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APOLLO 14 LRRR QUALIFICATION  
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## 1.0 INTRODUCTION

This technical memo meets the requirements of CCP 242, Exhibit F-1, Item 28 and supports the QTRR activity of the Laser Ranging Retro Reflector. The report has been arranged to reflect the qualification rationale differences between qualification and flight for Apollo 14, and LRRR qualification test results pertinent to evaluating its readiness for final acceptance:

- a) DIAGRAM "A" represents the qualification rationale for Apollo 11. DIAGRAM "B" represents the qualification rationale for Apollo 14.
- b) TABLE I shows differences between Qual and Flight Models.
- c) TABLE II shows differences between Flight Model and Qual Model Array Assemblies.
- d) TABLE III of Appendix A shows component history, status, and reference documents.
- e) TABLE IV of Appendix B shows the qualification test results.

This report has been finalized to support Flight Model delivery and is part of the Acceptance Data Package.

## 2.0 SUMMARY

Qualification test results show that design objectives for the structural, and deployment parameters have been met. The LRRR Qual Model is now fully qualified.

## 3.0 DISCUSSION

### A. Qualification Rationale

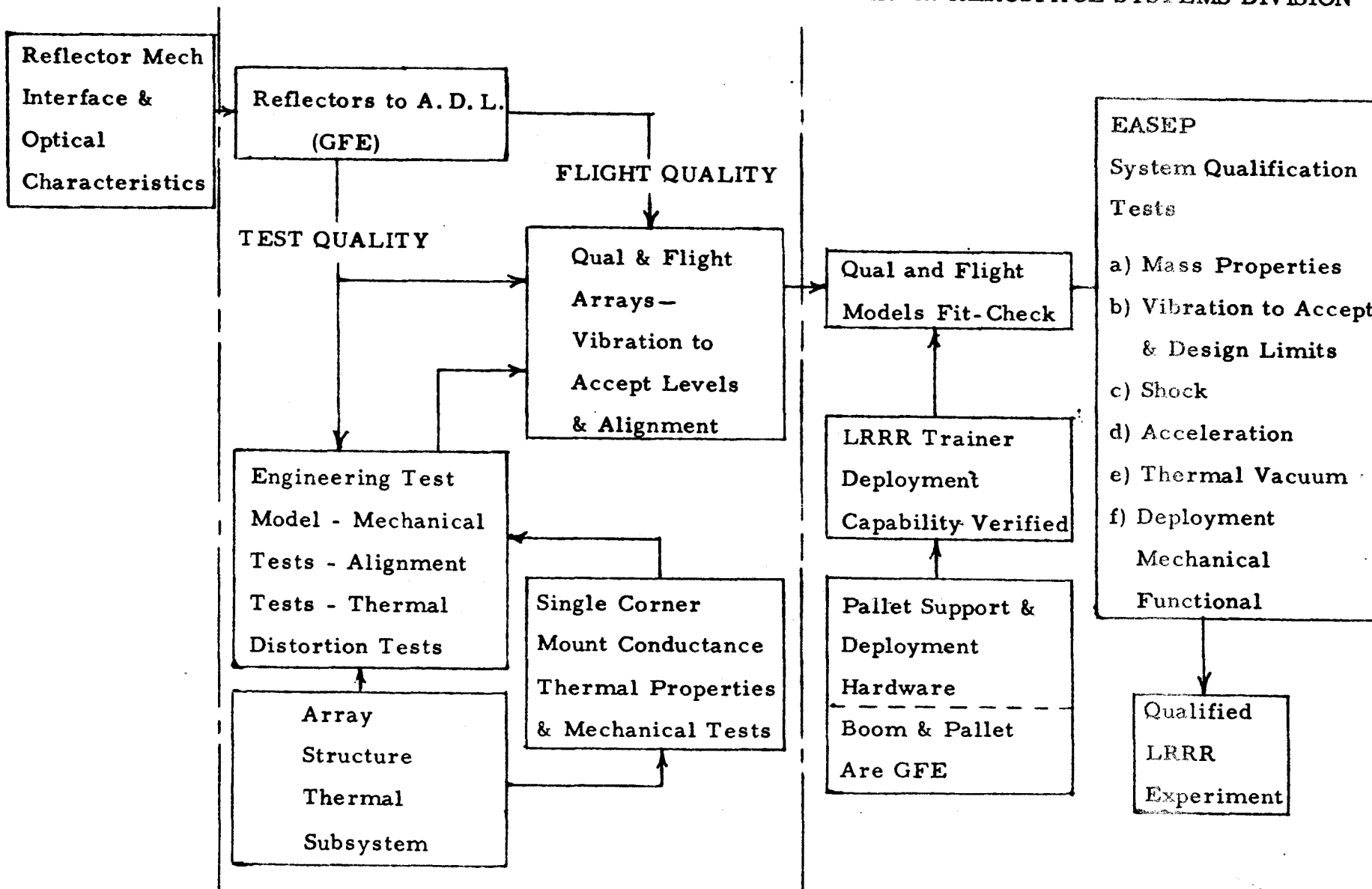
Diagram "A" shows the qualification rationale for Apollo 11 and is reproduced from EATM-57A. It is included here since it is the Apollo 11 Qual Array that was used during Qual testing. The qualification rationale for Apollo 14 is shown in diagram "B". The array for Apollo 14 LRRR is identical to that for Apollo 11 with the following exceptions:

