SOUTHWEST RESEARCH INSTITUTE

8500 Culebra Road, San Antonio, Texas 78228

Department of Applied Electromagnetics

DOCUMENT NO. MP-1
REVISION A

MANAGEMENT PLAN

FOR THE

M074 SPECIMEN MASS MEASUREMENT DEVICE

AND THE

M172 BODY MASS MEASUREMENT DEVICE

SECTION III - RELIABILITY

PRELIMINARY - NASA APPROVAL PENDING

1.0 INTRODUCTION

The purpose of this document is to describe the reliability program plan which will be established at Southwest Research Institute (SwRI) for use during the design, fabrication and testing of specimen and body mass measurement devices for NASA Skylab missions. The program described in this document meets the requirements of End Item Specifications Nos. MSC-KW-E-69-10, Revision B, and MSC-KW-E-69-11, Revision B. This program and the reliability programs of suppliers as well as all technical data and documentation generated in the development of these devices are subject to continuous examination, evaluation and inspection by MSC or its designated representative.

Instructions for Preparation of a Failure Mode and Effects Analysis (FMEA)

The FMEA shall be prepared on as many pages as necessary using the FMEA form for each page.

Line 1 -

a. End Item/Subsystem/Component - Identify the item for which the FMEA is being conducted to the level of its identity. For example:

End Item: Astronaut Maneuvering Unit No. XXX

Subsystem: Propulsion No. XXX

Component: Thruster No. XXX

b. Page/Date/Superseding - All pages shall be numbered consecutively and the total number of pages in the FMEA shall be entered on each page. The date on which each page is submitted shall be entered. If the page being submitted supersedes a previously submitted page, the date of the previous page shall be entered on the superseding line. If there has been no previous submission, "NA" shall be entered.

Line 2 -

a. Name - Name of system function or component under analysis for failure modes and effects. Breakdown of a system for analysis shall normally be down to the lowest practicable level at the time of the FMEA. In special cases such as electronic systems using integral modular units as system building blocks, the modules may be listed rather than listing its parts.

b. Identification Number - Drawing number by which the contractor identifies and describes each component or module. These drawings shall include configuration, mechanical, and electrical characteristics.

c. Drawing Reference Designation - Reference designation used by manufacturer to identify the component or module on the schematic. Applicable schematic and wiring numbers shall also be listed.

FIGURE 3.4-1 - GENERAL FORMAT FOR FAILURE MODE AND EFFECTS ANALYSIS

d. Reliability Logic Diagram Number - Identification number of FMEA reliability logic block diagram and of the function.

e. Function - Concise statement of the function performed.

f. Failure Mode and Cause - Give the specific failure mode after considering the four basic failure conditions:

(1) Premature operation
(2) Failure to operate at a prescribed time
(3) Failure to cease operation at a prescribed time
(4) Failure during operation

For each applicable failure mode, describe the cause including operational and environmental stress factors, if known.

g. Mission Phase - Phase of mission in which critical failure occurs, e.g., Prelaunch: checkout, countdown; Flight: boost phase, earth orbit, etc. Where the subphase, event, or time can be defined from approved operational or flight profiles, the most definitive timing information shall also be entered for the assumed time of critical failure occurrence. The most definitive time information that can be determined should also be given for the failure effects under the columns titled "Failure Effects On."

h. Component Functional Assembly - A brief statement describing the ultimate effect of the failure on the function or component being analyzed. Examples of such statements are component rendered useless, component's usefulness marginal, or structurally weakened to unacceptable reliability level. Timing information as described under g. shall be given.

i. Subsystem - A brief description of the effect of the failure on the next higher assembly. Timing information as described under g. shall be given as to time of failure effect.

j. End Item - A description of the effect of the component failure on the end item. For the major end items of the overall space system, these effects are divided into failures affecting mission success and failures affecting crew safety. Examples of failures affecting mission success are abort, limited mission, degrade mission objectives, and vehicle loss, scrub, or hold, etc. Examples of failures affecting crew safety are total loss of crew, partial loss of crew, and loss of redundancy. For

