INDEPENDENT ORBITER ASSESSMENT

ANALYSIS OF THE MANNED MANEUVERING UNIT

21 NOVEMBER 1986

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY
HOUSTON DIVISION

SPACE TRANSPORTATION SYSTEM ENGINEERING AND OPERATIONS SUPPORT

WORKING PAPER NO. 1.0-WP-VA86001-09

INDEPENDENT ORBITER ASSESSMENT
ANALYSIS OF THE MANNED MANEUVERING UNIT

21 November 1986

This Working Paper is Submitted to NASA under
Task Order No. VA86001, Contract NAS 9-17650

PREPARED BY: P. S. Bailey
P.S. Bailey
Senior Analyst
Independent Orbiter
Assessment

APPROVED BY: [signature]
G.C. Raffaelli
MMU Lead
Independent Orbiter
Assessment

APPROVED BY: G.W. Knori
G.W. Knori
Technical Manager
Independent Orbiter
Assessment

APPROVED BY: W F Huning
W.F. Huning
Deputy Program Manager
STSEOS

CONTENTS

List of Figures

List of Tables

Independent Orbiter Assessment
Analysis of the Manned Maneuvering Unit

1.0 EXECUTIVE SUMMARY

The McDonnell Douglas Astronautics Company (MDAC) was selected in June 1986 to perform an Independent Orbiter Assessment (IOA) of the Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL). Direction was given by the STS Orbiter and GFE Projects Office to perform the hardware analysis using the instructions and ground rules defined in NSTS 22206, Instructions for Preparation of FMEA and CIL, 10 October 1986. The IOA approach features a top-down analysis of the hardware to determine failure modes, criticality, and potential critical items. To preserve independence, this analysis was accomplished without reliance upon the results contained within the NASA FMEA/CIL documentation. This report documents (Appendix C) the independent analysis results corresponding to the Manned Maneuvering Unit (MMU) hardware.

The MMU is a propulsive backpack, operated through separate hand controllers that input the pilot's translational and rotational maneuvering commands to the control electronics and then to the thrusters. Twenty-four thrusters on the unit provide the astronaut with six-degree-of-freedom maneuvering control capability. Dual electrical/power and propulsion systems have been designed into the MMU to optimize astronaut return to the Orbiter. Throughout the duration of its mission, the MMU performs propulsion, control, system maintenance and stowage and crewmember restraint/fit functions. MMU hardware employed to perform these functions comprise the following:

- Propulsion Subsystem
- Electrical/Power Subsystem
- Support Structures and Mechanisms
- Flight Support Station

The IOA analysis process utilized available MMU hardware drawings and schematics for defining hardware subsystems, assemblies, components, and hardware items. Final levels of detail were evaluated and analyzed for possible failure modes and effects. Criticality was assigned based upon the worst case severity of the effect for each identified failure mode.

Figure 1 presents a summary of the failure criticalities for each of the four major subdivisions of the MMU. A summary of the number of failure modes, by criticality, is also presented below with Hardware (HW) criticality first and Functional (F) criticality second.

Summary of IOA Failure Modes By Criticality (HW/F)							
Criticality:	1/1	2/1R	2/2	3/1R	3/2R	3/3	TOTAL
Number :	5	37	25	3	25	41	136

For each failure mode identified, the criticality and redundancy screens were examined to identify Potential Critical Items (PCIs). A summary of PCIs is presented as follows:

Summary of IOA Potential Critical Items (HW/F)						
Criticality:	1/1	2/1R	2/2	3/1R	3/2R	TOTAL
Number :	5	37	25	-	2	69

In summary, the IOA analysis of the MMU has found that the majority of the PCIs identified are resultant from the loss of either the propulsion or control functions, or are resultant from inability to perform an immediate or future mission. The five most severe criticalities identified are all resultant from failures imposed on the MMU hand controllers which have no redundancy within the MMU.

MMU ANALYSIS SUMMARY

CRIT.	1/1	2/1R	2/2	3/1R	3/2R	3/3	TOTAL
#FM	5	37	25	3	25	41	136
#PCI	5	37	25	–	2	–	69

ELECTRICAL/POWER

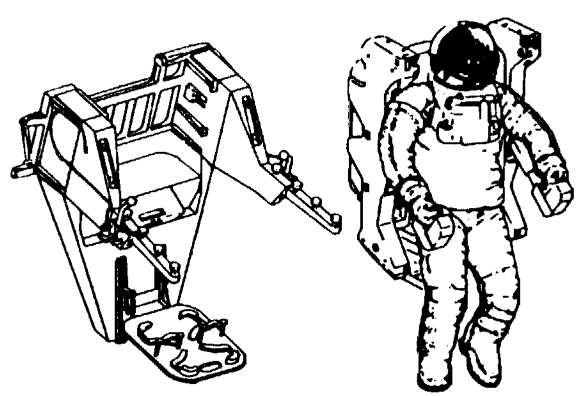
CRIT.	#FM	#PCI
1/1	5	5
2/1R	22	22
2/2	9	9
3/2R	5	–
3/3	19	–

SUPPORT STRUCTURES & MECHANISMS

CRIT.	#FM	#PCI
2/1R	2	2
2/2	11	11
3/2R	2	1
3/3	3	–

PROPULSION

CRIT.	#FM	#PCI
2/1R	13	13
2/2	4	4
3/1R	1	
3/2R	2	
3/3	2	



FSS

CRIT.	#FM	#PCI
2/2	1	1
3/1R	2	–
3/2R	16	1
3/3	17	–

CRIT - CRITICALITY
FM - FAILURE MODE
PCI - POTENTIAL CRITICAL ITEM

Figure 1 - MMU OVERVIEW ANALYSIS SUMMARY

2.0 INTRODUCTION

2.1 Purpose

The 51-L Challenger accident prompted the NASA to readdress safety policies, concepts, and rationale being used in the National Space Transportation System (NSTS). The NSTS Office has undertaken the task of reevaluating the FMEA/CIL for the Space Shuttle design. The MDAC is providing an independent assessment of the Orbiter and Government Furnished Equipment (GFE) FMEA/CIL for completeness and technical accuracy.

2.2 Scope

The scope of the independent FMEA/CIL assessment activity encompasses those Shuttle Orbiter subsystems and GFE hardware identified in the Space Shuttle Independent FMEA/CIL Assessment Contractor Statement of Work. Each subsystem analysis addresses hardware, functions, internal and external interfaces, and operational requirements for all mission phases.

2.3 Analysis Approach

The independent analysis approach is a top-down analysis utilizing as-built drawings to breakdown the respective subsystem into components and low-level hardware items. Each hardware item is evaluated for failure mode, effects, and criticality. These data are documented in the respective subsystem analysis report, and are used to assess the NASA and Prime Contractor FMEA/CIL reevaluation results. The IOA analysis approach is summarized in the following Steps 1.0 through 3.0. Step 4.0 summarizes the assessment of the NASA and Prime Contractor FMEAs/CILs that is performed and documented at a later date.

Step 1.0 Subsystem familiarization
- 1.1 Define subsystem functions
- 1.2 Define subsystem components
- 1.3 Define subsystem specific ground rules and assumptions

Step 2.0 Define subsystem analysis diagram
- 2.1 Define subsystem
- 2.2 Define major assemblies
- 2.3 Develop detailed subsystem representations

Step 3.0 Failure events definition
- 3.1 Construct matrix of failure modes
- 3.2 Document IOA analysis results

Step 4.0 Compare IOA analysis data to NASA FMEA/CIL
- 4.1 Resolve differences
- 4.2 Review in-house
- 4.3 Document assessment issues
- 4.4 Forward findings to Project Manager

2.4 MMU Ground Rules and Assumptions

Due to the unique functions performed by the MMU, the IOA project determined it necessary to establish groundrules and assumptions applicable solely to the MMU (reference Appendix B). These ground rules and assumptions, in addition to those established project wide (also provided in Appendix B), are intended to both complement and supplement those defined in NSTS 22206. Additional, they ensure that the IOA MMU analysis is capable of being understood by personnel who did not directly participate in the analysis.

3.0 SYSTEM DESCRIPTION

3.1 Design and Function

The MMU, reference Figure 2, is a modular, self-contained, propulsive backpack designed to attach to the Extravehicular Mobility Unit (EMU) and to be donned and doffed by one unassisted crewmember. When used, the MMU increases the Orbiter crew's Extravehicular Activcity (EVA) mobility by extending the range of their activities from the payload bay to other portions of the spacecraft, to appendages of payloads protruding from the cargo bay, or to other spacecraft entirely. When not in use, the MMU is stowed in the forward payload bay on the Flight Support Station (FSS), reference Figure 3. Two MMUs are typically flown on each Orbiter mission.

The IOA analysis has defined the MMU as being comprised of a propulsion subsystem, electrical/power subsystem, support structures and mechanisms, and the FSS. These subsystems and hardware can operate singly or in an integrated manner to perform four primary functions: propulsion, control, system maintenance and stowage, and crewmember restraint/fit.

1. Propulsion Subsystem - Two independent, identical subsystems are each capable of providing the translational and rotational forces necessary for propulsion. Inert GN2 propellant is stored in two pressure vessels. Activation of a motor-driven isolation valve (open) allows GN2 to flow to a pressure regulator and then to the thruster manifolds which consist of four 3-thruster (triad) assemblies for each of the two subsystems. Based on hand-controller and gyro inputs, electrical power to the thruster solenoid valves result in expansion of the nitrogen gas through a nozzle to produce propulsion. The two systems are isolated but can be interconnected through hand-actuated toggle valves. Quick-disconnect valves provide GN2 recharge capability for the pressure vessels when the MMU is stowed in the FSS. Figure 4 is a schematic of the propulsion subsystem.

2. Electrical/Power Subsystem - Encompasses the control electronics and the power storage and distribution within the MMU. Figure 5 presents an overview of this subsystem.

   The maneuvering control comprises three main elements - two hand controllers and the Control Electronics Assembly (CEA). These operate together to provide signals to the propulsion system for rotational or translational motion. The Rotational Hand Controller (RHC) furnishes switching logic that converts rotary motions of the handle to rotational commands. The RHC also supplies control for the attitude hold function. The Translational Hand Controller (THC) provides switching logic that converts the motions of the handle in three axes to translational commands. The THC also controls the propellant isolation valve.

ORIGINAL PAGE IS OF POOR QUALITY

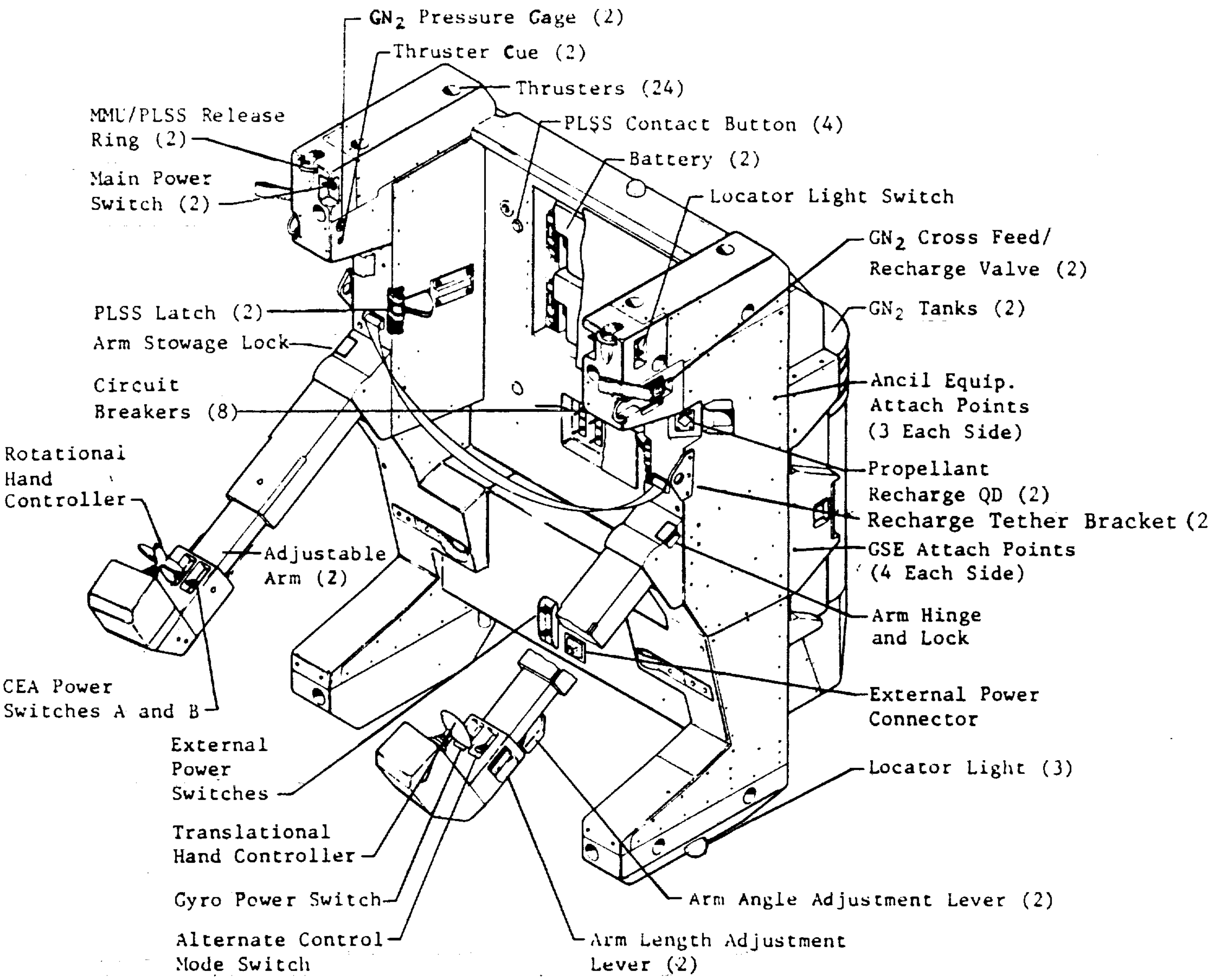


Figure 2 - MANNED MANEUVERING UNIT (MMU)