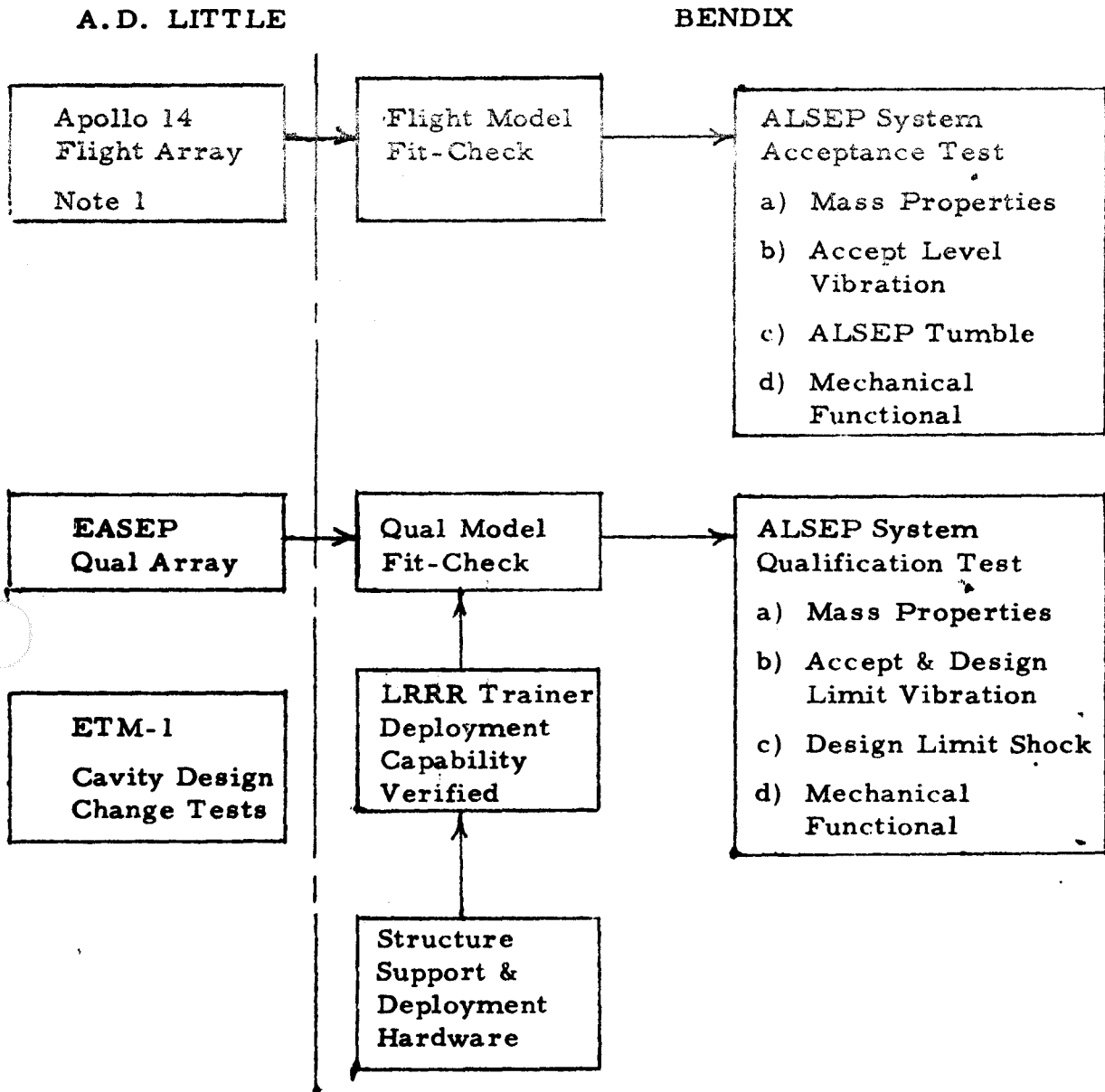
**APOLLO 11 LRRR READINESS QUALIFICATION RATIONALE  
DIAGRAM "A"**

**PERKIN ELMER**

**ARTHUR D. LITTLE**

**BENDIX AEROSPACE SYSTEMS DIVISION**





Note 1 - Flight array was subjected to vibration to acceptance level and alignment tests by A. D. L.

DIAGRAM "B"



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1. The retaining ring inside half-angle has been increased from  $1.5^{\circ}$  to  $6^{\circ}$ .
2. The new retaining rings are secured by rivets rather than by staking.

The CDR Board meeting minutes of 4-30-70 confirmed that these changes do not necessitate requalification of the array. The increased retainer ring angle was incorporated to improve optical performance. The use of riveting has improved the mechanical integrity of the array as demonstrated by tests performed on the engineering test model, ETM-1, by A. D. Little, Inc., under subcontract to Bendix.

**B. Qualification Acceptance Criteria**

The acceptance criteria for LRRR during system qualification was based on:

1. The system meeting mass property requirements per Design and Performance Specification, Exhibit B-1.
2. The system surviving simulated mission environments in vibration and shock.
3. Successful deployment of the array such that proper leveling and alignment may be accomplished.

The tests performed to verify these attributes are outlined in diagram "B." These attributes have been confirmed by test data analysis and visual inspection.