FIGURE 3.4-1 - GENERAL FORMAT FOR FAILURE MODE AND EFFECTS ANALYSIS

lower level end items where effects on the overall space system are unknown, the effects of a failure on the end item under analysis may be described as loss of inputs or outputs. Examples of such effects are loss of signal output, loss of output pressure, and shorted power input. Timing information as described under g. shall be given.

k. Failure Detection Method - A description of the methods by which the failure could be detected. Identify which of the following categories the failure detection means falls under:

(1) On-board visual/audible warning devices
(2) Automatic abort-sensing devices
(3) Ground Operational support system failure-sensing instrumentation
(4) Flight telemetry, ground support equipment console display, etc.
(5) None

Timing information as described under g. shall be given with respect to the reaction time available between time of component failure, time of detection, and time of critical failure effect.

l. Corrective Action Time Available/Time Required - A description of what corrective actions that the flight crew and the ground crew could take to circumvent the failure. If applicable, the time available for effective action and the time required shall be noted.

m. Failure Mode Category - Categorize the Failure Mode as follows:

(1) Category 1 - A failure which could adversely affect flight crew or ground personnel safety.

(2) Category 2 - A failure which could result in not achieving a primary mission objective but would not adversely affect crew safety.

(3) Category 3a - A failure which could result in not achieving a secondary mission objective but which would not adversely affect flight crew or ground personnel safety or preclude the achievement of any primary mission objectives.

FIGURE 3.4-1 - GENERAL FORMAT FOR FAILURE MODE AND EFFECTS ANALYSIS

(4) Category 3b - A failure which could not result in loss of a primary or secondary mission objective nor adversely affect flight crew or ground personnel safety.

n. Revision - An asterisk shall be placed in the revision block opposite each entry which has been changed since the previous submittal.