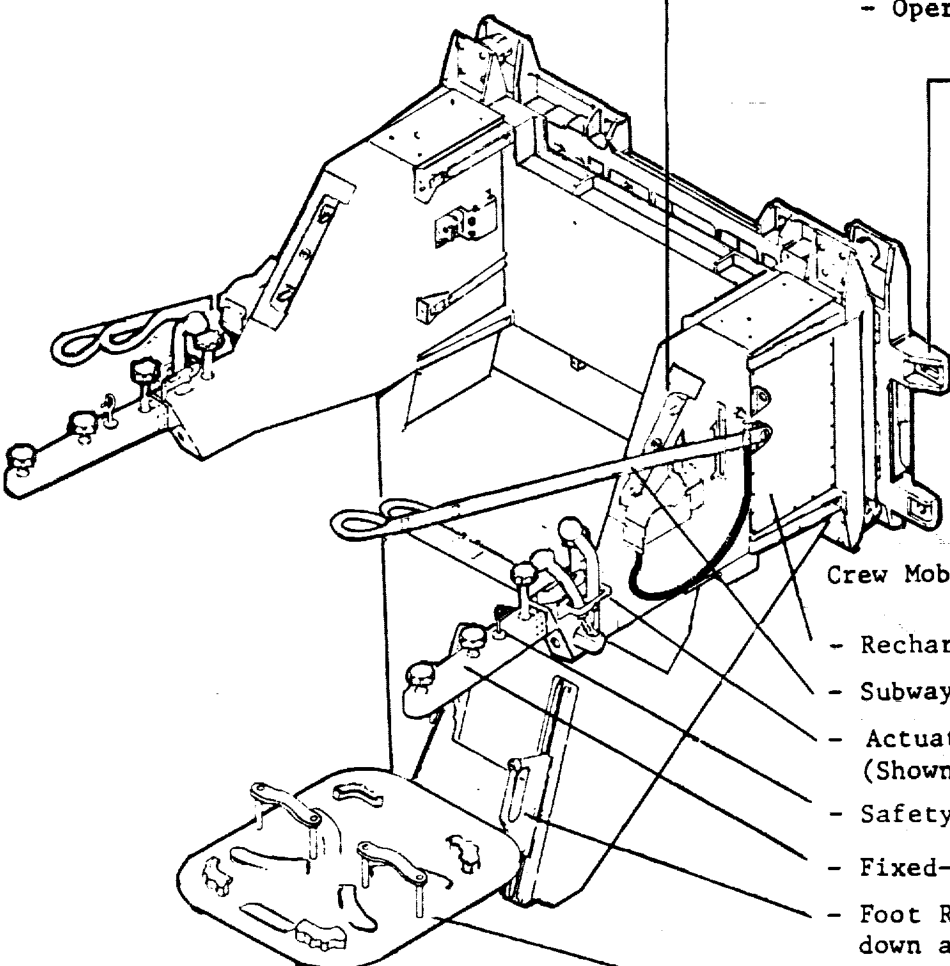


Figure 3 - FLIGHT SUPPORT STATION

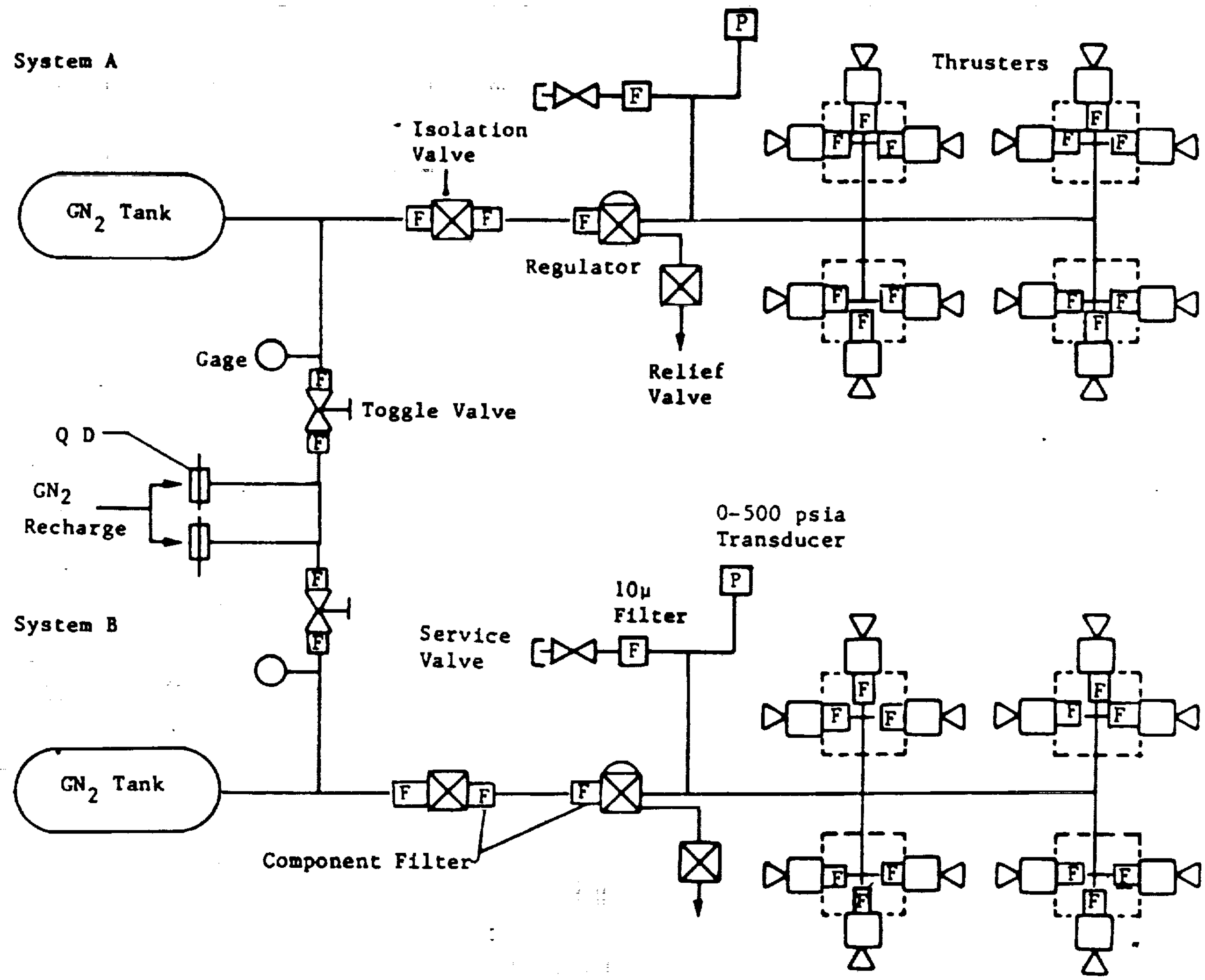


Figure 4 - PROPULSION SUBSYSTEM SCHEMATIC

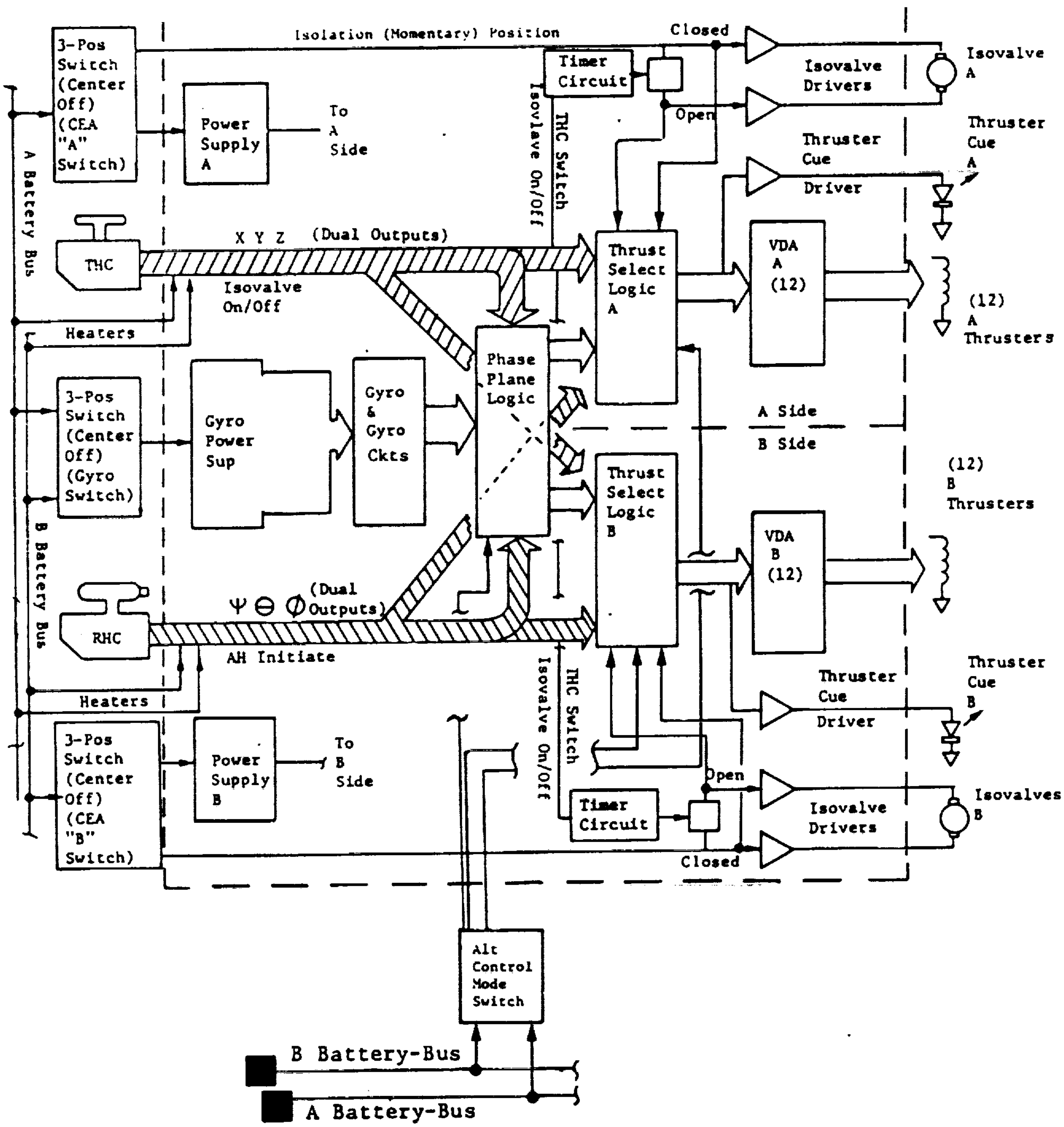


Figure 5 - ELECTRICAL/POWER SUBSYSTEM OVERVIEW

The CEA contains circuitry to operate the thruster valves of the propulsion system, and circuitry to respond to hand-controller commands for translational and rotational control. Gyro circuitry provides attitude and rate information. Phase-plane circuitry furnishes inputs for the thruster select logic for the automatic attitude hold mode of operation.

The thruster select logic uses either or both redundant thruster sets to convert manual and/or attitude hold commands to thrust commands. Valve drive amplifiers amplify the thruster valve signals to levels required for valve operation. Isolation valves, when open, allow GN2 to flow from the pressure vessels to the pressure regulators.

Thruster cue lights allow a visible indication of thruster commands and isolation valve operation.

The power comprises two silver-zinc batteries and two separate power distribution systems that include the circuit breakers, switches, and relays required for MMU operation. Power conditioners in the CEA, fed from the batteries, supply power to the CEA and hand controllers. Locator lights provide visible indication of the location of the EVA crewmember to an observing crewmember inside the Orbiter. The locator lights consist of a converter assembly and three light assemblies. The batteries also furnish heater power for the propulsion heaters and handcontroller case heaters. Heaters are required for both orbital storage and EVA operations. During EVA, skin temperatures can be as low as -120 degrees F, whereas most components must be above -60 degrees F for operation.

3. Support Structures and Mechanisms - The basic MMU structure consists of two side towers connected by the center structure and two arms. The towers support the thrusters and provide mounting for the MMU/FSS retention latches and the propulsion subsystem Quick Disconnects (QDs). The center structure supports the two batteries, eight circuit breakers, the CEA, two pressure vessels, and propulsion equipment. Also supported are the external power connector, and thermal cover, and the thermal covers for the batteries.

In conjunction with the towers, the center structure supports the retention system for the EMU. This EMU/MMU retention system consists of two independent manually activated latches, guide ramps, and back-support points. The arms can be pivoted and extended for flight or located in the stowed position.

4. Flight Support Station (FSS) - The FSS, reference Figure 3, provides MMU stowage, GN2 pressure vessel recharge, and stowage heaters for the MMU on the port or starboard side of the Orbiter near the EVA airlock and hatch.

The FSS structure comprises the side arms, foot restraints, and the Orbiter mounting structure. A locking handle and butterfly latch are provided for flight docking, capture, and release of the MMU. The foot restraints are adjustable on orbit to accomodate the full range of astronaut anthropometry. Shock mounts (vibration isolators) are provided to attenuate the Orbiter launch environment. The MMU is secured in the FSS during launch with four capture bolts and Gas Actuated Nuts (GANs) installed in the MMU. On astronaut operation, the nuts will actuate and MMU bolts release, allowing FSS egress. For contingency operations, the nuts can be manually engaged or disengaged.

The pneumatic portion of the FSS consists of a dual Orbiter interface which routes GN2 to redundant charging systems, either one of which can recharge the MMU propulsion system. Each charging system contains a charging valve, vent valve, flex hose, and one-half of the QD. GN2 can also be supplied to the GANs used for MMU-to-FSS launch attachment.

FSS heaters are supplied 28-Vdc power from the Orbiter through two independent power buses. Breakers in the Orbiter cabin furnish circuit protection. Five temperature sensors are provided for crew temperature monitoring of the MMU during orbital storage.

3.2 Interfaces and Locations

Interfaces occur between the MMU (including the FSS) and other Space Transportation System (STS) Orbiter elements in three specific areas. First, the MMU itself interfaces with the FSS. Second, structural, mechanical, electrical, and nitrogen recharge interfaces exist between the Orbiter and the FSS. Third, mechanical and man/machine interfaces exist between the crew-member in the EMU and the MMU.

When not in use the MMU is stowed in the front of the payload bay of the Orbiter on the FSS. Due to this location the MMU is continually exposed to the space environment when in orbit. The EMU to MMU interfaces are depicted in Figure 6. The MMU to FSS interfaces envelopes in the payload bay are depicted in Figures 7 and 8.

3.3 Hierarchy

Figures 9 through 13 illustrate the hierarchal relationships between the MMU, subsystems, and components employed for the enclosed IOA analysis.

