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*John*

SUBJ: Test Objectives Review Board

TO: SAFSL-1 (Maj Gen J. S. Bleymaier)

1. The Test Objectives Review Board was convened under my chairmanship on 3 January 1968. Other than this letter, the documentation generated by the Board consists of:

- a. Copies of all Contractor briefings.
- b. Daily minutes of the Board meetings.
- c. Copies of the briefing presented to you on 2 February 1968.

2. The Board consisted of myself, Mr. B. A. Hohmann, Aerospace Corporation, Co-chairman, and three Contractor members: Mr. R. K. Arnold, DAC, Mr. R. B. Chamberlain, G.E., and Mr. R. A. Grammer, EK. Maj L. G. Thompson was the recorder. All discussion, observations and recommendations presented in the briefing were agreed to by this Board. Five consultants from the SPO Air Force/Aerospace were in attendance at all Board meetings, participated in the discussions and made recommendations; however, they were not present during the Executive Sessions of the Board when the results were finalized.

3. Throughout the presentation on 2 February 1968 observations were presented. Eleven major recommendations were summarized of the 24 observations made. Attached hereto is a triple matrix that categorizes these observations by priority of importance (1, 2 or 3); as to whether they apply to general, development, qualification or acceptance testing; and whether they impact contractual, technical or schedule considerations. The order of listing under each priority indicates the relative importance of that recommendation.

4. In the course of achieving its basic objectives, the Test Objectives Review Board (TORB), individually and collectively, examined the Lab Vehicle Test Program in considerable depth, both qualitatively and quantitatively. Much of the quantitative examination (details of testing) was used in constructing the TORB briefing. However, a number of quantitative considerations, although not pertinent to the results briefed nor of sufficient magnitude to be presented in the briefing, are pertinent in themselves. Likewise, certain qualitative considerations (test techniques, etc.), of interest to the test program, were not appropriate to or directly associated with the Board's recommendations, and were not included in the presentation. The Board believes it is appropriate to bring some of these

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considerations to your attention. These are contained in the attachment. Many of these could and should be given further attention by the Offices of Primary Responsibility, and further action/resolution accomplished as appropriate.

5. The final documentation package consists of: a. Copy of this letter with attachments; b. Copy of all Contractor briefings; c. Daily minutes of Board meetings; d. Copy of briefing. The Contractor briefings (item b.) consist of several categories of information (e.g.: test plans not on contract, test plans on contract, preliminary test plans) and should be considered accordingly. The distribution of this documentation package will be:

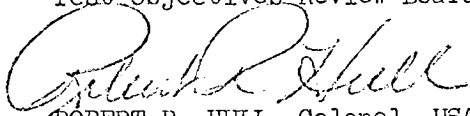
1 copy

SAFSL-4, -6, -12, -14, -16, 6595 ATW,  
DACO, GE, and EK

6 copies

Aerospace Corp.

6. The distribution of the above listed documentation, together with the presented briefing, are the final products of the Board. I consider the Test Objectives Review Board terminated as of this date.



ROBERT R. HULL, Colonel, USAF  
Chairman, Test Objectives Review Board

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1. Observation Matrix
2. General Observations

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OBSERVATION MATRIX

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ATCH 1

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PRIORITY I

OBSERVATION	TEST CATEGORY	CONSIDERATION IMPACT		GENERAL
		CONTRACTUAL	TECHNICAL	
<p>REVERSE ORDER OF LMQTV/LV-3 ASSEMBLY AND CHECKOUT FLOW.</p> <p>UPGRADE EDCTU TO A LV ELECTRICAL SYSTEMS DEVELOPMENT TOOL AND MAINTAIN, IN UPDATED CONFIGURATION, FOR TROUBLESHOOTING PURPOSES.</p> <p>HARDWARE ACCEPTANCE POLICY ON EXISTING CONTRACTS IS INCONSISTENT.</p> <p>OPTIMIZE MMTS CHECKOUT CAPABILITY.</p> <p>INCLUDE MMCTA IN DEVELOPMENT PROGRAM ON 114 AT GE.</p> <p>ASSOCIATES IDENTIFY TEST OBJECTIVES FOR INTEGRATED TESTING, AND SPO PROVIDE CONTRACTUAL COVERAGE FOR ACCOMODATING THESE TESTS.</p> <p>INVESTIGATE VALIDITY OF VIBRATION/ACOUSTIC TESTS TO MEET ACCEPTANCE OBJECTIVES.</p>	<p>Q,A</p> <p>D</p> <p>A</p> <p>G</p> <p>D</p> <p>D,G</p> <p>A</p>	<p>X</p> <p></p> <p>X</p> <p>X</p> <p></p> <p>X</p> <p></p>	<p></p> <p>X</p> <p></p> <p>X</p> <p>X</p> <p></p> <p>X</p>	<p>2</p>