FIGURE 3.4-1 - GENERAL FORMAT FOR FAILURE MODE AND EFFECTS ANALYSIS

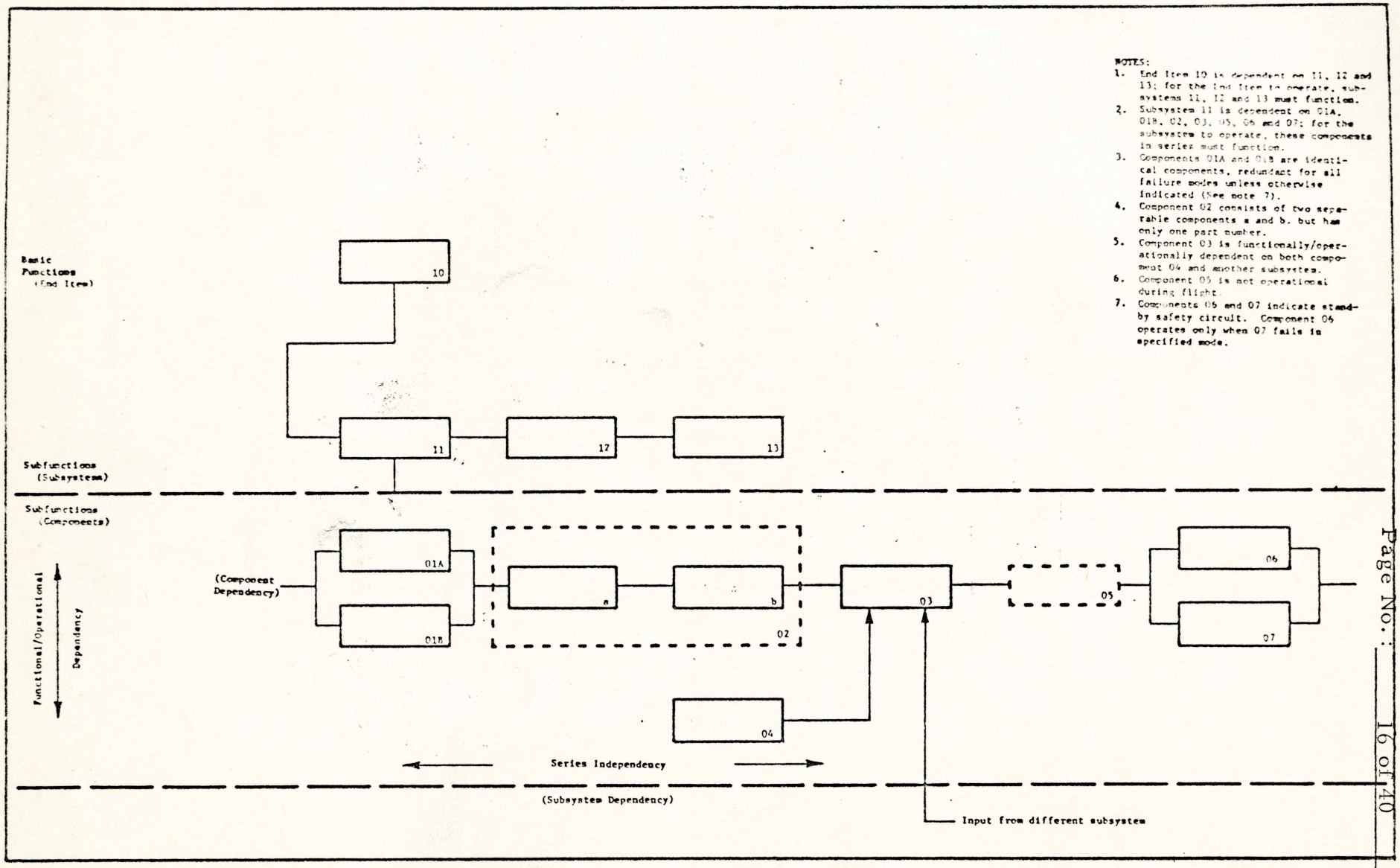

FIGURE 3.4.1.1-1 - GENERAL RELIABILITY LOGIC BLOCK DIAGRAM SCHEME

(3) Each failure mode of the system component and its effect on the system will be analyzed at the lowest level of system definition, as developed from the top down. Where system functional definition has not reached the level of identification of the system functions with the specific type of hardware that will perform these functions, the FMEA will be based upon failure of the system functions giving the general type of hardware envisioned as the basis for system design. Four basic conditions of component or functional failure will be considered.

(a) Premature operation

(b) Failure to operate at a prescribed time

(c) Failure to cease operation at a prescribed time

(d) Failure during operation

The FMEA will assume that only the failure under consideration has occurred. When redundancy or other means have been provided in the system to prevent undesired effects of a particular failure, the redundant element will be considered operational and the failure effects terminated at this point in the system. When the effects of a failure propagate to the top level of a system and cause the system to fail, the failure is defined as a critical failure in the system. When an FMEA is being performed on an already built system, the analyst may find cases where redundancies or other means of preventing failure effects do little to improve the failure situation or where the redundancies may actually worsen it. These cases will be reported for the next higher level. Where the scope of the FMEA program permits, the redundance or other failure effects preventive means will not halt the continuation of the failure effects analysis toward the top level of the system.

(4) Each potential failure mode of each system component and the effects of each failure mode of the system will be documented by completing an FMEA analysis based on that shown in Figure 3.4-1. The FMEA will include a description of the compensating features or in-mission actions which may minimize the effect of the failure upon component, subsystem or system operation, where applicable.

3.4.2 Single Failure Point Summary

A Single Failure Point Summary for Categories 1 and 2 failure modes will be prepared. After initial submittal, any additions or changes that become necessary will be reported within 24 hours. The Single Failure Point Summary will include:

(1) Item name and part number

(2) Failure mode, after considering the four basic failure conditions as follows:

(a) Premature operation

(b) Failure to operate at prescribed time

(c) Failure to cease operation at the prescribed time

(d) Failure during operation

(3) Effect of the failure on the system

(4) Criticality of the failure as follows:

(a) Criticality I - A Single Point Failure which could by itself adversely affect flight crew or ground personnel safety.