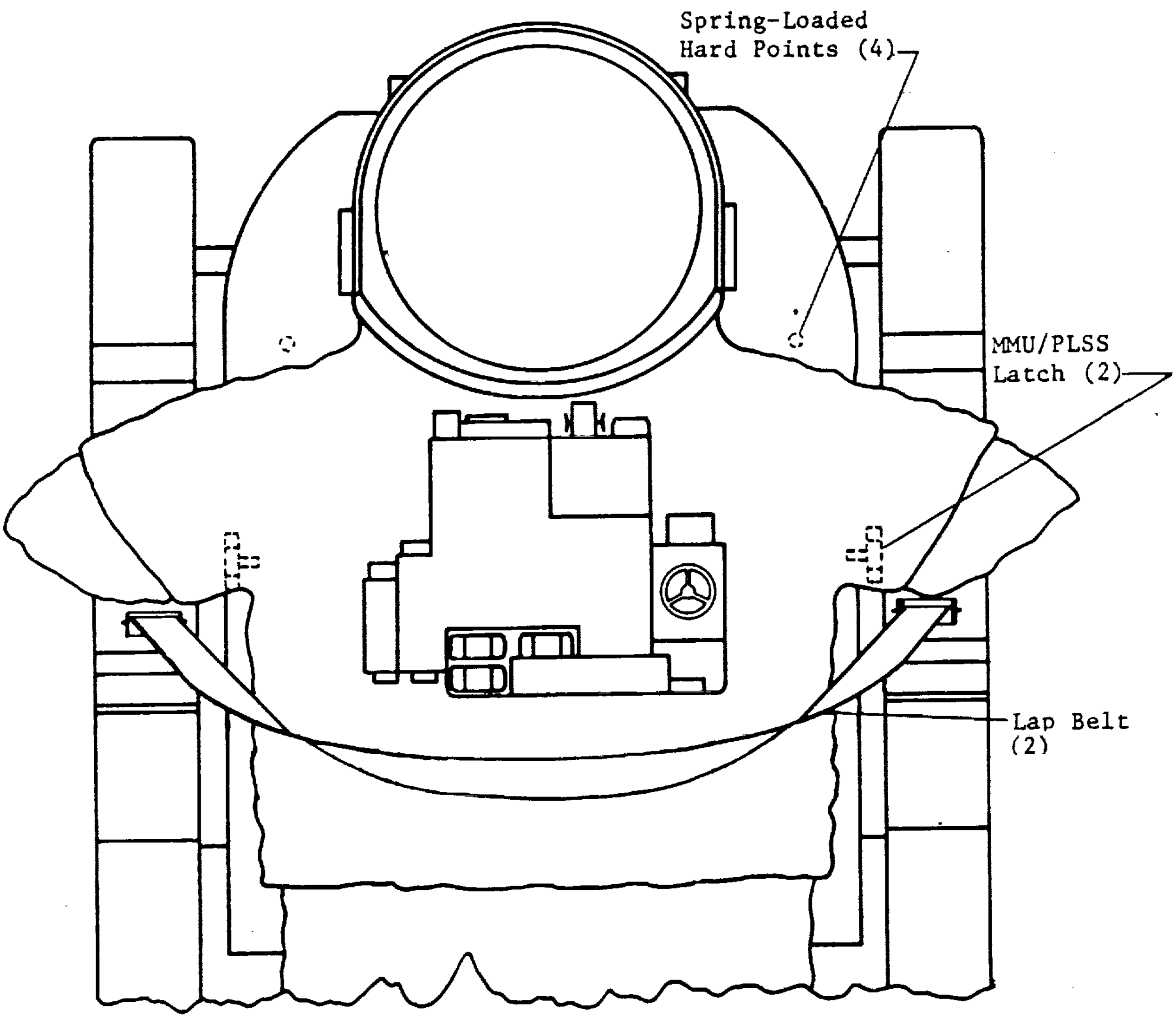


Figure 6 - MMU-EMU INTERFACES

ORIGINAL PAGE IS
OF POOR QUALITY

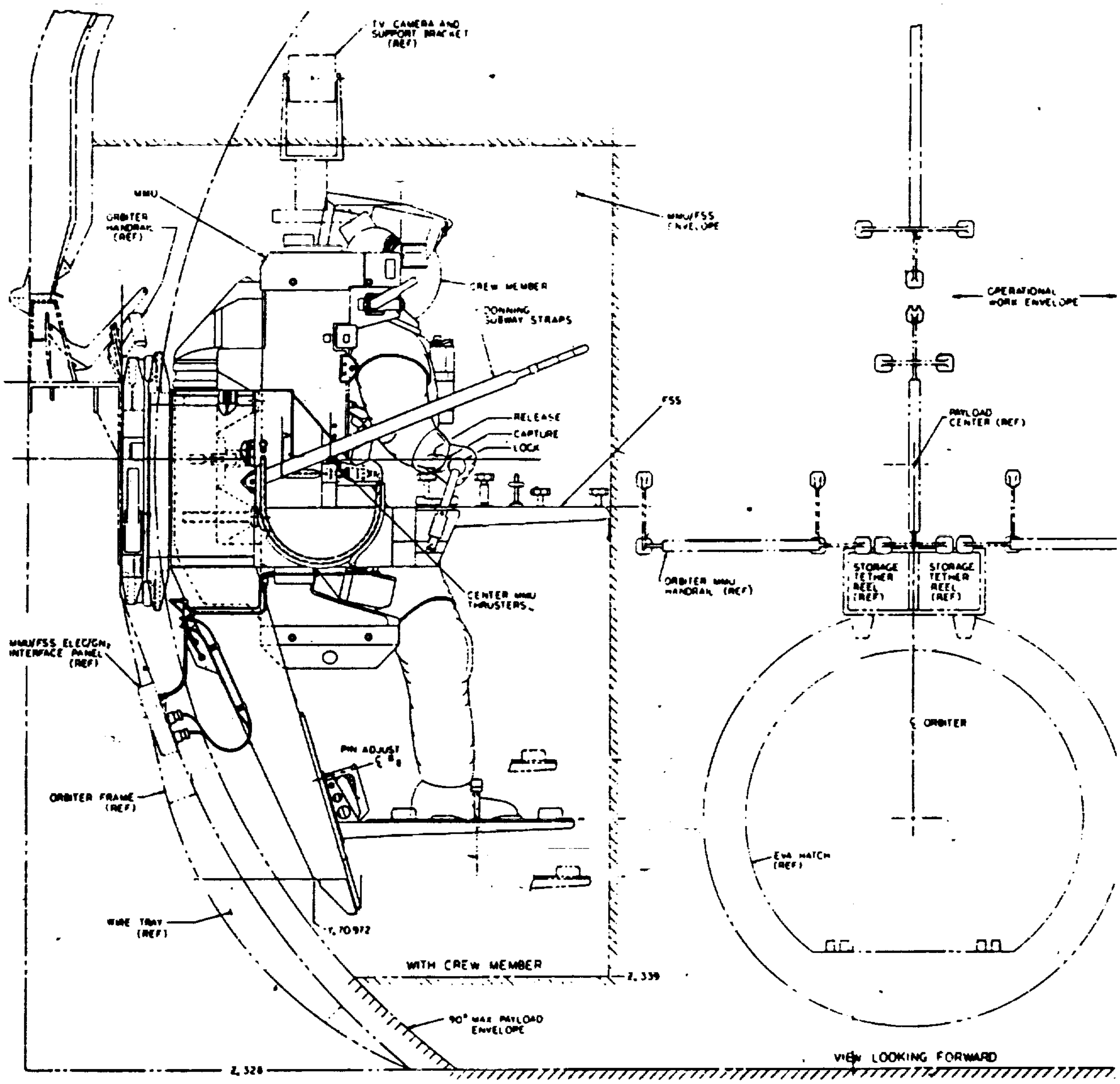


Figure 7 - MMU-FSS ENVELOPE - PORT SIDE

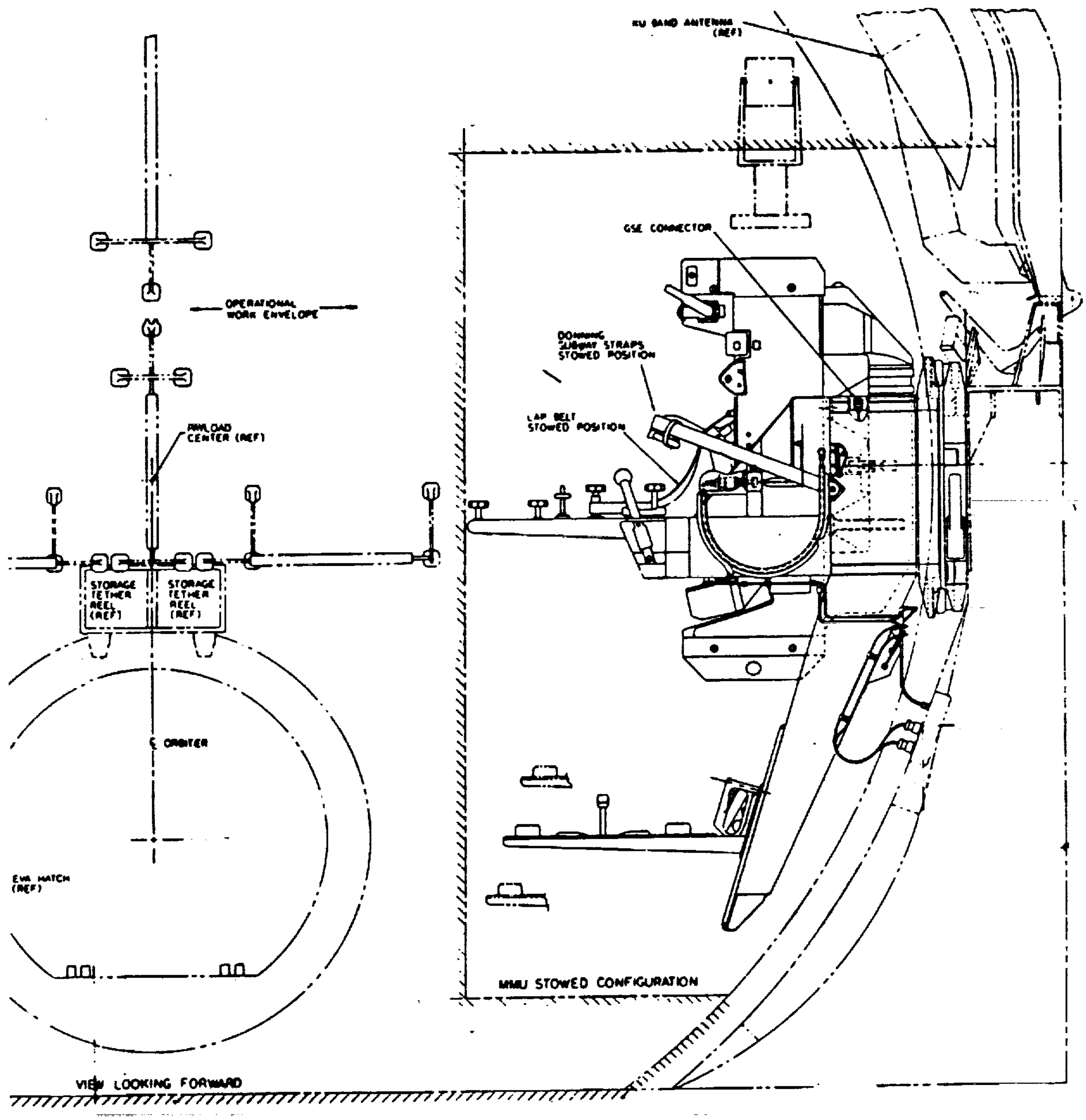


Figure 8 - MMU-FSS ENVELOPE - STARBOARD SIDE

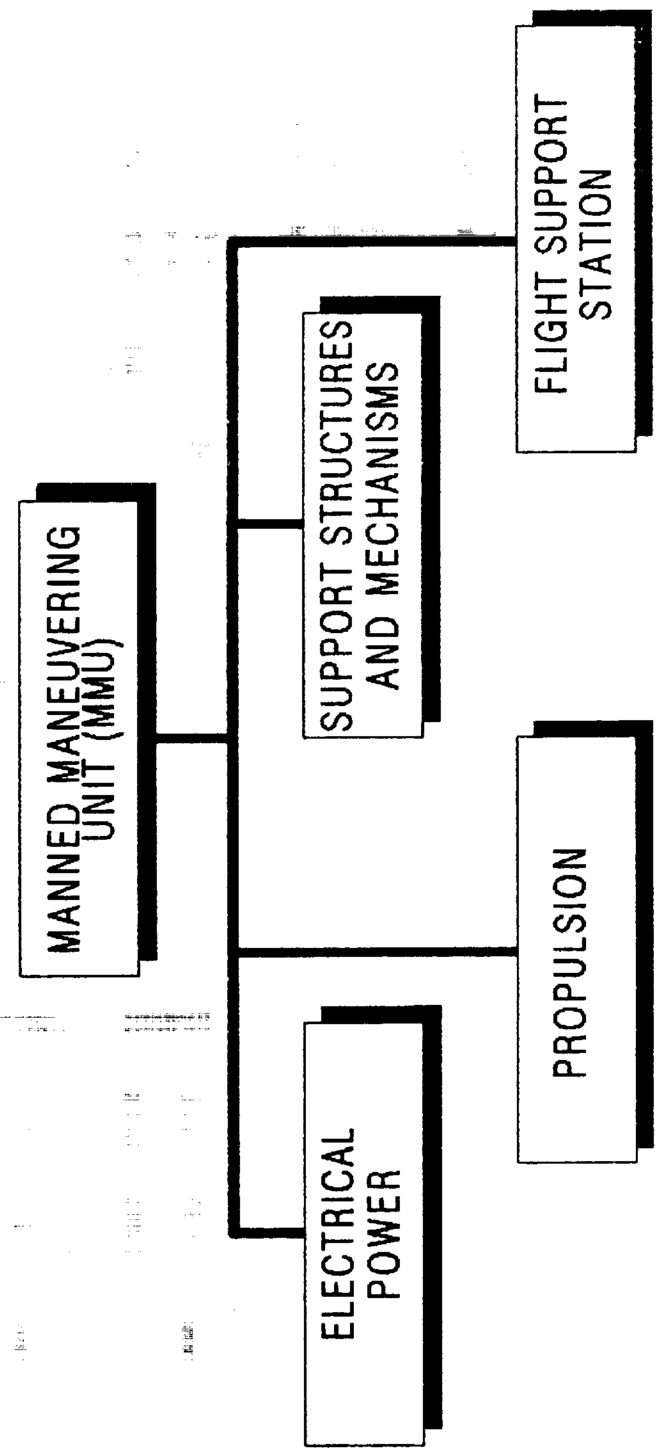


Figure 9 - MMU - TOP LEVEL HIERARCHY

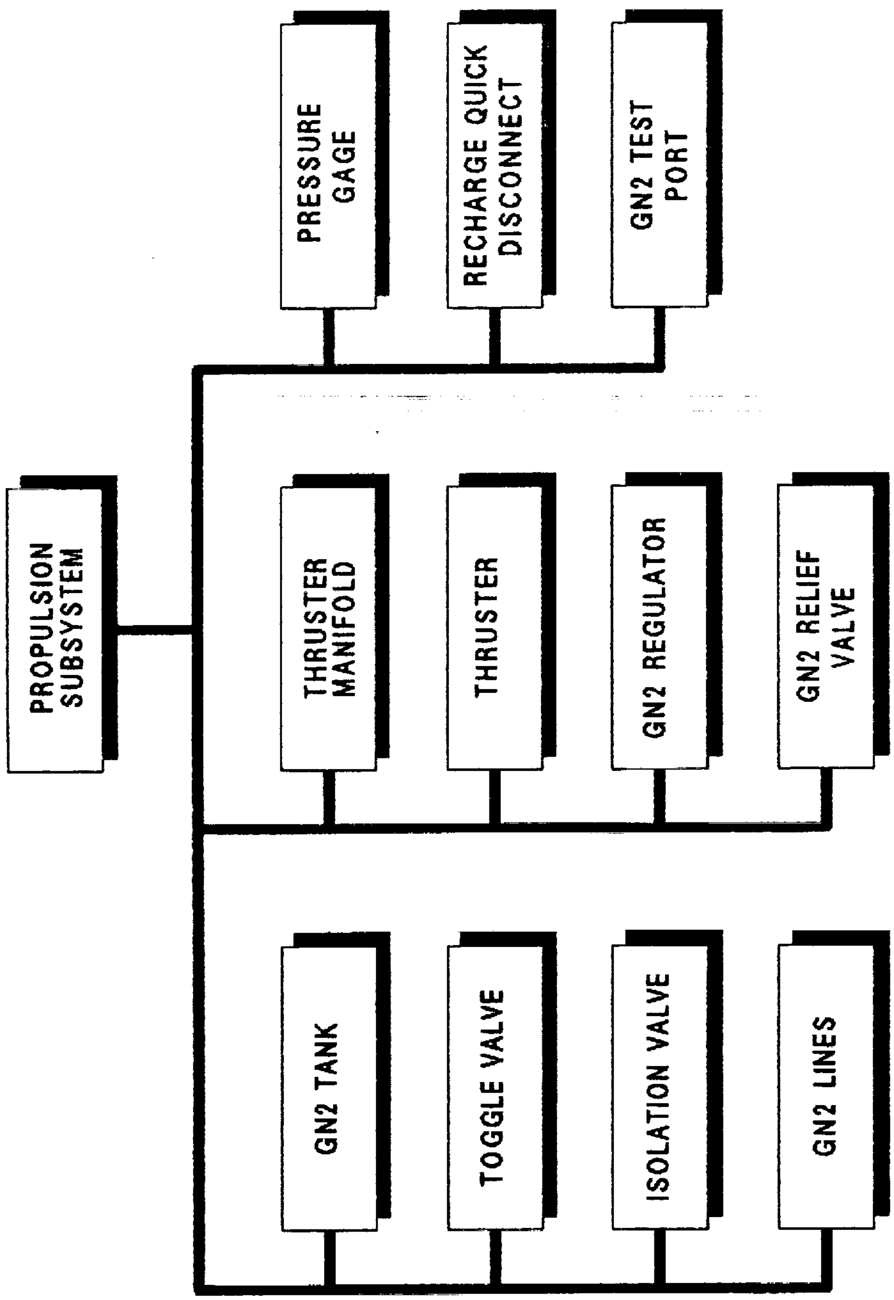


Figure 10 - PROPULSION SUBSYSTEM HIERARCHY

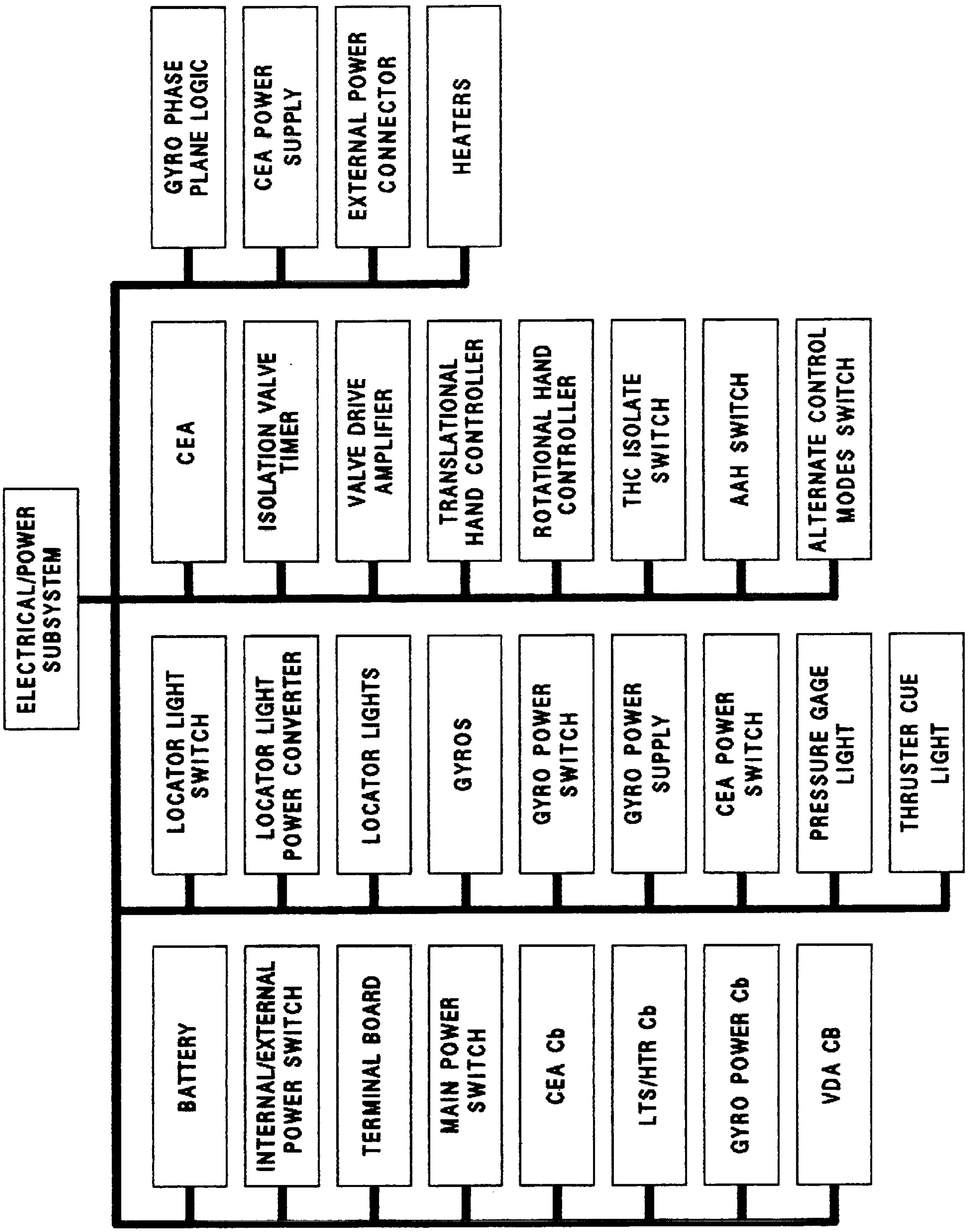


Figure 11 - ELECTRICAL/POWER SUBSYSTEM HIERARCHY

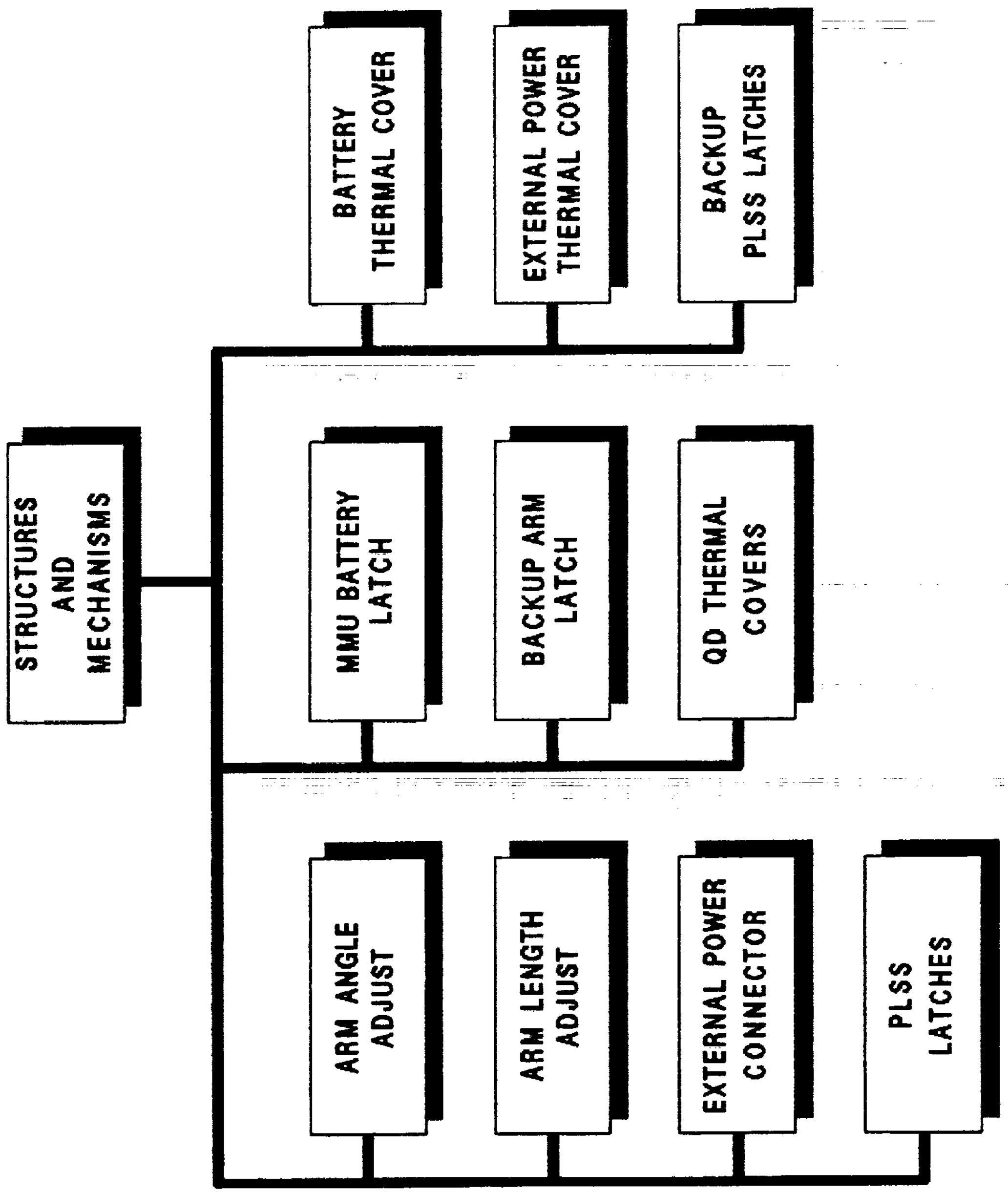


Figure 12 - HIERARCHY OF SUPPORT STRUCTURES AND MECHANISMS

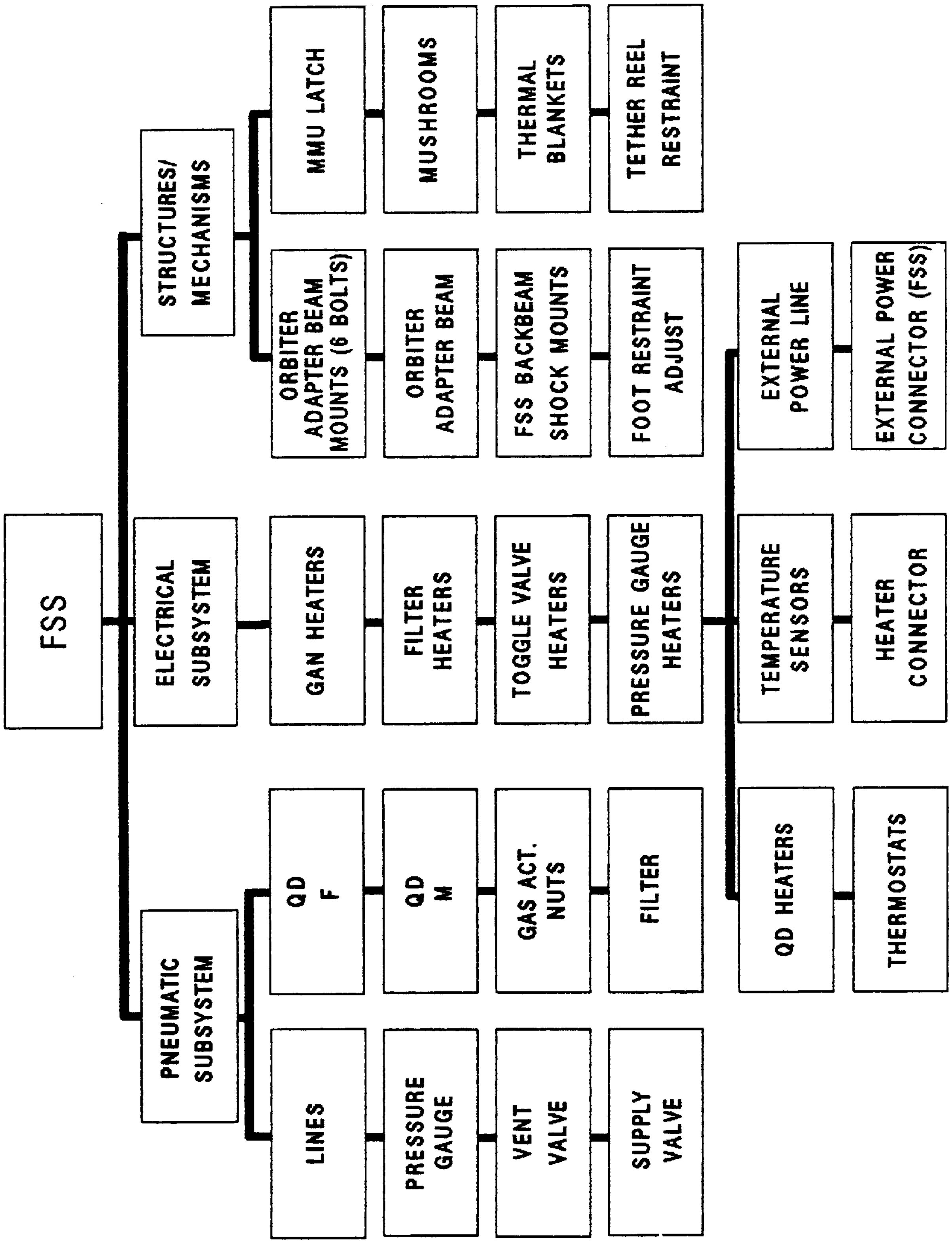


Figure 13 - FSS HIERARCHY

4.0 ANALYSIS RESULTS

The IOA analysis of the MMU resulted in the identification of 136 failure modes (reference Appendix C) from which 69 PCIs (reference Appendix D) were derived. The summary distributions of failure criticalities and their corresponding PCIs are provided in Tables I and II respectively.

TABLE I Summary of IOA Failure Modes and Criticalities

Criticality:	1/1	2/1R	2/2	3/1R	3/2R	3/3	TOTAL
Propulsion	-	13	4	1	2	2	22
Electrical/ Power	5	22	9	-	5	19	60
Support Structures & Mechanisms	-	2	11	-	2	3	18
FSS	-	-	1	2	16	17	36
TOTAL	5	37	25	3	25	41	136

TABLE II Summary IOA of Potential Critical Items

Criticality:	1/1	2/1R	2/2	3/1R	3/2R	TOTAL
Propulsion	-	13	4	-	-	17
Electrical/ Power	5	22	9	-	-	36
Support Structures & Mechanisms	-	2	11	-	1	14
FSS	-	-	1	-	1	2
TOTAL	5	37	25	-	2	69

More detailed discussions of the above findings are presented in the following paragraphs.

4.1 Analysis Results - Propulsion

The MMU propulsion subsystem analysis identified twenty-two (22) failure modes which could occur during a MMU mission. Of these twenty-two failure modes, seventeen (17) were considered PCIs and none were single point failures which could result in loss of life or vehicle. All seventeen single point failure PCIs resulted in mission impacts, and thirteen (13) of these could cause loss of life or vehicle if a redundant MMU propulsion or propulsion control function (typically by loss of a side) were lost.

4.2 Analysis Results - Electrical/Power

Five (5) electrical/power single point failures have been identified by the IOA; any one of which, if realized, can result in loss of crewperson by failure of MMU propulsion control capability.

An additional thirty-one (31) single point failure PCIs also exist as possible mission impacts. Within these PCIs are twenty-two (22) which, if analyzed in conjunction with redundant function failures (frequently loss of other side's propulsion or control functions), result in possible loss of the crewperson.

4.3 Analysis Results - Support Structures and Mechanisms

The hardware encompassed by support structures and mechanisms contains a total of eighteen (18) failure modes from which fourteen (14) PCIs have been identified. Thirteen (13) of these PCIs result in mission termination typically by failing the crewperson restraint/fit function or by failing either MMU mission preparation or consummables recharge. Additionally, two (2) of these PCIs can result in loss of crewperson when their redundant crewperson restraint function is failed. A remaining PCI (MDAC ID 197) also exists which will be both an EMU and MMU mission impact due to inability of the crewperson to release one of the four PLSS-to-MMU latches thereby requiring ingress into the Orbiter, via the airlock, with the MMU connected.

4.4 Analysis Results - FSS

Due to extensive redundancy and support functions, the FSS contains only two PCIs. MDAC analysis ID 220 revealed a mission impact due to inability of the MMU to be removed from the FSS, whereas ID 222 identified potential mission impact due to contamination causing component malfunction when redundant filters are failed.

5.0 REFERENCES

Reference documentation available from NASA was used in the analysis. The documentation used included:

1. NSTS 22206, Instructions for Preparation of Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL), 10 October 1986

2. MMU-SE-17-73, Manned Maneuvering Unit, Space Shuttle Program, Operational Data Book, Volume I, Rev. B, July 1985

3. MMU-SE-17-73, Manned Maneuvering Unit, Space Shuttle Program, Operational Data Book, Volume II, October 1984

4. 852MM000019, Propulsion Flow Diagrams, Rev C, 15 April 1986

5. 852CD0000825, Electrical Check Diagram FSS and MMU, 9 September 1986

APPENDIX A
ACRONYMS

AAH	-	Automatic Attitude Hold
CB	-	Circuit Breaker
CEA	-	Control Electronics Assembly
CIL	-	Critical Items List
EMU	-	Extravehicular Mobility Unit
EVA	-	Extravehicular Activity
F	-	Functional
FMEA	-	Failure Modes and Effects Analysis
FM	-	Failure Mode
FSS	-	Flight Support Station
GAN	-	Gas Actuated Nut
GFE	-	Government Furnished Equipment
GN2	-	Gaseous Nitrogen
HW	-	Hardware
HC	-	Hand Controller
HUT	-	Hard Upper Torso
IOA	-	Independent Orbiter Assessment
IVA	-	Intravehicular Activity
JSC	-	Johnson Space Center
LED	-	Light Emitting Diode
Lts	-	Lights
MDAC	-	McDonnell Douglas Astronautic Company
MMU	-	Manned Maneuvering Unit
NSTS	-	National Space Transportation System
PCI	-	Potential Critical Item
PLB	-	Payload Bay
PLSS	-	Portable Life-Support System
QD	-	fQuick Disconnect
RHC	-	Rotational Hand Controller
Sat Stab	-	Satellite Stabilization
SMM	-	Solar Maximum Mission
SOS	-	Space Operations Simulator
STS	-	Space Transportation System
TCS	-	Thermal Control System
THC	-	Translational Hand Controller
TPAD	-	Trunnion Pin Attach Device
VDA	-	Valve Drive Amplifier

APPENDIX B

DEFINITIONS, GROUND RULES, AND ASSUMPTIONS

APPENDIX B
DEFINITIONS, GROUND RULES, AND ASSUMPTIONS

B.1 Definitions

Definitions contained in NSTS 22206, Instructions For Preparation of FMEA/CIL, 10 October 1986, were used with the following amplifications and additions.

INTACT ABORT DEFINITIONS:

RTLS - begins at transition to OPS 6 and ends at transition to OPS 9, post-flight

TAL - begins at declaration of the abort and ends at transition to OPS 9, post-flight

AOA - begins at declaration of the abort and ends at transition to OPS 9, post-flight

ATO - begins at declaration of the abort and ends at transition to OPS 9, post-flight

CREDIBLE (CAUSE) - an event that can be predicted or expected in anticipated operational environmental conditions. Excludes an event where multiple failures must first occur to result in environmental extremes

