1980)

<u>Item No.</u>	<u>Enclosure</u>	<u>Total Uptime (Hours)*</u>	<u>No. of Chargeable Failures</u>	<u>Total Repair Time (Hours)</u>	<u>Failure Rate (Per Million Hours)</u>	<u>MTBF (Hours)</u>	<u>MTRR (Hours)</u>
1	Azimuth antenna enclosure	1,646.41	3	8.08	1,822.15	548.80	2.69
2	Azimuth antenna monitor antenna enclosure	1,646.41	0	--	--	--	--
3	Azimuth shelter	1,646.41	1	1.5	607.38	1,646.41	1.5
4	Elevation antenna enclosure	1,451.54	3	4.25	2,066.77	483.85	1.42
5	Elevation antenna monitor antenna enclosure	1,451.54	0	--	--	--	--
6	Elevation shelter	1,451.54	0	--	--	--	--

\*The test data do not include accurate downtime or accurate repair time for the air-conditioners in the enclosure. Thus, the air-conditioner units' test data are not included in this table.

TABLE 4. MLS AND PDME SYSTEMS UNIT TYPES, FAILURES, AND MAINTENANCE  
(MAY 21 TO JULY 31, 1980)

Item No.	Unit Type	Total Uptime (Hours)	No. of Chargeable Failures	Total Repair Time (Hours)	Failure Rate (Per Million Hours)	MTBF (Hours)	MTRR (Hours)
1	Azimuth antenna enclosure electronics	1,646.41	3	8.08	1,822.15	548.80	2.69
2	Azimuth antenna enclosure air-conditioners (2)	*	1	*	--	--	--
3	Azimuth antenna monitor antenna	1,646.41	0	0	0	--	--
4	Azimuth electronics rack	1,646.41	1	1.5	607.38	1,646.41	1.5
5	Azimuth electronics rack air-conditioner	*	0	0	0	--	--
6	Elevation antenna enclosure electronics	1,451.54	3	4.25	2,066.77	483.85	1.42
7	Elevation antenna enclosure air-conditioner (1)	*	1	*	--	--	--
8	Elevation antenna monitor antenna	1,451.54	0	0	0	--	--
9	Elevation electronics rack	1,451.54	0	0	0	--	--
10	Elevation electronics rack air-conditioner	*	0	0	0	--	--
11	PDME antenna	1,486.58	0	0	0	--	--
12	PDME electronics rack	1,486.58	1	12.5	672.68	1,486.58	12.5
13	PDME electronics rack environmental control, refer to item 5, above	*	0	0	0	--	--

\*The test data (facility logs) do not include accurate downtime or accurate repair time for the air-conditioners in the unit.

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APPENDIX A  
CHARGEABLE FAILURES LIST  
(Related to Table 4)

Table 4 Item No.	Failure Item No.	Failure Date	<u>Failure Description and Correction</u>
<u>1</u>	<u>Azimuth</u>	<u>Antenna</u>	<u>Enclosure Electronics</u>
	1	7/2/80	Self-test error indicator lit on antenna beam steering unit. "Self-test" found position phase shifter +54 bad. Removed serial number 107 and installed serial number 54. No feedback from Bendix as to why the phase shifter went bad. Corrective maintenance time, 0.5 hour.
	2	7/10/80	Self-test error indicator lit on antenna beam steering unit. "Self-test" found position phase shifter +54 bad. Removed serial number 54 and installed serial number 165. No feedback from Bendix as to why the phase shifter went bad. Corrective maintenance time, 0.5 hour.
	3	7/21/80	Beam bias signal seen by site personnel to exceed maximum allowable excursion to trip automatic executive fault action. Executive fault automatic shutdown of site transmission did not occur. Corrective maintenance found the printed circuit board socket for board 1A1A4A6 had two wirewrap terminals shorting. The terminals were separated, and this problem did not recur. Corrective maintenance time, 7.08 hours.
<u>2</u>	<u>Azimuth</u>	<u>Antenna</u>	<u>Enclosure Air-Conditioners</u>
	1	7/14/80	Beam bias signal went into maintenance alert. Air-conditioner number 1 on the right side of the enclosure was found to be frosted over. Turned power to the air-conditioner off, allowing the frost to melt. After a full melting the air-conditioner power was turned on and the beam bias signal was normalized. This situation recurred several times over the next 2 weeks. On 7/28/80, the air-conditioner was removed and serviced off the base by an authorized service company. The anti-icing circuit was found to be miswired. The wiring error was corrected and the air-conditioner reinstalled on 7/31/80. No similar problem has been reported for this air-conditioner as of the date of this report.

<u>3</u>	<u>Azimuth</u>	<u>Antenna</u>	<u>Monitor Antenna</u>
		None	
<u>4</u>	<u>Azimuth</u>	<u>Electronics</u>	<u>Rack</u>
	1	5/29/80	Manifold noise signal went into executive fault. Troubleshooting showed the U4 chip on the WCR printed circuit board (1A1A1A4A32) to be failed. Pulled bad card and replaced it with spare WCR card. Azimuth system transmitting again. Corrective maintenance time, 1.5 hours.
<u>5</u>	<u>Azimuth</u>	<u>Electronics</u>	<u>Rack Air-Conditioner</u>
		None	
<u>6</u>	<u>Elevation</u>	<u>Antenna</u>	<u>Enclosure Electronics</u>
	1 and 2	7/18/80	There had been a previous long term trend of bad phase shifter indications. The offline test showed the phase shifter positions +1 and +7 to be failed. Removed both bad phase shifters. The two bad phase shifters' serial numbers were not recorded in the logs and the numbers are not known at this time. No feedback from Bendix as to why the phase shifters were bad. Corrective maintenance time for both phase shifters was 3.5 hours.
	3	7/23/80	Ident ERP signal went into executive fault. Troubleshooting found the RF selector switch 1A1S1 bad. It was removed and replaced with a spare. The bad one was sent to the manufacturer with bad pin diodes. No feedback from the manufacturer as to why the pin diodes went bad. Corrective maintenance time, 0.75 hour.
<u>7</u>	<u>Elevation</u>	<u>Antenna</u>	<u>Enclosure Air-Conditioner</u>
	1	6/9/80	Power supply failure of +24 V. This power supply and the +15 V and +5 V power supplies are physically under the enclosure air-conditioner coils which eventually were seen to be frosting over with water dripping off (see 6/17/80). On 6/8/80, plastic wrap was placed on top of power supplies to keep dripping water from doing any further power supply damage. On 7/15/80, the air-conditioner anti-icing switch appeared defective. On 7/28/80, the air-conditioner was removed for servicing when the anti-ice switch was adjusted. The air-conditioner was reinstalled 7/31/80. No similar problem has recurred since then. The plastic covering over the power supplies was left in place.

<u>8</u>	<u>Elevation</u>	<u>Antenna</u>	<u>Monitor Antenna</u>
	None		
<u>9</u>	<u>Elevation</u>	<u>Electronics</u>	<u>Rack</u>
	None		
<u>10</u>	<u>Elevation</u>	<u>Electronics</u>	<u>Rack Air-Conditioner</u>
	None		
<u>11</u>	<u>PDME</u>	<u>Antenna</u>	
	None		
<u>12</u>	<u>PDME</u>	<u>Electronics</u>	<u>Rack</u>
	1	6/2-3/80	A light showing low sensitivity on the signal generator in the PDME maintenance monitor light. Troubleshooting showed the 1A2A5A4 board to be misaligned. Site personnel aligned the board in place. No similar recurrence of the problem since then. Corrective maintenance time, 12.5 hours.