(b) Criticality II - A Single Point Failure which by itself could result in not achieving a primary mission objective but would not adversely affect crew safety.

(5) Means of Detection - Normal methods of detecting failure such as panel lights, readouts, visual cues, audio tones, etc. Indication will be provided if no immediate means of detecting failure exists.

(6) Corrective Action - Design, test or procedural changes required to eliminate or minimize the effect of the single point failure.

(7) Rationale of Acceptance - Reasons will be presented why single failure point can be accepted without further design, test or procedural changes.

3.4.3 Hazards Summary

A hazards summary will be included in the FMEA report. The hazards summary will identify hazards in environment, hardware, test,

training, operational procedures and interface conditions and will discuss which steps have been or can be taken to relieve these hazards. However, only those hazards that fall into either of the following two hazard categories will be identified in the summary. The summary will list the hazards and show into which of the hazard categories each hazard falls.

(1) Safety Catastrophic - Condition(s) such that environment personnel error, design characteristics, procedural deficiencies, or subsystem or component malfunction will severely degrade system performance, and cause subsequent system loss, death, or multiple injuries to personnel.

(2) Safety Critical - Condition(s) that environment, personnel error, design characteristics, procedural deficiencies or subsystem or component malfunction will cause equipment damage or personnel injury, or will result in a hazard requiring immediate corrective action for personnel or system survival.

3.5 Nonconformance Reporting and Corrective Action

The R&QA Section will establish a strictly controlled system for the reporting, analysis, correction and data feedback of all failures and unsatisfactory conditions. Nonconformance reporting to the Manned Spacecraft Center will be initiated by the R&QA Section commencing with the start of first Acceptance Tests and will continue throughout the life of the contract. This reporting will include all failures and unsatisfactory conditions noted after the nonconformance source has been isolated to a replaceable assembly, or a comparable level. An analysis of the nonconformance will be conducted as soon as possible after isolation and the proposed corrective actions will be submitted to the Manned Spacecraft Center. Failures and unsatisfactory conditions which will be reported are defined as follows:

(1) Failure - The inability of a system, subsystem, component, or part to perform its required function under the specified conditions for the specified duration. All occurrences fitting this definition are failures even though the cause may be something other than an inherent part fault such as:

(a) The failure of another part.

(b) Human error in handling or procedures.

(c) Failure of test facilities, ground support equipment or other test equipment, or instrumentation.

(d) Adjustment or tuning which is not normal to inservice operation.

(2) Unsatisfactory Condition - An unsatisfactory condition is any major defect for which engineering disposition is required and which requires recurrence control beyond the specific article under consideration. It is a condition which cannot be corrected to the specified configuration using the standard planned operations. It is an event which could lead to a failed condition but does not affect the function of the article; i.e., contamination, corrosion, workmanship requiring engineering disposition, etc. (A defect is any deviation from the requirements established by applicable drawings, specifications, instructions, and/or assembly, test, handling, and storage procedures that does not have an effect on the required functions of the part or higher level of assembly. This definition excludes failures.)

3.5.1 Failure and Unsatisfactory Condition Reporting

All failures and unsatisfactory conditions as defined in Items (1) and (2) of paragraph 3.5 will be reported to the Manned Spacecraft Center within five days after the nonconformance source is isolated to a replaceable assembly, or a comparable level. Using the format shown in Figure 3.5.1-1, each report will contain the part number, name of part, serial number, part manufacturer, date problem was first detected, test being conducted when the problem occurred, conditions at time of problem, description of problem, cause of problem if known, and any other information considered pertinent.