D - DEVELOPMENT      A - ACCEPTANCE  
Q - QUALIFICATION    G - GENERAL

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PRIORITY II

OBSERVATION	TEST CATEGORY	CONSIDERATION IMPACT		
		CONTRACTUAL	TECHNICAL	SCHEMATIC
<p>CONDUCT INTEGRATED DAC/GE BIRDCAGE STRUCTURE TEST AT DAC.</p> <p>DAC CONDUCT A VIBRATION/ACOUSTIC QUALIFICATION TEST OF A FUNCTIONAL IM UNPRESSURIZED SECTION.</p> <p>DETERMINE VALIDITY OF GE CONSOLE RECEIVING FUNCTIONAL TEST AT DAC.</p> <p>LIMIT TOTAL THERMAL/VACUUM EXPOSURE IN QUALIFICATION TESTS OF MM SUBSYSTEM TO 30 DAYS.</p> <p>THE BOARD RECEIVED NO EVIDENCE OF EMPHASIS ON SINGLE POINT FAILURE TESTING ANYWHERE IN THE TEST PROGRAM.</p> <p>A CONSISTENT T/V POLICY SHOULD BE ESTABLISHED BY THE SPO FOR THE EQUIPMENTS LOCATED WITHIN THE PRESSURIZED SHELL.</p> <p>GE PAYLOAD EXCITATION DATA IS NECESSARY TO PERMIT VERIFICATION OF EK MATH MODELING PROCEDURES FOR PREDICTING COA ELEMENT MOTIONS.</p> <p>THERE IS LITTLE EVIDENCE OF SYSTEM LEVEL TESTING OF THE COMBINED IM TUNNEL AND TUNNEL HATCH.</p> <p>NO GE CONSOLE ENVIRONMENTAL TEST REQUIREMENTS SPECIFIED.</p>	<p>D</p> <p>Q</p> <p>A</p> <p>Q</p> <p>G</p> <p>D</p> <p>D</p> <p>G</p> <p>Q</p>	<p>X</p> <p></p> <p>X</p> <p>X</p> <p></p> <p></p> <p></p> <p></p> <p>X</p> <p></p>	<p>X</p> <p>X</p> <p></p> <p>X</p> <p>X</p> <p>X</p> <p>X</p> <p></p> <p>X</p> <p>X</p>	<p></p> <p></p> <p></p> <p></p> <p></p> <p></p> <p></p> <p></p> <p></p> <p></p>

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PRIORITY III

OBSERVATION	TEST CATEGORY	CONSIDERATION IMPACT		
		CONTRACTUAL	TECHNICAL	SCHEDULE
<p>SINCE THE LM-DTS ACOUSTIC TEST IS A ONE-TIME-ONLY TEST AND REQUIRES ACOUSTIC CHAMBER MODIFICATION AT DACO, THE FEASIBILITY OF USING AN EXISTING ACOUSTIC FACILITY SHOULD BE STUDIED.</p> <p>A COORDINATED (SPO/CONTRACTORS) ZERO "C" TEST PROGRAM (OBJECTIVES) SHOULD BE ESTABLISHED.</p> <p>THE SPO SHOULD INVESTIGATE THE REQUIREMENT FOR FURTHER UNDERWATER CREW SYSTEMS DEVELOPMENT.</p> <p>A MULTITUDE OF CABLES RUN THROUGH THE EVA HATCH FOR ACCEPTANCE LEVEL TESTING, WHICH COULD LEAD TO PANEL AND CONNECTOR WEAR DUE TO CABLE FLEXURE AND HANDLING.</p> <p>GE AND EK APPEAR TO HAVE THE OPPORTUNITY (HARDWARE AND FACILITY) TO SUBJECT NEAR PRIME SYSTEM LEVEL ASSEMBLIES 114 AND EM TO AN ACOUSTIC VIBRATION TEST.</p> <p>NO DUMMY ROSS BARRELL ON CONTRACT FOR LM CHECKOUT.</p> <p>NO CONSISTENT "REQUAL FACTOR" IN SYSTEM LEVEL QUAL CYCLES.</p>	D	X		
	D		X	
	D		X	
	A		X	
	D		X	
	A	X		
	Q			X

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ATTACHMENT

GENERAL OBSERVATIONS

1. There are at least three considerations that should be evaluated when a particular test (development, qualification or acceptance) is planned:
  - a) Considering both success and failure, where is the best place (plant location) to accomplish the test vs. supporting hardware/personnel required?
  - b) What tests can and should be accomplished on an integrated basis vs. the use of substitutes in lieu thereof?
  - c) What are the contractual elements that are enforced during the tests to insure the buyer a sound product before the contractor can consider he has provided a product of integrity and has fulfilled his contractual responsibility?