CONTINGENCY CREW PROCEDURES - procedures that are utilized beyond the standard malfunction procedures, pocket checklists, and cue cards

EARLY MISSION TERMINATION - termination of onorbit phase prior to planned end of mission

EFFECTS/RATIONALE - description of the case which generated the highest criticality

HIGHEST CRITICALITY - the highest functional criticality determined in the phase-by-phase analysis

MAJOR MODE (MM) - major sub-mode of software operational sequence (OPS)

MC - Memory Configuration of Primary Avionics Software System (PASS)

MISSION - assigned performance of a specific Orbiter flight with payload/objective accomplishments including orbit phasing and altitude (excludes secondary payloads such as GAS cans, middeck P/L, etc.)

MULTIPLE ORDER FAILURE - describes the failure due to a single cause or event of all units which perform a necessary (critical) function

OFF-NOMINAL CREW PROCEDURES - procedures that are utilized beyond the standard malfunction procedures, pocket checklists, and cue cards

OPS - software operational sequence

PRIMARY MISSION OBJECTIVES - worst case primary mission objectives are equal to mission objectives

PHASE DEFINITIONS:

PRELAUNCH PHASE - begins at launch count-down Orbiter power-up and ends at moding to OPS Major Mode 102 (liftoff)

LIFTOFF MISSION PHASE - begins at SRB ignition (MM 102) and ends at transition out of OPS 1 (Synonymous with ASCENT)

ONORBIT PHASE - begins at transition to OPS 2 or OPS 8 and ends at transition out of OPS 2 or OPS 8

DEORBIT PHASE - begins at transition to OPS Major Mode 301 and ends at first main landing gear touchdown

LANDING/SAFING PHASE - begins at first main gear touchdown and ends with the completion of post-landing safing operations

APPENDIX B
DEFINITIONS, GROUND RULES, AND ASSUMPTIONS

B.2 IOA Project Level Ground Rules and Assumptions

The philosophy embodied in NSTS 22206, Instructions for Preparation of FMEA/CIL, 10 October 1986, was employed with the following amplifications and additions.

1. The operational flight software is an accurate implementation of the Flight System Software Requirements (FSSRs).

   RATIONALE: Software verification is out-of-scope of this task.

2. After liftoff, any parameter which is monitored by system management (SM) or which drives any part of the Caution and Warning System (C&W) will support passage of Redundancy Screen B for its corresponding hardware item.

   RATIONALE: Analysis of on-board parameter availability and/or the actual monitoring by the crew is beyond the scope of this task.

3. Any data employed with flight software is assumed to be functional for the specific vehicle and specific mission being flown.

   RATIONALE: Mission data verification is out-of-scope of this task.

4. All hardware (including firmware) is manufactured and assembled to the design specifications/drawings.

   RATIONALE: Acceptance and verification testing is designed to detect and identify problems before the item is approved for use.

5. All Flight Data File crew procedures will be assumed performed as written, and will not include human error in their performance.

   RATIONALE: Failures caused by human operational error are out-of-scope of this task.

6. All hardware analyses will, as a minimum, be performed at the level of analysis existent within NASA/Prime Contractor Orbiter FMEA/CILs, and will be permitted to go to greater hardware detail levels but not lesser.

RATIONALE: Comparison of IOA analysis results with other analyses requires that both analyses be performed to a comparable level of detail.

7. Verification that a telemetry parameter is actually monitored during AOS by ground-based personnel is not required.

RATIONALE: Analysis of mission-dependent telemetry availability and/or the actual monitoring of applicable data by ground-based personnel is beyond the scope of this task.

8. The determination of criticalities per phase is based on the worst case effect of a failure for the phase being analyzed. The failure can occur in the phase being analyzed or in any previous phase, whichever produces the worst case effects for the phase of interest.

RATIONALE: Assigning phase criticalities ensures a thorough and complete analysis.

9. Analysis of wire harnesses, cables and electrical connectors to determine if FMEAs are warranted will not be performed nor FMEAs assessed.

RATIONALE: Analysis was substantially complete prior to NSTS 22206 ground rule redirection.

10. Analysis of welds or brazed joints that cannot be inspected will not be performed nor FMEAs assessed.

RATIONALE: Analysis was substantially complete prior to NSTS 22206 ground rule redirection.

11. Emergency system or hardware will include burst discs and will exclude the EMU Secondary Oxygen Pack (SOP), pressure relief valves and the landing gear pyrotechnics.

RATIONALE: Clarify definition of emergency systems to ensure consistency throughout IOA project.

B.3 MMU Ground Rules and Assumptions

1. Loss of the MMU's automatic attitude hold capability will not be considered life or vehicle threatening, or a mission impact.

   Rationale: To date no normal or contingency MMU operation has been identified or envisioned which would require the automatic attitude hold capability.

2. The availability of the Orbiter to perform a rescue of a stranded crewperson will not be considered in determining the criticality of the applicable failure mode.

   Rationale: The IOA project believes such an exclusion is necessary to ensure worst case scenario analysis results in the most appropriate criticality.

3. For all analyses, it is assumed that the MMU may be required for planned or contingency operations anytime up to initiation of the Orbiter deorbit phase.

   Rationale: The above assumption ensures that failures occuring subsequent to a MMU mission are analyzed for their effect on subsequent MMU missions.

4. The following MMU flight phase definitions are applicable for the analyses provided in Appendix C:

   Pre-Ops: The timeframe extending from installation in the Orbiter to removal of the MMU (on-orbit) from the FSS

   Ops: The on-orbit duration of time during which the MMU is manned and not stowed in the FSS

   Post-Ops: Any timeframe subsequent to on-orbit stowage of the MMU and prior to Orbiter mission completion

5. Although two (2) MMUs are flown on each mission, criticality assignment is performed without consideration to the availability of the second MMU.