Table I shows a comparison between Flight and Qual Models with specific reference to items which have passed Qualification Tests, and are considered Qualified.



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TABLE I  
COMPARISON OF LRRR FLIGHT AND QUAL CONFIGURATIONS

Item	Major Assembly of Hardware	Flight Model 2345711-501	Qual Model 2345711-502	Notes
1	Structure Assembly	2345727 (SN 3)	2345727 (SN 2)	
2	Bracket, I/F Left Rear	2345714	2345714	
3	Bracket, I/F Right Rear	2345715	2345715	
4	Bracket, I/F Right Fwd.	2345716	2345716	
5	Bracket, I/F Left Fwd.	2345717	2345717	
6	Bracket, Rear LH Array I/F	2345746	2345746	
7	Bracket, Rear RH Array I/F	2345747	2345747	
8	Bracket, Fwd. LH Array I/F	2345748	2345748	
9	Bracket, Fwd. RH Array I/F	2345749	2345749	
	Clevis, Strut	2345712	2345712	
11	End Clevis	2345721	2345721	
12	Angle, Compass Mtg.	2345752	2345752	
13	Handle Assembly	2345750	2345750	
14	Grip	2345750-1	2345750-1	
15	Brkt. Support, Right	2345750-2	2345750-2	
16	Brkt. Support, Left	2345750-3	2345750-3	
17	Angle, Attachment	2345750-4	2345750-4	
18	Gusset, Right Rear Bottom	2345727-1	2345727-1	
19	Gusset, Center Rear Bottom	2345727-2	2345727-2	
20	Gusset, Center Channel	2345727-3	2345727-3	
21	Gusset, Right Front Top	2345727-4	2345727-4	
22	Gusset, Left Front Top	2345727-5	2345727-5	
23	Gusset, Left Center	2345727-6	2345727-6	
24	Gusset, Left Rear Top	2345727-7	2345727-7	



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TABLE I (CONTINUED)