3.5.2 Significant Nonconformance Reporting

A significant nonconformance is any failure or unsatisfactory condition which will adversely affect safety, contribute to schedule impact or launch dalay, add significant cost, or which occurs during qualification testing. Significant nonconformances will be reported by telephone to the Manned Spacecraft Center within 24 hours after the nonconformance source is isolated to a replaceable assembly, or a comparable level. Subcontractors and suppliers will report significant nonconformances to the next higher level contractor in the contractor tier. Follow-up reports will be submitted in accordance with the requirements of paragraph 3.5.1

3.5.3 Analysis and Corrective Action

Failure analyses and corrective actions will be reported for each failure and unsatisfactory condition reported in accordance with paragraph 3.5.1. Using the format shown in Figure 3.5.3-1, Failure Analysis and Corrective Action Reports will be prepared for each reported failure and unsatisfactory condition (UC). Each report will reference the Failure and UC Report and define the method of analysis and document the results of the analysis; define the specific steps that will be taken to prevent recurrence of the problem; and, if alternate solutions are possible, will include the justification for the selected action. If the proposed corrective action necessary to prevent recurrence of the problem requires a change to the baseline configuration, the failure analysis and the proposed corrective action will be submitted with an Engineering Change Proposal (ECP) in accordance with the requirements of SwRI Document, MP-1, Section IV, Configuration Management. After approval of the change proposal, the approved Failure Analysis and Corrective Action Report will be submitted.

3.6 Subcontractor and Supplier Control

The R&QA Section will be responsible for insuring that the reliability of parts, materials, components and subsystems of Mass Measurement devices obtained from subcontractors and suppliers meet the reliability requirements of the End Item Specifications. This applies to items obtained from any supplier whether he be in the first or any subsequent tier. All procurement documents will include provision for review and evaluation of the subcontractor's and supplier's reliability effort by the Manned Spacecraft Center or its designated representatives. Identification of components and the extent of applicability of the reliability requirements to these components will be included in the Development Status Reports prepared in accordance with paragraph 8.6.3 of Document MSC-KA-D-68-1.

3.7 Design Review Program

In addition to the PDR and CDR design reviews described by Section IV of MP-1, Configuration Management, a formal program of planned, scheduled and documented design reviews at system, subsystem and major component level of Experiment Hardware will be established. These reviews will be comprehensive critical audits of all pertinent aspects of the design, particularly its reliability and safety, and be conducted at all major milestones in the program beginning in the feasibility stage and additionally at various stages in the evolution of each design. Participation in the reviews will include personnel from electrical design, mechanical design, packaging design, the procurement expediter, the manufacturing expediter, documentation, and testing. The Manager of the R&QA Section as well as other participating elements of SwRI will sign all design review reports to indicate concurrence with the completeness of the review and actions to be taken. The R&QA Section will also follow up on action items to insure that cognizant groups have completed these actions satisfactorily.

3.7.1 Reliability Design Review

The R&QA Section, with assistance from the project design engineers, will perform a reliability design review function. The design reviews will include: a detailed examination of the design documents, drawings, and specifications; review of current reliability estimates and achievements for each mode of operation; the effects of engineering decisions and trade-offs upon reliability achievements and an evaluation of the effects of part selection and application on the reliability of the final equipment. Evaluation will include analysis of environmental (e.g., temperature, humidity, and vibration) as well as physical stresses (e.g., electrical and mechanical) anticipated during intended use. Critical or marginal features of the equipment design which adversely affect reliability as determined by the design review will be identified. The Failure Mode and Effect Analyses Report Required by Section 3.4 will be of prime consideration in the design review.

The reliability design review function will be completed prior to final release of the equipment design, and the results of the design reviews will be documented and submitted to MSC. The provisions of this paragraph will serve as a checklist for the design aspects to be covered during reliability design reviews. These reviews will be conducted at any time at the call of the Project Manager or the Manager of the R&QA Section and as scheduled in the Development Status Reports.

3.7.2 Design Review Reports

Design review reports, including a listing of representation at the review, a statement of actions to be taken, and responsibility therefore will be provided in the form of Technical Reports. Insofar as practical, these reports will be submitted in the form in which they are prepared by the designer, design group, or other group performing the study. The internal documents of SwRI will be used to meet the requirements for technical reports.

3.7.3 Objective of Design Review Program

A principal objective of the design review program discussed in this section will be to prepare the Formal MSC design reviews described by Section IV, Configuration Management, of SwRI Document MP-1.