   Rationale: The assignment of worst case criticality is ensured by this assumption.

APPENDIX C
DETAILED ANALYSIS

This section contains the IOA analysis worksheets generated during the analysis of this subsystem. The information on these worksheets is intentionally similar to the NASA FMEAs. Each of these sheets identifies the hardware item being analyzed, and parent assembly, as well as the function. For each failure mode, the possible causes are outlined, and the assessed hardware and functional criticality for each mission phase is listed, as described in the NSTS 22206, Instructions for Preparation of FMEA and CIL, 10 October 1986. Finally, effects are entered at the bottom of each sheet, and the worst case criticality is entered at the top.

LEGEND FOR IOA ANALYSIS WORKSHEETS

Hardware Criticalities:

- 1 = Loss of life or vehicle
- 2 = Loss of mission or next failure of any redundant item (like or unlike) could cause loss of life/vehicle
- 3 = All others

Functional Criticalities:

- 1R = Redundant hardware items (like or unlike) all of which, if failed, could cause loss of life or vehicle.
- 2R = Redundant hardware items (like or unlike) all of which, if failed, could cause loss of mission.

Redundancy Screen A:

- 1 = Is Checked Out PreFlight
- 2 = Is Capable of Check Out PreFlight
- 3 = Not Capable of Check Out PreFlight
- NA = Not Applicable

Redundancy Screens B and C:

- P = Passed Screen
- F = Failed Screen
- NA = Not Applicable

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 100 FLIGHT: 2/1R

ITEM: GN2 TANK
FAILURE MODE: LEAK

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: IMPACT, OVERWRAP SEPARATION (MANV.)

EFFECTS/RATIONALE:
LOSS OF PROPELLANT LEADING TO LOSS OF SIDE, PROPULSIVE CAPABILITY. LOSS OF SECOND SIDE STRANDS CREWMEMBER IN FREE SPACE. POSSIBLE PROPULSIVE VENT LEADING TO LOSS OF CONTROL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 102 FLIGHT: 3/2R

ITEM: TOGGLE VALVE
FAILURE MODE: FAIL OPEN

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/2R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION SEAT FAILURE/WEAR

EFFECTS/RATIONALE:
FAILED OPEN VALVE CAUSES LOSS OF TOTAL REDUNDANCY, BUT NOT OF NOMINAL OPERATIONAL OR MALFUNCTION REDUNDANCY. LOSS OF BOTH VALVES DOES CAUSE LOSS OF PROPULSION SYSTEM REDUNDANCY AND REQUIRES MISSION TERMINATION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 103

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/2

ITEM: TOGGLE VALVE
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	2/2

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION ON SEAT, INLET OR OUTLET FILTER BLOCKED

EFFECTS/RATIONALE:
FAILED CLOSED VALVE PREVENTS USE OF PROPELLANT OF FAILED SIDE IN GOOD SIDE, BUT NORMAL SYSTEM REDUNDANCY PRESENT. FAILURE PREVENTS RECHARGE SO POST EVA MISSION MAY BE JEOPORDIZED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 104

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/2

ITEM: ISOLATION VALVE
FAILURE MODE: FAIL OPEN

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/2
OPS:	2/2
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MECHANICAL FAILURE, ELECTRICAL SHORT/OPEN

EFFECTS/RATIONALE:
IF DETECTED LOSS OF MISSION SINCE MMU MUST NOT BE FLOWN WITHOUT ISOLATE CAPABILITY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 105 FLIGHT: 2/1R

ITEM: ISOLATION VALVE
FAILURE MODE: FAIL CLOSE

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [F] C [F]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MECHANICAL FAILURE, ELECTRICAL SHORT/OPEN, INLET OR OUTLET FILTER BLOCKED.

EFFECTS/RATIONALE:
IF SUBSYSTEM A ISOLATION VALVE FAILS CLOSED, THE GAS TANK ON THAT SIDE IS SHUT OFF FROM THE THRUSTERS ON THAT SIDE. LOSS OF FUNCTION OF THAT SIDE RESULTS. LOSS OF PROPULSION SUBSYSTEM REDUNDANCY RESULTS, A MISSION RULE IS VIOLATED, LOSS OF MISSION RESULTS. LOSS OF OTHER SIDE CAN RESULT IN STRANDED CREWPERSON.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 106

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R

ITEM: GN2 LINES
FAILURE MODE: LEAK

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MATERIAL FAILURE AT SEALS AND/OR CONNECTORS

EFFECTS/RATIONALE:
IF LEAK IS LARGE, ISOLATION VALVE WILL BE CLOSED IF GAS HAS NOT ALL LEAKED OUT ALREADY. IN EITHER CASE, FUNCTION OF CORRESPONDING PROPULSION SUBSYSTEM IS LOST AND THEREFORE PROPULSION SUBSYSTEM REDUNDANCY IS LOST. THIS VIOLATES A MISSION RULE
RESULTING IN MISSION TERMINATION. LOSS OF OTHER SIDE CAN RESULT IN POSSIBLE LOSS OF CREWPERSON BY STRANDING.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 110 FLIGHT: 2/1R

ITEM: THRUSTER MANIFOLD
FAILURE MODE: LEAK

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MATERIAL FAILURE, SEAL FAILURE, THERMAL CYCLING

EFFECTS/RATIONALE:
IF LEAK IS LARGE, SIDE ISOLATED, CAUSING LOSS OF SIDE. POSSIBLE STRANDING OF CREWPERSON WITH LOSS OF OTHER SIDE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 111
FLIGHT: 2/1R

ITEM: THRUSTER MANIFOLD
FAILURE MODE: CONSTRICTION

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION, IMPACT, INLET FILTER BLOCKED

EFFECTS/RATIONALE:
IF CONSTRICTION OBSTRUCTIVE ENOUGH, MARKED LOSS OF THRUST RESULTS, LEADS TO EFFECTIVE LOSS OF SIDE. POSSIBLE STRANDING OF CREWMEMBER IF OTHER SIDE FAILS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 112 FLIGHT: 2/1R

ITEM: THRUSTER
FAILURE MODE: FAIL OPEN

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION, GALLING

EFFECTS/RATIONALE:
CAUSES UNCOMMANDED ACCELERATION, LOSS OF SIDE. POSSIBLE STRANDING OF CREWMEMBER IF OTHER SIDE FAILS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 113

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R

ITEM: THRUSTER
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: SHORT/OPEN CIRCUIT IN SOLENOID; CONTAMINATION, GALLING, FILTER BLOCKED

EFFECTS/RATIONALE:
CAUSES UNCOMMANDED ACCELERATION, SLUGGISH RESPONSE. SIDE CAN BE USED BUT IS PROBABLY BEST SHUT OFF. IF OTHER SIDE FAILS, CREWPERSON CANNOT CONTROL MMU AND MAY BE STRANDED OR DRIVE INTO OTHER OBJECT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 114

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R

ITEM: THRUSTER
FAILURE MODE: LEAK

LEAD ANALYST: P. BAILEY   SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MATERIAL FAILURE/FRACTURE, SEAL FAILURE

EFFECTS/RATIONALE:
LARGE LEAK COULD CAUSE LOSS OF ALL GAS ON SIDE. IF BOTH SIDES ARE LOST, POSSIBLE STRANDING OF CREWPERSON.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 116 FLIGHT: 2/1R

ITEM: GN2 REGULATOR
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MATERIAL FAILURE, CONTAMINATION, SPRING FRACTURE, FILTER BLOCKED

EFFECTS/RATIONALE:
REGULATOR FAILED CLOSED CAUSES LOSS OF SIDE. IF BOTH SIDES LOST, POSSIBLE STRANDING OF CREWPERSON.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 117 FLIGHT: 2/1R

ITEM: GN2 REGULATOR
FAILURE MODE: FAIL OPEN

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/1R
OPS:	2/1R
POST-OPS:	2/1R

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: SPRING FAILURE, MATERIAL FAILURE, CONTAMINATION

EFFECTS/RATIONALE:
REGULATOR FAILED OPEN CAUSES LOSS OF SIDE. IF RELIEF FAILS. POSSIBLE "EXPLOSIVE" FAILURE DUE TO OVERPRESSURIZATION OF MANIFOLD CAUSING HIGH VELOCITY SHRAPNEL, WHICH CAN CAUSE LOSS OF CREWPERSON.
LOSS OF OTHER SIDE CAN STRAND CREWPERSON.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 119 FLIGHT: 2/2

ITEM: GN2 REGULATOR
FAILURE MODE: FAIL LOW

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/2
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION, SPRING FAILURE, INCORRECT CAL.

EFFECTS/RATIONALE:
SLUGGISH CONTROL RESPONSE. MISSION TERMINATION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 120 FLIGHT: 2/1R

ITEM: GN2 RELIEF VALVE
FAILURE MODE: FAIL OPEN

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: SPRING FAILURE

EFFECTS/RATIONALE:
FAILED OPEN CAUSES LOSS OF ALL GAS UNLESS ISO. VALVE IS CLOSED. MISSION TERMINATION POSSIBLE. LOSS OF OTHER SIDE CAN RESULT IN CREWPERSON BEING STRANDED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 121 FLIGHT: 3/1R

ITEM: GN2 RELIEF VALVE
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/1R
OPS:	3/1R
POST-OPS:	3/1R

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: SPRING FAILURE, CONTAMINATION

EFFECTS/RATIONALE:
IF REGULATOR FAILS OPEN AND RELIEF VALVE ALSO FAILS CLOSED, CAPABILITY TO REGULATE GAS PRESSURE AT THRUSTER MANIFOLD IS LOST, RESULTING IN POSSIBLE EXPLOSION OF MANIFOLD, DAMAGE TO ORBITER, OR LOSS OF CREWMEMBER.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 122 FLIGHT: 2/1R

ITEM: PRESSURE GAGE
FAILURE MODE: LEAK

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MATERIAL FAILURE

EFFECTS/RATIONALE:
LEAK CAUSES GAS LOSS, LOSS OF SIDE IF LEAK LARGE ENOUGH. POSSIBLE STRANDING OF CREWPERSON IF BOTH SIDES ARE LOST.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 123

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3

ITEM: PRESSURE GAGE
FAILURE MODE: FAIL HIGH (INDICATION)

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MATERIAL FAILURE OF BOURDON TUBE - TUBE RELAXES, CONTAMINATION

EFFECTS/RATIONALE:
IF DETECTED, DIAGNOSE WITH MALF PROCEDURE. CONTINUE MISSION, NO IMPACT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 124 FLIGHT: 3/3

ITEM: PRESSURE GAGE
FAILURE MODE: FAIL LOW (INDICATION)

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION/BLOCKAGE OF BOURDON TUBE

EFFECTS/RATIONALE:
IF DETECTED, DIAGNOSE WITH MALF PROCEDURE. CONTINUE MISSION, NO IMPACT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 125 FLIGHT: 2/2

ITEM: RECHARGE QUICK DISCONNECT
FAILURE MODE: FAIL OPEN/LEAK

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	2/2

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION, MATERIAL DEFECT OF SEAL, SPRING FRACTURE

EFFECTS/RATIONALE:
FAIL OPEN WILL PREVENT RECHARGE AND SUBSEQUENT MISSIONS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 126

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/2R

ITEM: RECHARGE QUICK DISCONNECT
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/2R

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MATERIAL DEFECT, SPRING FRACTURE, CONTAMINATION

EFFECTS/RATIONALE:
FAILURE CLOSED OF BOTH QD'S PREVENTS RECHARGE AND SUBSEQUENT MISSIONS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 127 FLIGHT: 2/1R

ITEM: GN2 TEST PORT
FAILURE MODE: LEAK

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) PROPULSION SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: SEAL FAILURE

EFFECTS/RATIONALE:
LOSS OF GAS RESULTING IN LOSS OF SIDE. POSSIBLE STRANDING OF CREWPERSON WITH LOSS OF BOTH SIDES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 128
FLIGHT: 2/1R

ITEM: BATTERY
FAILURE MODE: NO OUTPUT - LOW OUTPUT

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION, CORROSION, OPEN

EFFECTS/RATIONALE:
LOSS OF BATTERY INDUCES LOSS OF PROPULSION SUBSYSTEM. POSSIBLE STRANDING OF CREWPERSON.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 129

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R

ITEM: INTERNAL/EXTERNAL POWER SWITCH
FAILURE MODE: FAIL OPEN

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION, MATERIAL FAILURE

EFFECTS/RATIONALE:
LOSS OF POWER TO HEATERS RESULTS, POSSIBLE LOSS OF SIDE IF LOW TEMP. LIMITS EXCEEDED AND EQUIPMENT DAMAGED. POSSIBLE STRANDING OF CREWPERSON WITH LOSS OF BOTH SIDES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 130 FLIGHT: 2/2

ITEM: INTERNAL/EXTERNAL POWER SWITCH
FAILURE MODE: FAIL TO INTERNAL POSITION

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/2
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION, MATERIAL FAILURE OF CONTACT-FRACTURE

EFFECTS/RATIONALE:
POWER NOT AVAILABLE TO HEATERS DURING STORAGE, POSSIBLE LOSS OF SIDE DUE TO EQUIPMENT UNDER TEMPS. MISSION TERMINATION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 131 FLIGHT: 2/1R

ITEM: INTERNAL/EXTERNAL POWER SWITCH
FAILURE MODE: FAIL TO EXTERNAL POSITION

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/2
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION, MATERIAL FAILURE OF CONTACTS-FRACTURE

EFFECTS/RATIONALE:
POWER LOSS TO HEATERS DURING FLIGHT. POSSIBLE LOSS OF SIDE. POSSIBLE STRANDING OF CREWPERSON WITH LOSS OF BOTH SIDES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 132

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R

ITEM: TERMINAL BOARD
FAILURE MODE: SHORT

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: DEBRIS, CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF POWER TO AFFECTED CIRCUITS AND/OR RAPID BATTERY POWER USAGE CAUSES LOSS OF SIDE AND MISSION TERMINATION. POSSIBLE TO STRAND CREWPERSON WITH LOSS OF OTHER ELECTRICAL SUBSYSTEM.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 133
FLIGHT: 2/1R

ITEM: TERMINAL BOARD
FAILURE MODE: FAIL OPEN

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/2
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: IMPACT, VIBRATION

EFFECTS/RATIONALE:
LOSS OF POWER TO AFFECTED CIRCUITS. LOSS OF SIDE. POSSIBLE LOSS OF CREWPERSON WITH LOSS OF BOTH SIDES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 134 FLIGHT: 2/1R

ITEM: MAIN POWER SWITCH
FAILURE MODE: FAIL OFF

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/2
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: A OR B SIDE
PART NUMBER:

CAUSES: CONTAMINATION, CORROSION, UNDER TEMPERATURE

EFFECTS/RATIONALE:
LOSS OF POWER TO SIDE. POSSIBLE STRANDING OF CREWPERSON WITH LOSS OF BOTH SIDES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 135

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/2

ITEM: MAIN POWER SWITCH
FAILURE MODE: FAIL ON

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/2
OPS:	3/3
POST-OPS:	2/2

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION, UNDER TEMPERATURE

EFFECTS/RATIONALE:
CANNOT EMPLOY EXTERNAL PWR DURING STOWAGE, HENCE NO HEATERS & POSSIBLE DAMAGE TO UNIT. MISSION TERMINATION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 136

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R

ITEM: LTS/HTR.cb
FAILURE MODE: FAIL OPEN

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
LOSS OF POWER TO ALL HEATERS, POSSIBLE LOSS OF SIDE. POSSIBLE STRANDING OF CREWPERSON WITH LOSS OF BOTH SIDES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 137

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/2R

ITEM: LTS/HTR.Cb
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/2R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION, CORROSION, MECHANICAL FAILURE

EFFECTS/RATIONALE:
LOSS OF cb PROTECTION IN CASE OF OVERCURRENT TO HEATERS OF LOCATOR LIGHTS. 2ND FAILURE (i.e. SHORT) REQUIRED FOR MISSION TERMINATION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 138
FLIGHT: 2/1R

ITEM: CEA CIRCUIT BREAKER
FAILURE MODE: FAIL OPEN

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION MANUFACTURING DEFECT

EFFECTS/RATIONALE:
LOSS OF POWER TO ASSOCIATED SUBSYSTEM CEA. THIS RESULTS IN LOSS OF ASSOCIATED PROPULSION SUBSYSTEM, FORCES IMMEDIATE TERMINATION OF MISSION. IF BOTH CEA cb's FAIL OPEN, CREWMEMBER IS STRANDED DUE TO LOSS OF ALL CONTROL AUTHORTY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 139 FLIGHT: 3/2R

ITEM: CEA CIRCUIT BREAKER
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/2R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION, CORROSION, MECHANICAL FAILURE

EFFECTS/RATIONALE:
NO cb PROTECTION IN CASE OF OVERCURRENT TO CEA. 2ND FAILURE (i.e. SHORT) REQUIRED FOR MISSION TERMINATION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 140

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3

ITEM: GYRO PWR cb
FAILURE MODE: FAIL OPEN

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
MAY CAUSE LOSS OF AUTOMATIC ATTITUDE HOLD. MISSION CONTINUES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 141

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/2R

ITEM: GYRO PWR cb
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/2R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION, CORROSION, MECHANICAL FAILURE

EFFECTS/RATIONALE:
NO OVERCURRENT PROTECTION. IF A SECOND FAILURE (i.e. SHORT) OCCURS DAMAGE TO GYROS MAY CAUSE DAMAGE TO OTHER CEA COMPONENTS. MISSION TERMINATES IF DETECTED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 142

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R

ITEM: VDA cb
FAILURE MODE: FAIL OPEN

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
LOSS OF POWER TO VDA'S. RESULTS IN LOSS OF SIDE. POSSIBLE LOSS OF CREWPERSON WITH LOSS OF BOTH SIDES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 143
FLIGHT: 3/2R

ITEM: VDA cb
FAILURE MODE: FAIL CLOSE

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/2R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION, MECHANICAL FAILURE, CORROSION

EFFECTS/RATIONALE:
NO OVERCURRENT PROTECTION TO VDA'S. IF AI SHORT OCCURS, POSSIBLE DAMAGE TO OTHER COMPONENTS AND MISSION TERMINATION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 144

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3

ITEM: LOCATOR LIGHT SWITCH
FAILURE MODE: FAIL OFF

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [F]

LOCATION:
PART NUMBER:

CAUSES: CONTAMINATION, MECHANICAL FAILURE, ELECTRICAL OPEN

EFFECTS/RATIONALE:
LOSS OF LOCATOR LIGHTS. MISSION CONTINUES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 145
FLIGHT: 3/3

ITEM: LOCATOR LIGHT SWITCH
FAILURE MODE: FAIL ON POSITION A

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: CONTAMINATION, MECHANICAL FAILURE, SHORT

EFFECTS/RATIONALE:
LIGHT POWER SOURCE NOT SELECTABLE. MISSION CONTINUES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 146 FLIGHT: 3/3

ITEM: LOCATOR LIGHT SWITCH
FAILURE MODE: FAIL ON POSITION B

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION:
PART NUMBER:

CAUSES: CONTAMINATION, MECHANICAL FAILURE, SHORT

EFFECTS/RATIONALE:
LIGHT POWER SOURCE NOT SELECTABLE. MISSION CONTINUES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 147 FLIGHT: 3/2R

ITEM: LOCATOR LIGHT POWER CONVERTER
FAILURE MODE: FAIL HIGH/FAIL LOW

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/2R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: CONTAMINATION, SHORT

EFFECTS/RATIONALE:
LOSS OF LOCATOR LIGHTS MAY RESULT. MISSION MAY BE IMPACTED DUE TO POWER UASGE ON THE BATTERY SIDE WITH SHORT AND IF OTHER SIDE'S POWER FAILS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 148

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3

ITEM: LIGHT
FAILURE MODE: 1-3 LIGHTS BURN OUT

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: MATERIAL DEFECT. LIFETIME LIMIT.