Item	Major Assembly of Hardware	Flight Model 2345711-501	Qual Model 2345711-502	Notes
25	Gusset, Left Front Bottom	2345727-8	2345727-8	
26	Gusset, Right Front Bottom	2345727-9	2345727-9	
27	Gusset, Right Front Bottom	2345727-10	2345727-10	
28	Channel, Front	2345727-11	2345727-11	
29	Channel, Left	2345727-12	2345727-12	
30	Channel, Diagonal	2345727-13	2345727-13	
31	Channel, Rear	2345727-14	2345727-14	
32	Channel, Right	2345727-15	2345727-15	
33	Channel, Extension	2345727-16	2345727-16	
34	Channel, Center	2345727-17	2345727-17	
	Support	2345727-18	2345727-18	
36	Angle Bracket, Front	2345727-19	2345727-19	
37	Angle Bracket, Rear	2345727-20	2345727-20	
38	Spacer	2345727-21	2345727-21	
39	Spacer Bolt	2345727-22	2345727-22	
40	Angle Support, Front	2345727-23	2345727-23	
41	Angle Support, Rear	2345727-24	2345727-24	
42	Support Angle	2345727-25	2345727-25	
43	Suncompass Assy.	2345760	2345760	
44	Bracket, Suncompass	2345761	2345761	
45	Reflector, Light	2345733	2345733	
46	Gnomon Assy.	2345762 (SN 7)	2345762 (SN 6)	
47	Gnomon	2345762-1	2345762-1	
48	Suncompass Plate	2345762-2	2345762-2	
49	Rear Support, LH Assy.	2345740	2345740	
	Support Rod	2345739	2345739	





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TABLE I (CONTINUED)

Item	Major Assembly of Hardware	Flight Model 2345711-501	Qual Model 2345711-502	Notes
51	Bracket, Rear Support LH	2345741	2345741	
52	Rod	2345742	2345742	
53	Cover Assembly	2342584	2342584	
54	Cover-Mylar	2342584-1	2342584-1	
55	Lanyard Assembly	2342583	2342583	
56	Velcro-Pad (Hook)	2342583-2	2342583-2	
57	Pin	2342583-4	2342583-4	
58	Ring	2342589	2342589	
59	Guide Cover Lanyard	2342587	2342587	
60	Guide-Lanyard Fwd.	2342588	2342588	
61	Guide, Left Fwd.	2342588-1	2342588-1	
62	Guide, Right Fwd.	2342588-2	2342588-2	
63	Separator Tube	2342588-3	2342588-3	
64	Array Assembly	2345755	2345754	Note 1
65	Retro Reflector Array	ADL 7066	ADL 7028 2342528	
66	Pad	2345743-3		
67	Leveling Leg Assy.	2345724	2345724	
68	Slider Latch	2345713	2345713	
69	End Pivot	2345722	2345722	
70	Leg Strut	2345723	2345723	
71	Tube, Leveling Leg	2345725	2345725	
72	Latch	2345726	2345726	
73	Pin, Pivot	2345735	2345735	
74	Spring, Torsion Left	2345729-1	2345729-1	



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TABLE I (CONTINUED)

Item	Major Assembly of Hardware	Flight Model 2345711-501	Qual Model 2345711-502	Notes
75	Spring, Torsion Right	2345729-2	2345729-2	
76	Foot Assembly	2345720	2345720	
77	Foot	2345719	2345719	
78	Foot Bracket	2345718	2345718	
79	Pin, Pivot	2345736	2345736	
80	Shim, Laminated	2342568	2342568	
81	Support	2345711-3	2345711-3	
82	Plate, Identification	2345728-1	2345728-2	
83	Handling Socket Assy.	2345764-1	2345764-1	
84	Dowel Pin	2345744	2345744	
85	Pad, Nylon Fastener	2345743-1	2345743-1	
86	Pad, Nylon Fastener	2345743-2	2345743-2	
87	Pin Assy-Quick Release	2345745	2345745	
88	Handle, Ring	2345745-1	2345745-1	



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NOTE: (1) The following table lists the configuration differences between Flight and Qualification configurations of the Array Assemblies:

TABLE II  
FLIGHT MODEL AND QUAL MODEL ARRAY ASSEMBLY DIFFERENCES

	FLIGHT		QUAL	
Array Assembly	2345755		2345754	
Array	7066 (ADL)	Apollo 14 LRRR Flt Array has riveted retainer rings	7028 (ADL)	Qual LRRR Array has staked retainer rings
Retainer Rings	7066-003	6° Taper Cavity	7028-003	1.5° Taper Cavity
Panel Structure Assembly	7066-01	Accommodates 6° Taper Rings	7028-01	Accommodates 1.5° Taper Rings
Insulation Assembly	7066-02	Has ascent heating thermal protection Not cut-outs for handles	7028-02	Does not have ascent heating thermal protection Has cut-outs for EASEP handle



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APPENDIX A

Table III lists the components of the LRRR experiment and shows the test history of each. Qualification tests performed at the system level are also identified.