There is a natural tendency by all three contractors to plan their testing along the lines of their contractual hardware. There is thus a very strong desire to complete hardware development, qualification and/or acceptance testing at a given associate's plant before that hardware moves offsite, and to construct "testing" accordingly. This leads to a lack of possible benefits that could accrue during integrated testing. Thus, if the total LV were being "bought" from one contractor, and that contractor happened to build certain pieces of the LV in Philadelphia, Huntington Beach, etc., the development, qualification and acceptance testing would probably be done much more on an integrated basis than it is presently. The contractual aspects of the LV hardware acquisition, and the vested responsibilities of the OPR's associated therewith, have configured the test flow/program, to the probable detriment of the total LV testing. This condition cannot be eliminated without restructuring the contracts.

2. SAFSL 10003 is a critical document to the environmental test program for each associate contractor of the Lab Vehicle. Since the degree of environmental exposure for development, qualification, and acceptance testing of hardware is largely determined by this document, an error could

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become extremely costly. Special emphasis should be given to insure frequent technical updating of requirements within this document and a careful review of the contractor's interpretation of its contents.

3. It appears that considerable technical insight regarding component/system weaknesses, failure modes, operating life, etc., could be achieved by a degradation analysis of the hardware subjected to the various system qualification activities, such as LMQTV and GE 115. This could be done on a very selective basis to minimize cost. Since this program has very little "effectiveness" or "extended life" testing planned, this approach could yield data applicable to both the 30 day and extended mission activities. Since the segment level qualification articles will be generally refurbished for 6 and 7, the tear-down and analysis of these selected components could be conducted in parallel with the refurbishment effort with little impact.

4. During the brief meeting the Board held with NASA, it was evident that certain Apollo hardware was required to be re-qualified to higher levels of vibration. NASA concluded during a re-examination of their acceptance/qualification test program that a minimum of 6 g's rms should be imposed on electrical equipment with the equipment functioning to detect discrepancies in manufacturing. (Some LM components require less than 4 g's rms.) Also, NASA (and GE to some extent) are actively exploring thermal cycling of electrical equipment as a quality assurance screen for defects during component acceptance. A review of the component/subsystem qualification and acceptance test program for technical validity and consistency by the OPR's would be desirable in such areas as:

- a) Number of components to be qualified
- b) Vibration levels and times
- c) Feasibility of thermal cycling
- d) Power on or off

Examples of concern are as follows:

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- a) The testing of the camera is limited to those tests (qualification and acceptance) received at the vendor's facility and to those received in the LMQTV at DAC just prior to the launch of LV-3. Additional testing may be required to provide the same testing philosophy to the camera as to the other AVE components.
- b) Three major sub-sections of the OA are subjected to acceptance vibration test before assembly. The validity of these tests is questioned for two reasons:
  - 1) Induced vibration may result in excessive stresses on sensitive mechanical components which does not represent a realistic acceptance environment.
  - 2) These tests are conducted on assemblies which are predominately mechanical, not electrical. Vibration acceptance tests are not conducted on mechanical assemblies in other parts of the LV.

5. As was stated in the briefing, there was no evidence that special emphasis was given in any of the contractors' test plans with regard to areas of single point failures. The qualification and acceptance test programs must include tests which will thoroughly evaluate equipment performance in areas in which unavoidable single point failure modes may remain. For example, there appears to be a single point failure source in the servo control system for the primary and diagonal mirrors. Although it is understood that only about 50% of adjustment range is lost by failure of one servo; all servos, however, are controlled by the same black box. A black box failure, therefore, could mean single point failure. If the foregoing is correct, re-design may be required to provide redundancy and eliminate this single point failure potential. In any case, special attention should be paid to the servo control system during qualification and acceptance tests in order to determine the health status of the system prior to flight, since it appears that this system may be extremely difficult to check out in the launch configuration.

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