EFFECTS/RATIONALE:
EACH LAMP HAS 4 INDEPENDENT FILAMENTS ON 2 SEPARATE BUSES. LAMPS OPERATE INDEPENDENTLY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 149 FLIGHT: 3/3

ITEM: GYRO POWER SWITCH
FAILURE MODE: FAIL OPEN (OFF)

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION:
PART NUMBER:

CAUSES: CONTAMINATION, UNDERTEMP.

EFFECTS/RATIONALE:
LOSS OF AUTOMATIC ATTITUDE HOLD. MISSION CONTINUES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 150 FLIGHT: 3/3

ITEM: GYRO POWER SWITCH
FAILURE MODE: FAIL ON IN A OR B

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [NA]

LOCATION:
PART NUMBER:

CAUSES: CONTAMINATION, UNDERTEMP.

EFFECTS/RATIONALE:
INABILITY TO SELECT ALTERNATE POWER SOURCE OR DESELECT CURRENT POWER SOURCE. MISSION CONTINUES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 151
FLIGHT: 3/3

ITEM: GYRO POWER SUPPLY
FAILURE MODE: FAIL OFF/FAIL HIGH/FAIL LOW

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3) GYRO POWER SUPPLY
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [NA]

LOCATION:
PART NUMBER:

CAUSES: OVERTEMP, CONTAMINATION, MECHANICAL FAILURE, SHORT

EFFECTS/RATIONALE:
CAUSES DEGRADATION OR LOSS OF AUTOMATIC ATTITUDE HOLD. MISSION CONTINUES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 152
FLIGHT: 2/1R

ITEM: CEA POWER SWITCH
FAILURE MODE: FAIL ON IN ISO.

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION, MECHANICAL FAILURE

EFFECTS/RATIONALE:
ISOLATES SIDE, CAUSES LOSS OF SIDE. POSSIBLE LOSS (STRANDING) OF CREWPERSON IF OTHER SIDE FAILS ALSO.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 153

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3

ITEM: CEA POWER SWITCH
FAILURE MODE: FAIL ON

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [F]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION, UNDER TEMP.

EFFECTS/RATIONALE:
INABILITY TO SELECTIVELY ISOLATE WITHOUT USE OF MAIN PWR SW. NO IMPACTS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 154 FLIGHT: 2/1R

ITEM: CEA POWER SWITCH
FAILURE MODE: FAIL OFF

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION, UNDER TEMP.

EFFECTS/RATIONALE:
UNDER TEMP FAILURES WOULD OCCUR BEFORE FLIGHT. MISSION TERMINATION. POSSIBLE LOSS OF CREWPERSON WITH LOSS OF OTHER CEA DURING FLIGHT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 155

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3

ITEM: CEA POWER SWITCH
FAILURE MODE: FAIL OFF IN ISO.

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MECHANICAL FAILURE, CORROSION, CONTAMINATION

EFFECTS/RATIONALE:
NO EFFECT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 156 FLIGHT: 3/3

ITEM: PRESSURE GAGE LIGHT
FAILURE MODE: FAIL OFF

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: OPEN, THERMAL CYCLING

EFFECTS/RATIONALE:
GAUGE MAY FREEZE BUT OTHER GAUGE MAY BE USED. LOSS OF BOTH RESULTS IN NO IMPACTS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 157

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3

ITEM: THRUSTER CUE LT.
FAILURE MODE: FAIL OFF

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES:

EFFECTS/RATIONALE:
NON-CRITICAL FUNCTION. NO IMPACTS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 158 FLIGHT: 2/1R

ITEM: CONTROL ELECTRONICS ASSEMBLY
FAILURE MODE: FAIL ON 1-12 CH.

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: MATERIAL DEFECT, CONTAMINATION, SHORT

EFFECTS/RATIONALE:
LOSS OF SIDE, UNCOMMANDED ACCELERATION. POSSIBLE STRANDING OF CREWPERSON WITH LOSS OF BOTH SIDES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 159
FLIGHT: 2/1R

ITEM: CONTROL ELECTRONICS ASSEMBLY
FAILURE MODE: FAIL OFF 1-12 CH.

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: MATERIAL DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF SIDE, UNCOMMANDED ACCELERATION. SINGLE CHANNEL FAILURE MAY BE DIFFICULT TO DETECT. POSSIBLE STRANDING OF CREWPERSON WITH LOSS OF BOTH SIDES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 160 FLIGHT: 2/1R

ITEM: CONTROL ELECTRONICS ASSEMBLY
FAILURE MODE: NOISY OUTPUT

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: MATERIAL DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
ERATIC RESPONSE TO COMMANDS. VEHICLE MAY BECOME UNCONTROLLABLE UNTIL SIDE TURNED OFF. POSSIBLE STRANDING OF CREWPERSON WITH LOSS OF BOTH SIDES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 161 FLIGHT: 2/1R

ITEM: CONTROL ELECTRONICS ASSEMBLY
FAILURE MODE: LOGIC FAILURE

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: MATERIAL DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
ERATIC RESPONSE TO COMMANDS. VEHICLE MAY BECOME UNCONTROLLABLE UNTIL SIDE TURNED OFF. POSSIBLE LOSS OF CREWPERSON WITH LOSS OF BOTH SIDES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 162
FLIGHT: 2/2

ITEM: ISOLATION VALVE TIMER
FAILURE MODE: FAIL OFF

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/2
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: ELECTRONICS FAILURE, DUE TO THERMAL CYCLING, OPEN, SHORT

EFFECTS/RATIONALE:
MISSION TREMINATION WITH LOSS OF ACCESS TO MAINFOLD DURING PRE-OPS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 163

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/2

ITEM: ISOLATION VALVE TIMER
FAILURE MODE: TOO SHORT

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/2
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MATERIAL FAILURE, SOLID-STATE TIMER DRIFTS, ELECTRICAL SHORT

EFFECTS/RATIONALE:
VALVE WILL EITHER NOT FULLY CLOSE OR NOT FULLY OPEN DEPENDING ON TIME OF FAILURE. MISSION TERMINATION WITH LOSS OF EFFICIENCY IN SIDE WHERE VALVE FAILED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 164 FLIGHT: 2/1R

ITEM: ISOLATION VALVE TIMER
FAILURE MODE: FAILS ON

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MATERIAL FAILURE

EFFECTS/RATIONALE:
DRIVES MOTOR AFTER VALVE FULLY OPEN OR CLOSED. CAN BURN OUT MOTOR. USES EXCESSIVE BATTERY POWER. MISSION TERMINATION. POSSIBLE STRANDING OF CREWPERSON WITH LOSS OF OTHER SIDE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 166
FLIGHT: 2/1R

ITEM: VALVE DRIVER AMPLIFIER
FAILURE MODE: FAIL OFF

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MATERIAL FAILURE, ELECTRICAL OPEN

EFFECTS/RATIONALE:
THRUSTER FAILS OFF, ISO VLV. FAILS OPEN OR CLOSED. MISSION TERMINATION. CREWMEMBER COULD BE STRANDED WITH LOSS OF OTHER SIDE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 167 FLIGHT: 2/1R

ITEM: VALVE DRIVER AMPLIFIER
FAILURE MODE: FAIL ON

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MATERIAL FAILURE

EFFECTS/RATIONALE:
THRUSTER FAIL ON OR ISO VLV. MOTOR CONTINUOUSLY DRIVEN. MISSION TERMINATION. POSSIBLE STRANDING OF CREWPERSON WITH LOSS OF OTHER SIDE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 168 FLIGHT: 2/1R

ITEM: VALVE DRIVER AMPLIFIER
FAILURE MODE: NOISY

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MATERIAL FAILURE, CONTAMINATION

EFFECTS/RATIONALE:
INTERMITTANT UNCOMMANDED ACCELERATIONS, ERRATIC CONTROL RESPONSE. MISSION TERMINATION. POSSIBLE STRANDING OF CREWPERSON IF BOTH SIDES FAIL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 169 FLIGHT: 1/1

ITEM: TRANSLATIONAL HAND CONTROLLER
FAILURE MODE: FAIL ON 1-3 AXES

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/2
OPS:	1/1
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: LOOSE MAGNET, MECHANICAL JAMMING

EFFECTS/RATIONALE:
FAILURE CANNOT BE ISOLATED. LOSS OF PROPULSION CONTROL. ABORT REQUIRED. RESCUE REQUIRED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 170 FLIGHT: 1/1

ITEM: TRANSLATIONAL HAND CONTROLLER
FAILURE MODE: FAIL OFF 1-3 AXES

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/2
OPS:	1/1
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [NA] C [NA]

LOCATION:
PART NUMBER:

CAUSES: LOOSE MAGNET, MECHANICAL JAMMING

EFFECTS/RATIONALE:
IF FAIL OFF IN ALL 3 AXES, LOSS OF PROPULSION FUNCTION. RESCUE REQUIRED. CREWPERSON IS STRANDED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 171 FLIGHT: 1/1

ITEM: ROTATIONAL HAND CONTROLLER
FAILURE MODE: FAIL ON (1-3 AXES)

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/2
OPS:	1/1
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [NA] C [NA]

LOCATION:
PART NUMBER:

CAUSES: LOOSE MAGNET, MECHANICAL JAMMING

EFFECTS/RATIONALE:
FAILURE CANNOT BE ISOLATED. ABORT REQUIRED. RESCUE REQUIRED. CREWPERSON STRANDED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 172 FLIGHT: 1/1

ITEM: ROTATIONAL HAND CONTROLLER
FAILURE MODE: FAIL OFF (1-3 AXES)

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/2
OPS:	1/1
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [NA] C [NA]

LOCATION:
PART NUMBER:

CAUSES: LOOSE MAGNET, MECHANICAL JAMMING

EFFECTS/RATIONALE:
CREWMEMBER MAYNOT BE ABLE TO RETURN TO ORBITER WITH THC ONLY.
CREWPERSON CAN BE STRANDED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 173 FLIGHT: 1/1

ITEM: THC ISOLATE SWITCH
FAILURE MODE: FAIL ON

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/2
OPS:	1/1
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [NA] C [NA]

LOCATION:
PART NUMBER:

CAUSES: MECHANICAL JAM, SWITCH MAT'L FAIL

EFFECTS/RATIONALE:
LOSS OF ALL PROPULSIVE CAPABILITY. RESCUE REQUIRED. CREWPERSON STRANDED

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 174

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/2

ITEM: THC ISOLATE SWITCH
FAILURE MODE: FAIL OFF

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/2
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [NA] C [NA]

LOCATION:
PART NUMBER:

CAUSES: MECHANICAL JAM, SWITCH MAT'L FAILS

EFFECTS/RATIONALE:
INABILITY TO ABORT VIA THC. MISSION TERMINATION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 175 FLIGHT: 2/2

ITEM: AUTOMATIC ATTITUDE HOLD SWITCH
FAILURE MODE: FAIL ON

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/2
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [F] C [F]

LOCATION:
PART NUMBER:

CAUSES: MECHANICAL FAILURE

EFFECTS/RATIONALE:
EXCESSIVE USE OF PROPELLANT FOR ROTATIONAL MANEUVERS. MISSION IMPACT/TERMINATION RESULTS

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 176

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3

ITEM: AUTOMATIC ATTITUDE HOLD SWITCH
FAILURE MODE: FAIL OFF

LEAD ANALYST: P. BAILEY   SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: MECHANICAL FAILURE

EFFECTS/RATIONALE:
NO CRITICAL IMPACTS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 177
FLIGHT: 2/2

ITEM: ALTERNATE CONTROL MODES SWITCH
FAILURE MODE: FAIL OFF

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/2
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [F] C [F]

LOCATION:
PART NUMBER:

CAUSES: MATERIAL FAILURE OF CONTACTS-FRACTURE, UNDER TEMP

EFFECTS/RATIONALE:
DEGRADATION IN ABILITY TO STABILIZE SATELLITE OR MATCH RATES WITH SPINNING SATELLITE. INABILITY TO SELECTIVELY DISABLE AAH WITHOUT ACTUAL ROTATIONAL INPUT. INABILITY TO SELECT SATELLITE STABILIZATION THRUSTER SELECT LOGIC. POSSIBLE MISSION IMPACT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 178

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3

ITEM: ALTERNATE CONTROL MODES SWITCH
FAILURE MODE: FAIL ON SATELLITE STABILIZER

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [F] C [F]

LOCATION:
PART NUMBER:

CAUSES: MATERIAL FAILURE DUE TO THERMAL CYCLING, CONTAMINATION BINDS SWITCH

EFFECTS/RATIONALE:
DEGRADATION IN ABILITY TO PERFORM ROTATIONAL MANEUVERS. SATELLITE STABILIZATION THRUSTER SELECT LOGIC IS USED FOR ALL COMMANDS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 179 FLIGHT: 3/3

ITEM: ALTERNATE CONTROL MODES SWITCH
FAILURE MODE: FAIL ON IN "AXIS INHIBIT"

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [F] C [F]

LOCATION:
PART NUMBER:

CAUSES: MATERIAL FAILURE DUE TO THERMAL CYCLING, CONTAMINATION BINDS SWITCH

EFFECTS/RATIONALE:
ONE (OR MORE) ROTATIONAL AXES INHIBIT FROM AUTOMATIC ATTITUDE HOLD. NO IMPACTS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 180 FLIGHT: 3/3

ITEM: GYRO PHASE PLANE LOGIC
FAILURE MODE: FAIL OFF 1-3 CH.

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [NA] C [NA]

LOCATION:
PART NUMBER:

CAUSES: MATERIAL DEFECT, OVERTEMP, CONTACTS FRACTURE, OPEN

EFFECTS/RATIONALE:
LOSS OF AAH IN AFFECTED AXIS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 181 FLIGHT: 3/3

ITEM: GYRO PHASE PLANE LOGIC
FAILURE MODE: NOISY/FALSE OUTPUTS

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3) CEA
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [NA] C [NA]

LOCATION:
PART NUMBER:

CAUSES: MATERIAL DEFECT DUE TO CONTACTS FRACTURED, OVERTEMP

EFFECTS/RATIONALE:
MAY FORCE SHUTDOWN OF AAH. NO IMPACTS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 182 FLIGHT: 2/1R

ITEM: CEA PWR SPLY
FAILURE MODE: FAIL HIGH OR LOW, GREATER THAN 5.1V, LESS THAN 4.9V

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: OVERTEMP, SHORT

EFFECTS/RATIONALE:
DIGITAL LOGIC IN CEA FAILS DUE TO INCORRECT VOLTAGE INPUT. LOSS OF CONTROL AUTHORITY TO THAT PROPULSION SIDE RESULTS. LOSS OF CEA LOGIC SELECT RESULTS IN MISSION TERMINATION. POSSIBLE LOSS OF CREWPERSON IF OTHER POWER SUPPLY FAILS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 183 FLIGHT: 2/1R

ITEM: WIRE HARNESS
FAILURE MODE: SHORT OR OPEN CIRCUIT

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
LOSS OF AFFECTED SIDE DUE TO LACK OF, OR ERRATIC, CONTROL AUTHORITY. POSSIBLE STRANDING OF CREWPERSON WITH LOSS OF BOTH SIDES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 184

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/2

ITEM: EXTERNAL POWER CONNECTOR
FAILURE MODE: FAIL OPEN, 1 OR MORE PINS

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/2
OPS:	3/3
POST-OPS:	2/2

REDUNDANCY SCREENS: A [2] B [P] C [F]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: BENT PIN, CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF HEATER POWER DURING STOWAGE RESULTING IN LOSS OF HEATED COMPONENT AND LOSS OF MISSION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 185

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/2

ITEM: HEATERS
FAILURE MODE: FAIL OFF

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/2
OPS:	2/2
POST-OPS:	2/2

REDUNDANCY SCREENS: A [2] B [P] C [F]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: ELECTRICAL OPEN/SHORT

EFFECTS/RATIONALE:
POSSIBLE LOSS OF HEATED COMPONENT DURING STORAGE OR FLIGHT. MISSION TERMINATION REQUIRED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 186 FLIGHT: 2/1R

ITEM: HEATERS
FAILURE MODE: FAIL ON (CEA)

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MATERITAL DEFECT IN THERMOSTAT

EFFECTS/RATIONALE:
POSSIBLE LOSS OF CEA SIDE DUE TO OVERTEMP. POSSIBLE STRANDING OF CREWPERSON IF BOTH CEA SIDES LOST.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 187

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3

ITEM: GYROS
FAILURE MODE: DRIFT

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [F] C [F]

LOCATION:
PART NUMBER:

CAUSES: OUT OF SPEC. TEMPERATURE

EFFECTS/RATIONALE:
CONTINUOUS ROTATIONAL INPUT, NO ATT. HOLD IN THAT AXIS. (AAH MUST BE DISABLED).