3.8 Subcontractor and Supplier Design Reviews

The provisions of paragraph 3.7 will be invoked on all subcontractors or suppliers providing major components or subsystems for the mass measuring devices. Provisions will be made for participation by appropriate representatives of SwRI.

3.9 Engineering Design Changes

An analysis will be performed on each proposed change to identify and resolve possible reliability problems and hazards that may be introduced into the system by incorporation of the change. The results of such analyses will be provided to the Configuration Control Board for consideration.

3.10 Standardization of Design Practices

A continuous design and processing standardization effort will be maintained for the mass measuring devices and the results of this effort will be formalized in memorandums and other documentation forms for use of design, drafting, fabrication, processing and inspection personnel. Existing standards and specification will be used insofar as practicable, modifying them as necessary to meet the reliability requirements. Although establishment of design and processing standards is not normally a reliability responsibility, the R&QA Section will be responsible for reviewing these standards for adequacy in meeting reliability

requirements and for insuring that they are being followed. The standards of all suppliers will also be reviewed by the R&QA Section for compatibility, and all standards will be subject to inspection by the Manned Spacecraft Center. Any deviations from standard practices will be a subject of design reviews. Typical areas to be covered in this standardization system include:

(1) Process specifications.

(2) Fabrication, assembly, and machining standards (e.g., mechanical, structural, electrical and electronics).

(3) Drafting practice and drawing specifications.

(4) General design specifications for electronic assemblies (e.g., mechanical support, clearance of parts, heat dissipation allowance, etc.)

(5) General design specifications for mechanical assemblies.

(6) General guides for design simplification.

(7) Procedures for ensuring formalization in drawings and specifications of changes made to correct nonconformances.

3.11 Specifications

3.11.1 Selection of Specifications and Standards

Specifications and standards necessary for the design and development of mass measurement hardware, in addition to those specified in the AAP and the applicable End Item Specification, will be selected in the following order of precedence except for electrical, electronic and electromechanical parts:

(1) NASA specifications and standards
(2) Federal specifications and standards
(3) Military specifications and standards (MIL, JAN or MS)
(4) Other Governmental specifications and standards
(5) Industry specifications (e.g., those promulgated by nationally recognized associations, committees, and technical societies)
(6) Specifications and standards generated by the developer of Experiment Hardware

Responsibility for the approval of specifications and standards is assigned to the R&QA Section.

3.11.1.1 Electrical, Electronic and Electromechanical Parts Specifications

Design specifications for electrical, electronic and electromechanical parts will be selected from military and industrial specifications which include reliability and quality assurance requirements for each application consistent with other requirements of this End Item Specification. Where adequate military and industrial specifications do not exist, controlling design specifications will be prepared and will include reliability and quality assurance requirements.

(1) Screening procedures will be implemented for electrical, electronic, and electromechanical parts and shall be prepared using the guidelines contained in Appendix A of MSCM 5320. An EEE Parts List, SwRI Document No. EPL-1, will identify all EEE parts in use and will include as a minimum the following:

(a) Generic part, type, name and number
(b) Common designation
(c) Name of manufacturer
(d) Manufacturer's part number
(e) Package type
(f) Specification name and number
(g) Quantities used per replaceable assembly and identification of replaceable assembly
(h) Limited life part restrictions
(i) Methods of qualification and status. Methods of qualification and qualification status shall be coded as follows:

1 - As part of a higher assembly
2 - By similarity
3 - By test
4 - By existing data
5 - By combination of similarity and test
6 - By combination of existing data and test
7 - By existence on other NASA approved parts lists
A - Qualified
B - Limited qualification or approval
C - To be qualified

(2) Controlled electrical, electronic and electromechanical (EEE) parts - Controlled EEE parts which are procured to specifications that include reliability and quality assurance requirements for each application consistent with other requirements of End Item Specifications will be used. Parts selected from commercial catalogs and purchased without any reference to any controlling user specification are uncontrolled and will not be used unless absolutely necessary. The order of precedence in the selection of qualified EEE parts, after the design specification has been selected or prepared, will be as follows:

(a) Military Qualified Parts Lists
(b) Other lists as determined by reference to data sources which will include but are not limited to:

1 Apollo Spacecraft Parts and Materials Information Service
2 Interagency Data Exchange Program (IDEP)
3 Electronic Component Reliability Center (ECRC)
4 Failure Rate Data Program (FARADA)

(c) Unqualified parts which will require qualification by SwRI or by the parts supplier will be at the parts level and the plans for qualification will be included in the Verification Plans, a series of documents required by Section V, Test Management, of SwRI Document MP-1, and identifiable by the letter prefix, VP.