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APPENDIX A  
QSL TABLE III

Hardware Item	Qualification Requirements			Present Qual Status	Qualification Test Completed			Remarks
	Description	Quantitative Req.	Source Woc.		Description	Test Procedure	Start Date	
Laser Ranging Retro Reflector	Reflectors	Mech. Interface Per Drawings	ICD Drawing 2342001B	Optically & Dimensionally Qualified at Perkin Elmer	System Level	2341500 Mass Prop 2341502 Vib. Accept. Lvl. 2341504	3-27-69	GFE - Optical Performance & dim. requirements documented in Retro-Reflector ADP
	Teflon Mounting Rings	Mech. & Thermal Interface	7028-001A 7028-002A	Design Verification During Eng. & Development Tests	System Level	Vib. Des. Lvl. 2341506 Shock 2341508 Accel. 2341510	3-30-69 3-31-69	ADL memos: 1) Suitability of Tef. as mat. in LR <sup>3</sup> mtg. 20 Nov. 68. 2) Temp compstd. mount gskt for retro-refl Rev. 2 Jan. 69 EATM-52
	Array <sup>(1)</sup> Structure	Mech. & Thermal Interface	7066 (Top Assy)	Design Verification During Eng. & Development Tests	System Level	Mech. Dep. 2341512 Therm Vac.	3-28-69 4-03-69 4-08-69	ADL memo: Mech. Des. ASP of retro-refl mount 31 Dec. 68, Retro-refl phase A report 29 Jan. 69, EATM-52
	Structural Support & Deployment Hardware	Mech. & Astronaut Interface	Exhibit F-1 IC 314128 2345711	Qualified at System Level	System Level	Mass Prop 2345466 Vib. Accept. Lvl. 2345467 Vib. Des. Lvl. 2345468 Shock 2345469 Mech. Dep. 2345471	8-3-70	Apollo 14 Qual-Mod Test Results (See Table IV)
(1) Array Structure is defined to include a) retaining rings b) thermal insulation c) panel structure d) mounting brackets (front & back)								



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APPENDIX B

Table IV lists the components of the LRRR and shows the system Qualification Tests results of each.



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APPENDIX B

TABLE IV

QUALIFICATION TEST RESULTS

VIBRATION					THERMAL VACUUM TP 2341512		REMARKS		
Item Nomenclature & Part Number	Qual Accept. Level TP 2341502	Qual Design Limit TP 2341502	Shock TP 2341506	Accel. TP 2341508	Temp	Pressure	Mech. Func. Deploy. TP 2341510	Mass Properties TP 2341500	
Retro Reflectors P/N B100-2663	Passed 3-30-69	Passed 3-31-69	Passed 3-28-69	Passed 4-3-69	Passed 4-15-69	Passed 4-15-69	Passed 4-8-69	Passed 3-27-69	
Teflon Mounting Rings P/N B7028-001 P/N C7028-002	Passed 3-30-69	Passed 3-31-69	Passed 3-28-69	Passed 4-3-69	Passed 4-15-69	Passed 4-15-69	Passed 4-8-69	Passed 3-27-69	
*Array Structure P/N 2345754	Passed 3-30-69	Passed 3-31-69	Passed 3-28-69	Passed 4-3-69	Passed 4-15-69 (1) DR's AR 5025, 5004, 5083	Passed 4-15-69	Passed 4-8-69	Passed 3-27-69	(1) DR AB 5025 Thermocouple short at feedthrough - Closed DR AB 5004 Unable to adjust variable transformer to raise temperature to 85°F - Closed DR AB 5083 OT temp not able to meet +250° ± for 4 hrs - Closed
Structural Support, & Deployment Hardware P/N 2345727 P/N 2345724	(2) DR AB 8326 DR AB 8311 Passed 8-8-70 TP 2345467	Passed 8-10-70 TP 2345468	Passed 8-11-70 TP 2345469	N/R Statement of Work & Approved Integrated Test Plan	N/R Statement of Work & Approved Integrated Test Plan	N/R Statement of Work & Approved Integrated Test Plan	Passed 8-13-70 TP 2345471	Passed 8-3-70 TP 2345466	(2) DR AB8311 - O.T. at 10-25 HZ Vibration - Closed  DR AB8326 - O.T. at 52-59 Hz Vibration-Closed

\*Array Structure is defined to include:

- retaining rings
- Thermal insulation
- panel structure
- mounting brackets (front & rear)