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 188 FLIGHT: 3/3

ITEM: GYROS
FAILURE MODE: FAIL OFF

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [F] C [F]

LOCATION:
PART NUMBER:

CAUSES: OUT OF SPEC. TEMPERATURE, ELECTRICAL OPEN

EFFECTS/RATIONALE:
NO AAH IN AFFECTED AXIS. MISSION MAY CONTINUE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 189 FLIGHT: 3/3

ITEM: ARM ANGLE ADJUST
FAILURE MODE: ARM DOES NOT LATCH TO FLIGHT POSITION (UNLATCHED, LATCHED STOWED, LATCHED WORKSITE, LATCHED FLIGHT).

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) STRUCTURES & MECHANISMS
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: LEFT OR RIGHT ARM
PART NUMBER:

CAUSES: MECHANISM BINDS, CONTAMINATION

EFFECTS/RATIONALE:
LATCH IS DISENGAGED ENTIRELY AND PINNED IN FLIGHT POSITION. NO IMPACTS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 190 FLIGHT: 2/2

ITEM: ARM LENGTH ADJUST
FAILURE MODE: FAIL UNLATCHED

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) STRUCTURES & MECHANISMS
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/2
OPS:	2/2
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: LEFT OR RIGHT SIDE
PART NUMBER:

CAUSES: MECHANISM BINDS

EFFECTS/RATIONALE:
POOR CREWMAN FIT CAN RESULT IN DIFFICULTY/INABILITY TO COMPLETELY CONTROL TRANSLATIONS OR ROTATIONS. MISSION IMPACT/TERMINATION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 191 FLIGHT: 2/2

ITEM: ARM LENGTH ADJUST
FAILURE MODE: FAIL LATCHED SHORT

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) STRUCTURES & MECHANISMS
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/2
OPS:	2/2
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: LEFT OR RIGHT SIDE
PART NUMBER:

CAUSES: ADJUSTS MECHANISM BINDS

EFFECTS/RATIONALE:
POOR CREWMAN FIT CAN RESULT IN DIFFICULTY/INABILITY TO COMPLETELY CONTROL TRANSLATIONS OR ROTATIONS. MISSION IMPACT/TERMINATION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 192

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/2

ITEM: ARM LENGTH ADJUST
FAILURE MODE: FAIL LATCHED LONG

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) STRUCTURES & MECHANISMS
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/2
OPS:	2/2
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: LEFT OR RIGHT SIDE
PART NUMBER:

CAUSES: ADJUSTS MECHANISM BINDS

EFFECTS/RATIONALE:
POOR CREWMAN FIT CAN RESULT IN DIFFICULTY/INABILITY TO COMPLETELY CONTROL TRANSLATIONS OR ROTATIONS. MISSION IMPACT/TERMINATION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 194

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/2

ITEM: EXTERNAL POWER CONNECTOR
FAILURE MODE: FAIL CONNECTED

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) STRUCTURES & MECHANISMS
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/2
OPS:	2/2
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: CONNECTOR BINDS DUE TO THERMAL CYCLING

EFFECTS/RATIONALE:
MISSION LOST, INABILITY TO LEAVE FSS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 195 FLIGHT: 2/2

ITEM: EXTERNAL POWER CONNECTOR
FAILURE MODE: FAIL DISCONNECTED

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) STRUCTURES & MECHANISMS
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/2
OPS:	3/3
POST-OPS:	2/2

REDUNDANCY SCREENS: A [2] B [P] C [F]

LOCATION:
PART NUMBER:

CAUSES: MECHANISM BINDS DUE TO THERMAL CYCLING

EFFECTS/RATIONALE:
COMPONENTS AND SUBSEQUENT USE OF MMU MAY BE LOST DUE TO LACK OF POWER TO HEATERS WHEN IN FSS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 196 FLIGHT: 2/1R

ITEM: PLSS LATCHES
FAILURE MODE: FAIL OPEN

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) STRUCTURES & MECHANISMS
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/2R
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: LEFT OR RIGHT SIDE
PART NUMBER:

CAUSES: MECHANICAL BINDING OR DAMAGE, CONTAMINATION

EFFECTS/RATIONALE:
LAP BELTS PROVIDE BACKUP. LOSS OF LATCHING CAPABILITY MAY RESULT IN LOSS OF CREW VIA SEPARATION FROM MMU IF LAP BELT FAILS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
FLIGHT: 3/2R
MDAC ID: 197

ITEM: PLSS LATCHES
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) STRUCTURES & MECHANISMS
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/2R

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: LEFT OR RIGHT SIDE
PART NUMBER:

CAUSES: MECHANICAL BINDING OR DAMAGE, CONTAMINATION

EFFECTS/RATIONALE:
ONLY ONE LATCH NEEDS TO OPERATE FOR PLSS RELEASE. IF ALL LATCHES FAIL CLOSED, CREWMEMBER ENTERS AIRLOCK WITH MMU ATTACHED AND SUBSEQUENT MISSIONS ARE IMPACTED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 198
FLIGHT: 2/2

ITEM: MMU BATTERY LATCHES
FAILURE MODE: FAIL UNLATCHED

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) STRUCTURES & MECHANISMS
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/2
OPS:	/NA
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: MECHANICAL FAILURE - BINDS, SPRING FRACTURES

EFFECTS/RATIONALE:
LOSS OF SIDE RESULTS SINCE SECURE POWER SOURCE IS NOT AVAILABLE. MISSION TERMINATION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 199

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/2

ITEM: MMU BATTERY LATCHES
FAILURE MODE: FAIL LATCHED

LEAD ANALYST: P. BAILEY   SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) STRUCTURES & MECHANISMS
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	2/2

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MECHANICAL FAILURE - BINDS, SPRING FRACTURES

EFFECTS/RATIONALE:
BATTERY CANNOT BE RECHARGED, SUBSEQUENT MISSION LOST.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 200

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/2

ITEM: BACKUP ARM LATCH
FAILURE MODE: FAIL LATCHED

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) STRUCTURES & MECHANISMS
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/2
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: RIGHT OR LEFT ARM
PART NUMBER:

CAUSES: SNAP FAILS MECHANICALLY - BINDS

EFFECTS/RATIONALE:
UNLESS LATCH IS CUT, ARM CANNOT BE RELEASED, MMU NOT FLYABLE. IF LATCH CUT, PRIMARY LATCH MUST BEAR ENTRY & LANDING LOADS ALONE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 201
FLIGHT: 2/2

ITEM: BACKUP ARM LATCH
FAILURE MODE: FAIL UNLATCHED

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) STRUCTURES & MECHANISMS
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	2/2
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: RIGHT OR LEFT ARM
PART NUMBER:

CAUSES: SNAP FAILS MECHANICALLY, DEBRIS IN SNAP

EFFECTS/RATIONALE:
ARM DAMAGED IF PRIMARY LATCH FAILS. MISSION IMPACT OR DAMAGE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
SUBSYSTEM: MMU
MDAC ID: 202

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/2R

ITEM: QD THERMAL COVERS
FAILURE MODE: FAIL OPEN

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) STRUCTURES & MECHANISMS
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/2R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: VELCRO FAILURE DUE TO EMBRITTLEMENT

EFFECTS/RATIONALE:
QD MAY BECOME INOPERABLE IF EXPOSED TO EXTREMES OF HEAT OR COLD. USE OTHER QD FOR RECHARGE. NO RECHARGE IF BOTH QD'S ARE FAILED. MISSION TERMINATION FOR SUBSEQUENT MISSIONS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 203 FLIGHT: 2/2

ITEM: BATTERY THERMAL COVER
FAILURE MODE: FAIL OPEN DURING STOWAGE

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) STRUCTURES & MECHANISMS
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	2/2

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: VELCRO FAILURE DUE TO EMBRITTLEMENT

EFFECTS/RATIONALE:
BATTERIES MAY FAIL DUE TO EXPOSURE TO TEMPERATURE EXTREMES. CAUSES DIFFICULTY WITH RECHARGE, POSSIBLE DELAY/LOSS IN SECOND MISSION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 204 FLIGHT: 3/3

ITEM: BATTERY THERMAL COVER
FAILURE MODE: FAIL OPEN DURING FLIGHT

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) STRUCTURES & MECHANISMS
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [F] C [F]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CREWMEMBER IMPACT. VELCRO FAILURE DUE TO EMBRITTLEMENT

EFFECTS/RATIONALE:
NO IMPACT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 205
FLIGHT: 3/3

ITEM: EXT. PWR. THERMAL COVER
FAILURE MODE: FAIL OPEN DURING FLIGHT

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) STRUCTURES & MECHANISMS
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [F]

LOCATION:
PART NUMBER:

CAUSES: CREWMEMBER IMPACT. VELCRO FAILURE DUE TO EMBRITTLEMENT

EFFECTS/RATIONALE:
NO IMPACT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 206 FLIGHT: 2/1R

ITEM: BACKUP PLSS LATCHES (LAP BELTS)
FAILURE MODE: FAIL OPEN DURING FLIGHT

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) STRUCTURES & MECHANISMS
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/2R
OPS:	2/1R
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: CREW ERROR, WORN EYELET, BROKEN CONE

EFFECTS/RATIONALE:
REDUNDANT BACKUP LATCHES PREVENT LOSS OF CREW IN CASE OF PRIMARY LATCH/FAILURE. FULL COMPLEMENT OF LATCHES REQUIRED TO BEGIN/CONTINUE FLIGHT. LOSS OF ALL LATCHES CAN RESULT IN LOSS OF CREWPERSON BY SEPARATION FROM MMU.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 207 FLIGHT: 2/2

ITEM: BACKUP PLSS LATCHES
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) STRUCTURES & MECHANISMS
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	2/2

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: RIGHT OR LEFT SIDE
PART NUMBER:

CAUSES: BROKEN CONE DUE TO IMPACT OR MATERIAL DEFECT

EFFECTS/RATIONALE:
MMU LOST FOR SUBSEQUENT MISSION DUE TO LOSS OF FULL REDUNDANCY IN LATCHES WHICH ENSURE CREWMEMBER RESTRAINT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 208 FLIGHT: 3/2R

ITEM: GN2 LINES
FAILURE MODE: LEAK

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) FSS
3) PNEUMATIC SUBSYSTEM
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/2R

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MATERIAL FAILURE, CREWMEMBER IMPACT, SEAL FAILURE

EFFECTS/RATIONALE:
LOSS OF ONE RECHARGE SYSTEM, POSSIBLE ORBITER GAS LOSS (OTHER FSS COULD BE USED FOR RECHARGE). MISSION LOST IF OTHER FSS LOST.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 210 FLIGHT: 3/2R

ITEM: GN2 LINES
FAILURE MODE: BLOCKED

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) FSS
3) PNEUMATIC SUBSYSTEM
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/2R

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: CONTAMINATION, PINCHED BY CREWMEMBER IMPACT

EFFECTS/RATIONALE:
LOSS OF ONE RECHARGE SYSTEM. SUBSEQUENT MISSIONS LOST IF OTHER SUBSYSTEM LOST.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 211
FLIGHT: 3/2R

ITEM: PRESSURE GUAGE
FAILURE MODE: LEAK

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) FSS
3) PNEUMATIC SUBSYSTEM
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/2R

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: SAEL FAILURE/GALLED

EFFECTS/RATIONALE:
LOSS OF GN2, INACCURATE GAS READINGS, LOSS OF SIDE. POSSIBLE LOSS OF SUBSEQUENT MISSIONS WITH LOSS OF BOTH SIDES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
SUBSYSTEM: MMU
MDAC ID: 212

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/2R

ITEM: VENT VALVE
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) FSS
3) PNEUMATIC SUBSYSTEM
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/2R

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: DEBRIS/CONTAMINATION, MECHANICAL FAILURE, GALLING OF TOGGLE OR FOLLOWER, UNDER TEMP

EFFECTS/RATIONALE:
LOSS OF AFFECTED RECHARGE SYSTEM. LOSS OF SUBSEQUENT MISSIONS WITH LOSS OF BOTH SIDES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
SUBSYSTEM: MMU
MDAC ID: 213

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/2R

ITEM: VENT VALVE
FAILURE MODE: FAIL OPEN

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) FSS
3) PNEUMATIC SUBSYSTEM
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/2R

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: DEBRIS, GALLING OF TOGGLE OR FOLLOWER, BELLEVILE SPRING FAILURE

EFFECTS/RATIONALE:
PROBABLE LOSS OF AFFECTED SIDE EXCESSIVE GAS LOSS. GANS MIGHT BE FIRED PREMATURELY. POSSIBLE LOSS OF SUBSEQUENT MISSIONS WITH LOSS OF BOTH SIDES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
SUBSYSTEM: MMU
MDAC ID: 214

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/2R

ITEM: VENT VALVE
FAILURE MODE: LEAK

LEAD ANALYST: P. BAILEY   SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) FSS
3) PNEUMATIC SUBSYSTEM
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/2R

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: O-RING FAILURE

EFFECTS/RATIONALE:
LOSS OF ONE RECHARGE SYSTEM, POSSIBLE ORBITER GAS LOSS. MISSION LOST IF OTHER FSS LOST.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 215 FLIGHT: 3/3

ITEM: QD-HOSE END
FAILURE MODE: FAIL OPEN, LEAK

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) MMU
2) FSS
3) PNEUMATIC SUBSYSTEM
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: THREADS GALLED O-RING DAMAGE

EFFECTS/RATIONALE:
NO EFFECT TO OPERATIONS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
SUBSYSTEM: MMU
MDAC ID: 216

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/2R

ITEM: QD-HOSE END
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) PNEUMATIC SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/2R

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: THREAD GALL CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF AFFECTED SIDE AND LOSS OF SUBSEQUENT MISSIONS IF BOTH SIDES LOST.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 217
FLIGHT: 3/2R

ITEM: QD-FIXED HALF
FAILURE MODE: LEAK, FAILED OPEN

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) PNEUMATIC SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/2R

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: POPPET NOT SEALED, O-RING DAMAGE, DEBRIS

EFFECTS/RATIONALE:
LOSS OF RECHARGE SIDE IF LEAK BAD ENOUGH. GANS WOULD REQUIRE MANUAL ACTUATION. POSSIBLE LOSS OF SUBSEQUENT MISSIONS IF OTHER SIDE FAILS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 218
FLIGHT: 3/2R

ITEM: QD-FIXED HALF
FAILURE MODE: FAILED CLOSED

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) PNEUMATIC SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/2R

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: DEBRIS, GALLING OF POPPET

EFFECTS/RATIONALE:
LOSS OF RECHARGE SIDE IF LEAK BAD ENOUGH. GANS WOULD REQUIRE MANUAL ACTUATION. LOSS OF SUBSEQUENT MISSIONS IF OTHER SIDE FAILS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 219 FLIGHT: 3/1R

ITEM: GAS ACTUATED NUTS (4)
FAILURE MODE: FAIL OPEN

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) PNEUMATIC SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/1R

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: SEGMENT BINDING, PISTON BINDING/GALLING, O-RING FAILURE, SPRING FAILURE, STRIPPED THREADS, UNDERTEMP

EFFECTS/RATIONALE:
GANS ARE BACKUP TO FSS/PLSS LATCHES. LOSS OF MORE THAN ONE GAN MAY ALLOW DAMAGE TO MMU DURING ENTRY BUT HAS NO IMPACT ON MMU MISSION.
"1R" BECAUSE IF THEY FAIL DURING ENTRY, ESPECIALLY AN ABORT OR OTHER HARD LANDING, MMU MAY FREE ITSELF FROM THE FSS AND CONSTITUTE A DANGER TO THE CREW AS IT ROLLS AROUND THE PLB.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 220 FLIGHT: 2/2

ITEM: GAS ACTUATED NUTS (4)
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) PNEUMATIC SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	2/2
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [ ]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: SEGMENT BINDING, PISTON BINDING, GALLED THREADS, UNDERTEMP

EFFECTS/RATIONALE:
MISSION TERMINATION DUE TO EMU STUCK IN STATION. (TOOL NOW AVAILABLE TO BACK BOLTS OUT/IN).