(3) Design deratings for electrical, electronic, and electromechanical parts will be established using the guidelines contained in Appendix B of MSCM 5320 to provide for reliable operation at expected operating stress levels. These design deratings will be based on the parts maximum ratings which as limiting values define the electrical, mechanical, thermal and environmental ratings beyond which either initial performance of service life of the part is impaired.

3.11.2 End Item and Configuration Specifications

Procedures for the control of End Item and Configuration Specifications are presented in SwRI Document No. MP-1, Section IV, Configuration Management. Responsibility for the documentation of configuration management is assigned to the R&QA Section. The R&QA Section will assist in establishing the integrity of the design

approach considering Failure Mode and Effects Analyses, Single Failure Point Summaries, Hazard Summaries, breadboard models, mockups, circuit circuit logic diagnosis, packaging techniques, qualification status of selected parts and materials, test data, inspectability, etc.

3.11.2.1 Specification Control System Summary

As detailed in Section IV of MP-1, a separate End Item Specification will be prepared for Flight Hardware, Mockup Hardware and Flight Type Training Hardware. The Ground Support Equipment (leveling fixture) will be specified by means of a GSE Data Sheet. A Configuration Specification will be prepared for each End Item Specification and will consist of four sections:

(1) Design Approach
(2) Detail Design
(3) Qualification Status, and
(4) Configuration Status

The Design Approach section will be used during the Preliminary Design Review (PDR) to determine acceptability of design. After appropriate modification during the PDR, this section will become a part of the baseline configuration and may be changed only through Engineering Change Proposal/SpecificationChange Notice procedures. This section will not be maintained after the Critical Design Review (CDR).

The Detail Design section of each Configuration Specification will be used during CDR at which time the acceptability of the completed design will be determined. After appropriate modification, this section becomes the baseline configuration for the manufacture of hardware. With the exception of minor drawing changes as defined in the Configuration Management Plan, the Detail Design section may be changed only through the approval of Engineering Change Proposals or Specification Change Notices.

The Qualification Status section of each Configuration Specification will report the qualification status of test articles identified in Verification Plans. This section will be submitted for review and will be updated to indicate revisions as required by the resubmittal of the complete Section or pages thereof. If updating is accomplished by the submittal of only those pages which are changed, the submittal will be accompanied by a page to be inserted at the beginning of the Section which indicates the effective dates of every page in this section.

The Configuration Specification section will report the status of all changes to the baseline configuration. This section will be submitted for review and updated in the same manner as the Qualification Status section. Engineering Change Proposals/Specification Change Notices will not be used to update this section.

3.12 Maintainability

Maintainability, a joint responsibility of the design engineers and R&QA, will be considered as a goal throughout design review, production and test programs. As guidance during these programs, the following requirements will apply:

3.12.1 General

(1) The SMMD and BMMD will be designed to provide accessibility, replaceability and serviceability consistent with efficient servicing, testing, and maintenance requirements.

(2) The principles of modular construction will be employed in design to permit maintenance and replacement to be performed at the component level. (A component is a combination of parts, subassemblies or assemblies; usually a self-contained integral unit). Components expected to require servicing or maintenance will be designed to be accessible without the removal of other components or wire bundles.