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
SUBSYSTEM: MMU
MDAC ID: 221

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/2R

ITEM: FILTER
FAILURE MODE: LEAK

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) PNEUMATIC SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/2R

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: SEAL FAILURE

EFFECTS/RATIONALE:
LARGE LEAK WILL FORCE SHUTDOWN OF SIDE AND DEFICIENT RECHARGE. SHUTDOWN OF BOTH SIDES PREVENTS MMU RECHARGE AND SUBSEQUENT MISSIONS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 222 FLIGHT: 3/2R

ITEM: FILTER
FAILURE MODE: FRACTURE

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) PNEUMATIC SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/2R
OPS:	3/3
POST-OPS:	3/2R

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: EMBRITTELMENT DUE TO UNDERTEMP

EFFECTS/RATIONALE:
DEBRIS PRODUCED MAY CAUSE MALFUNCTION OF COMPONENTS IN REMAINDER OF SIDE IF REDUNDANT FILTER ELEMENTS WERE TO ALSO FAIL. SUCH A SCERNAIO WILL IMPACT SUBSEQUENT MISSIONS. MAY CAUSE RECHARGE/VENT VALVES ON FSS TO CLOG DUE TO DEBRIS, OR OTHER FILTER VALVES OR REGULATOR IN MMU PNEUMATIC SUBSYSTEMS TO MALFUNCTION, FAILING OPEN OR CLOSED. OR CLOSED

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 223
FLIGHT: 3/3

ITEM: GAN HEATERS
FAILURE MODE: OPEN

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) ELECTRICAL SUBSYSTEM
3) GAN 1-4
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: SHORT, OPEN CIRCUIT

EFFECTS/RATIONALE:
GAN MAY MALFUNCTION WITH LOSS OF HEATER, BUT BOLT CAN BE MANUALLY OPERATED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 224 FLIGHT: 3/3

ITEM: HEATER FOR FSS RECHARGE SYSTEM PNEUMATIC FILTER
FAILURE MODE: FAIL OPEN, SHORT CIRCUIT

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MATERIAL FAILURE OF CONTACTS-FRACTURE DEBRIS

EFFECTS/RATIONALE:
IF HEATER FAILS, FILTER MAY BECOME EMBRITTLED AND FRACTURE UNDER PRESSURIZATION IMPULSE. REQUIRES DOWNSTREAM FAILURE FOR MISSION IMPACTS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 225 FLIGHT: 3/2R

ITEM: TOGGLE VALVE HEATERS
FAILURE MODE: OPEN CIRCUIT, SHORT CIRCUIT

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/2R

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MATERIAL FAILURE OF CONTACTS-FRACTURE DEBRIS

EFFECTS/RATIONALE:
TOGGLE VALVE MAY FAIL TO OPERATE. USE OTHER SIDE FOR RECHARGE. TERMINATION OF SUBSEQUENT MISSIONS IF BOTH SIDES FAILED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
SUBSYSTEM: MMU
MDAC ID: 226

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3

ITEM: PRESSURE GUAGE HEATERS
FAILURE MODE: FAIL OPEN, SHORT CIRCUIT

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MATERIAL FAILURE OF CONTACTS-FRACTURE DEBRIS

EFFECTS/RATIONALE:
PRESSURE GUAGE MAY MALFUNCTION. NO IMPACTS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 227 FLIGHT: 3/2R

ITEM: QD HEATERS
FAILURE MODE: FAIL OFF, OPEN CIRCUIT, SHORT CIRCUIT

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/2R

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: MATERIAL FAILURE OF CONTACTS-FRACTURE DEBRIS

EFFECTS/RATIONALE:
QD MAY FAIL CAUSING LOSS OF ONE RECHARGE SIDE. LOSS OF BOTH SIDES INHIBITS PERFORMACE OF SUBSEQUENT MISSIONS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
SUBSYSTEM: MMU
MDAC ID: 228

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/2R

ITEM: HEATER THERMOSTATS
FAILURE MODE: FAIL OPEN

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/2R

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SYSTEM A OR B
PART NUMBER:

CAUSES: MATERIAL FAILURE OF CONTACTS-FRACTURE, THERMAL CYCLING

EFFECTS/RATIONALE:
HEATED COMPONENTS (QDs) MAY FAIL DUE TO UNDERTEMP. POSSIBLE LOSS OF SUBSEQUENT MISSIONS IF BOTH QDs ARE FAILED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 229 FLIGHT: 3/3

ITEM: HEATER THERMOSTATS
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SYSTEM A OR B
PART NUMBER:

CAUSES: CONTIMNATION, CONTACTS-FRACTURE

EFFECTS/RATIONALE:
HEATED COMPONENTS MAY FAIL DUE TO OVERTEMP. NO CRITICAL IMPACTS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 230 FLIGHT: 3/3

ITEM: TOGGLE VALVE TEMP. SENSORS
FAILURE MODE: LOSS OF SIGNAL

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: ELECTRICAL OPEN

EFFECTS/RATIONALE:
LOSS OF TEMP. INDICATION; MISSION CONTINUES. NO IMPACTS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 231 FLIGHT: 3/3

ITEM: TOGGLE VALVE TEMP. SENSORS
FAILURE MODE: FAIL HIGH

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: MATERIAL FAILURE (CHEMICAL ABSORBTION-OZONE)

EFFECTS/RATIONALE:
FALSE HIGH READING; MISSION CONTINUES. NO IMPACT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
SUBSYSTEM: MMU
MDAC ID: 232

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3

ITEM: TOGGLE VALVE TEMP. SENSORS
FAILURE MODE: FAIL LOW

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) ELECTRICAL SUBSYSTEM
3) A OR B TEMP SENSORS
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: MATERIAL FAILURE (CHEMICAL ABSORBTION-OZONE)

EFFECTS/RATIONALE:
FALSE LOW READING; MISSION CONTINUES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 233 FLIGHT: 3/3

ITEM: ORBITER POWER CONNECTOR
FAILURE MODE: FAIL OPEN (1 OR MORE PINS)

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [F]

LOCATION:
PART NUMBER:

CAUSES: DEBRIS, PIN FAILURE DUE TO MISALIGNMENT OR FRACTURE

EFFECTS/RATIONALE:
LOSS OF PARTIAL OR ALL HEATER POWER TO FSS/MMU AND ALL TEMPERATURE SENSOR OUTPUT. HEATED COMPONENTS MAY FAIL. MISSION CONTINUES; SOME THERMAL CONDITIONING MAY BE REQUIRED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
SUBSYSTEM: MMU
MDAC ID: 234

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3

ITEM: EXTERNAL POWER LINE/CONNECTOR
FAILURE MODE: OPEN CIRCUIT

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) ELECTRICAL SUBSYSTEM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: DEBRIS IN CONNECTOR, DAMAGED PIN/INSULTATION

EFFECTS/RATIONALE:
FULL OR PARTIAL LOSS OF HEATER POWER TO MMU AND/OR MMU TEMPERATURE "SENSOR OUTPUT" FROM MMU IS RESULT OF CONNECTOR FAILURE. MISSION CONTINUES; THERMAL PRECONDITIONING MAY BE REQUIRED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 235 FLIGHT: 3/1R

ITEM: ORBITER ADAPTOR BEAM MOUNTS (6)
FAILURE MODE: FRACTURE

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) STRUCTURES
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/1R
OPS:	3/1R
POST-OPS:	3/1R

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: MATERIAL FAILURE DUE TO FATIGUE OR THERMAL CYCLING

EFFECTS/RATIONALE:
LOSS OF ONE BOLT IS TOLERABLE. LOSS OF ALL BOLTS CAUSES SEPARATION OF FSS FROM ORBITER; POSSIBLE DAMAGE TO ORBITER DURING ASCENT OR ENTRY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
SUBSYSTEM: MMU
MDAC ID: 237

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/2R

ITEM: BACKBEAM SHOCK MOUNTS (4)
FAILURE MODE: SPLITTING, FRACTURING

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) STRUCTURES
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/2R
OPS:	3/2R
POST-OPS:	3/2R

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: MECHANICAL FAILURE, UNDERTEMP, CHEMICAL ATTACK

EFFECTS/RATIONALE:
LOSS OF SHOCK ISOLATION ALLOWS TRANSMISSION OF VIBRATION TO FSS/MMU RESULTING IN POSSIBLE DAMAGE TO AND LOSS OF FSS/MMU FOR MISSION OPERATIONS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 238 FLIGHT: 3/3

ITEM: FOOT RESTRAINT ADJUST
FAILURE MODE: JAM UNLOCKED

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) MECHANISM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: GALLING, DEBRIS

EFFECTS/RATIONALE:
MISSION CONTINUES WITH OR WITHOUT FOOT/RESTRAINT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
SUBSYSTEM: MMU
MDAC ID: 239

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3

ITEM: FOOT RESTRAINT ADJUST
FAILURE MODE: JAM LOCKED

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) MECHANISM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: GALLING, DEBRIS

EFFECTS/RATIONALE:
MISSION CONTINUES WITH OR WITHOUT FOOT/RESTRAINT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
SUBSYSTEM: MMU
MDAC ID: 240

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3

ITEM: MMU LATCH
FAILURE MODE: JAM OPEN

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) MECHANISM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: DEBRIS, MATERIAL GALLING

EFFECTS/RATIONALE:
LAUNCH RESTRAINT BOLTS (GANS) BACKUP LATCHES. LOSS OF GANS ALSO REQUIRES MMU STRAPDOWN IN MIDDECK.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 241
FLIGHT: 3/3

ITEM: MMU LATCH
FAILURE MODE: JAM CLOSED

LEAD ANALYST: P. BAILEY
SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) MECHANISM
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: SIDE A OR B
PART NUMBER:

CAUSES: DEBRIS, MATERIAL GALLING

EFFECTS/RATIONALE:
RELEASED/DISENGAGED MANUALLY. BACKED UP BY GAS ACTUATED NUTS.
LATCH JAMMED CLOSED PREVENTS MMU FROM BEING RELEASED FROM FSS.
LATCH CAN BE OVERRIDDEN MANUALLY IF NECESARY, WHICH DISABLES
LATCH.
GAS ACTUATED NUTS WOULD THEN BE ENGAGED TO SECURE MMU IN FSS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
SUBSYSTEM: MMU
MDAC ID: 242

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3

ITEM: MUSHROOM KNOBS (8)
FAILURE MODE: FRACTURE

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) STRUCTURE
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: LEFT AND RIGHT SIDE RAILS
PART NUMBER:

CAUSES: MATERIAL FAILURE

EFFECTS/RATIONALE:
NO EFFECT; MISSION CONTINUES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
SUBSYSTEM: MMU
MDAC ID: 243

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/2R

ITEM: THERMAL BLANKETS
FAILURE MODE: FAIL OPEN

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2)
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/2R

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION:
PART NUMBER:

CAUSES: VELCRO RELEASE

EFFECTS/RATIONALE:
QD'S OR RECHARGE SYSTEM VALVES MAY MALFUNCTION FROM THERMAL EXPOSURE RESULTING IN LOSS OF RECHARGE AND SUBSEQUENT MISSION CAPABILITY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: MMU
MDAC ID: 244 FLIGHT: 3/3

ITEM: TETHER REEL RESTRAINT
FAILURE MODE: FRACTURE

LEAD ANALYST: P. BAILEY SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) STRUCTURES
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: RIGHT OR LEFT SIDERAIL
PART NUMBER:

CAUSES: MATERIAL FAILURE DUE TO THERMAL CYCLING

EFFECTS/RATIONALE:
MISSION CONTINUES WITH OR WITHOUT RESTRAINT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
SUBSYSTEM: MMU
MDAC ID: 245

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3

ITEM: TETHER REEL RESTRAINT
FAILURE MODE: DEFORMATION

LEAD ANALYST: P. BAILEY   SUBSYS LEAD: G. RAFFAELLI

BREAKDOWN HIERARCHY:
1) FSS
2) STRUCTURES
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC
PRE-OPS:	3/3
OPS:	3/3
POST-OPS:	3/3

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: RIGHT OR LEFT SIDERAIL
PART NUMBER:

CAUSES: THERMAL CYCLING

EFFECTS/RATIONALE:
MISSION CONTINUES WITH OR WITHOUT RESTRAINT.

REFERENCES:

APPENDIX D
POTENTIAL CRITICAL ITEMS

MDAC ID	CRIT	ITEM	FAILURE MODE
169	1/1	THC	FAIL ON 1-3 AXES
170	1/1	THC	FAIL OFF 1-3 AXES
171	1/1	RHC	FAIL ON (1-3 AXES)
172	1/1	RHC	FAIL OFF (1-3 AXES)
173	1/1	THC ISOLATE SWITCH	FAIL ON
100	2/1R	GN2 TANK	LEAK
105	2/1R	ISOLATION VALVE	FAIL CLOSE
106	2/1R	GN2 LINES	LEAK
110	2/1R	THRUSTER MANIFOLD	LEAK
111	2/1R	THRUSTER MANIFOLD	CONSTRICTION
112	2/1R	THRUSTER	FAIL OPEN
113	2/1R	THRUSTER	FAIL CLOSED
114	2/1R	THRUSTER	LEAK
116	2/1R	GN2 REGULATOR	FAIL CLOSED
117	2/1R	GN2 REGULATOR	FAIL OPEN
120	2/1R	GN2 RELIEF VALVE	FAIL OPEN
122	2/1R	PRESSURE GAGE	LEAK
127	2/1R	GN2 TEST PORT	LEAK
128	2/1R	BATTERY	NO OUTPUT - LOW OUTPUT
129	2/1R	INTERNAL/EXTERNAL POWER SW	FAIL OPEN
131	2/1R	INTERNAL/EXTERNAL POWER SW	FAIL TO EXTERNAL POSITION
132	2/1R	TERMINAL BOARD	SHORT
133	2/1R	TERMINAL BOARD	FAIL OPEN
134	2/1R	MAIN POWER SWITCH	FAIL OFF
136	2/1R	LTS/HTR.cb	FAIL OPEN
138	2/1R	CEA CIRCUIT BREAKER	FAIL OPEN
142	2/1R	VDA cb	FAIL OPEN
152	2/1R	CEA POWER SWITCH	FAIL ON IN ISO.
154	2/1R	CEA POWER SWITCH	FAIL OFF
158	2/1R	CONTROL ELECTRONICS ASSY	FAIL ON 1-12 CH.
159	2/1R	CONTROL ELECTRONICS ASSY	FAIL OFF 1-12 CH.
160	2/1R	CONTROL ELECTRONICS ASSY	NOISY OUTPUT
161	2/1R	CONTROL ELECTRONICS ASSY	LOGIC FAILURE
164	2/1R	ISOLATION VALVE TIMER	FAILS ON
166	2/1R	VALVE DRIVER AMPLIFIER	FAIL OFF
167	2/1R	VALVE DRIVER AMPLIFIER	FAIL ON
168	2/1R	VALVE DRIVER AMPLIFIER	NOISY
182	2/1R	CEA PWR SPLY	FAIL HIGH OR LOW, GREATER THAN 5.1V, LESS THAN 4.9V

APPENDIX D
POTENTIAL CRITICAL ITEMS

MDAC ID	CRIT	ITEM	FAILURE MODE
183	2/1R	WIRE HARNESS	SHORT OR OPEN CIRCUIT
186	2/1R	HEATERS	FAIL ON (CEA)
196	2/1R	PLSS LATCHES	FAIL OPEN
206	2/1R	BACKUP PLSS LATCHES (LAP BELTS)	FAIL OPEN DURING FLIGHT
103	2/2	TOGGLE VALVE	FAIL CLOSED
104	2/2	ISOLATION VALVE	FAIL OPEN
119	2/2	GN2 REGULATOR	FAIL LOW
125	2/2	RECHARGE QUICK DISCONNECT	FAIL OPEN/LEAK
130	2/2	INTERNAL/EXTERNAL POWER SW	FAIL TO INTERNAL POSITION
135	2/2	MAIN POWER SWITCH	FAIL ON
162	2/2	ISOLATION VALVE TIMER	FAIL OFF
163	2/2	ISOLATION VALVE TIMER	TOO SHORT
174	2/2	THC ISOLATE SWITCH	FAIL OFF
175	2/2	AUTOMATIC ATTITUDE HOLD SW	FAIL ON
177	2/2	ALTERNATE CONTROL MODES SW	FAIL OFF
184	2/2	EXTERNAL POWER CONNECTOR	FAIL OPEN, 1 OR MORE PINS
185	2/2	HEATERS	FAIL OFF
190	2/2	ARM LENGTH ADJUST	FAIL UNLATCHED
191	2/2	ARM LENGTH ADJUST	FAIL LATCHED SHORT
192	2/2	ARM LENGTH ADJUST	FAIL LATCHED LONG
194	2/2	EXTERNAL POWER CONNECTOR	FAIL CONNECTED
195	2/2	EXTERNAL POWER CONNECTOR	FAIL DISCONNECTED
198	2/2	MMU BATTERY LATCHES	FAIL UNLATCHED
199	2/2	MMU BATTERY LATCHES	FAIL LATCHED
200	2/2	BACKUP ARM LATCH	FAIL LATCHED
201	2/2	BACKUP ARM LATCH	FAIL UNLATCHED
203	2/2	BATTERY THERMAL COVER	FAIL OPEN DURING STOWAGE
207	2/2	BACKUP PLSS LATCHES	FAIL CLOSED
220	2/2	GAS ACTUATED NUTS (4)	FAIL CLOSED
197	3/2R	PLSS LATCHES	FAIL CLOSED
222	3/2R	FILTER	FRACTURE