(3) Access covers not completely removable will be self-supporting when open. Where access is required, the following practices will be followed in order of preference:

(a) An opening with no cover
(b) A hinged metal cover with captive quick-opening fasteners, capable of manual operation without the use of tools
(c) Item (b) above, but requiring the use of tools
(d) Other

(4) The replacement, servicing or maintenance of any component will require opening or removal of a minimum of covers or panels. Although undesirable, if it is necessary to place one component behind another, the component requiring most frequent access will be most readily accessible. Openings and work spaces provided for the adjustment and handling of components will be ample to permit the required activity and, where feasible, permit direct viewing of the components being manipulated. Where components, connectors, and similar items must be inserted through a small access, external indication of the position of insertion will be provided.

3.12.2 Additional Requirements for In-Flight Maintainability

Where in-flight maintenance is required based on the nature of the experiment and/or the criticality, complexity, reliability, or reactivation requirements, the following will apply:

(1) Positive malfunction isolation to the component level will be provided and will minimize necessity for astronaut interpretations or reference to handbooks. Each access will be labeled with the nomenclature of the component(s) or area accessible through it.

(2) Components will be replaceable and adjustments possible with the use of a minimum number of tools which will be standard tools wherever possible. The design will make maximum use of standard replaceable components. Tools will be compatible for use

in the natural and induced environments as applicable. The requirements for tools will be coordinated with the needs of other experiments and space vehicle systems to provide common usage tools wherever possible.

(3) Replacement of a component or maintenance adjustment will not result in loss or invalidation of data obtained prior to the replacement or adjustment.

(4) Replacement components will be designed with alignment devices such as keys or pins.

3.12.3 Maintenance

It is anticipated that there will be no scheduled maintenance procedures for either the SMMD or the BMMD. The only unscheduled maintenance operations which can be performed outside of the Southwest Research Institute facility are replacement of an electronics subsystem and cleaning of the electro-optical transducer components. The procedures for accomplishing these maintenance operations will be described in detail in the Operating, Maintenance and Handling Procedures (Volume III, Ground Operating, Maintenance and Handling Procedures). Verification of maintainability will be accomplished during Acceptance tests on flight hardware by physical inspection; documentation such as drawings, manufacturing records and purchase requisitions; or both. Control and documentation of such verification is as specified in the Verification Plans.

3.13 Parts and Materials Program

A parts and materials program will be established and implemented under the responsibility of the Reliability and Quality Assurance Section. This program will insure that all parts and materials utilized in end item hardware comply fully with the contract requirements. The major elements of the parts and materials program are:

(1) Requirements
(2) Selection and Specifications
(3) Procurement
(4) Incoming Inspection
(5) In-process Tests and Inspections
(6) Verification

A brief discussion of each of these elements is provided in the following paragraphs.

3.13.1 Requirements

The requirements for parts and materials are specified in Section 3.0 of the End Item Specification. Table 3.13.1-1 lists the relevant Section 3.0 paragraphs of the applicable End Item Specifications.

3.13.2 Selection and Specifications

The selection and specification of electrical, electronic and electromagnetic (EEE) parts will be in accordance with Paragraph 3.11.1.1 above. Materials and parts falling outside the classification of EEE parts and nonmetallic materials will be selected and specified in accordance with Paragraph 3.11.1 above. Nonmetallic materials will be controlled in accordance with Document MP-1, Section IX. In all cases, selection and specification of parts and materials shall be the joint responsibility of the cognizant design engineer and the Reliability and Quality Assurance Section. The Reliability and Quality Assurance Section's extensive files on parts and materials will be utilized in performing this task.

3.13.3 Procurement

Purchase requisitions will be prepared in accordance with an internal project document. This document specifies the procedural steps to be followed by project participants in procuring parts, materials, and services for the end item hardware. Each purchase requisition will be reviewed and approved by the Reliability and Quality Assurance Section to insure that all reliability aspects are considered. In reviewing these requisitions, the Reliability and Quality Assurance Section will insure that the parts and materials are properly specified and meet the requirements of the End Item Specifications.

3.13.4 Incoming Inspection

As a part of the Quality Assurance program (see Document MP-1, Section II), an incoming inspection will be performed on each part and material procured for use in the end item hardware. The scope of this inspection is described in Document MP-1, Section II, hence no further coverage will be provided here.