# INDEPENDENT ORBITER ASSESSMENT

ASSESSMENT
OF THE
INSTRUMENTATION
SUBSYSTEM
FMEA/CIL

**18 FEBRUARY 1988** 

### MCDONNELL DOUGLAS ASTRONAUTICS COMPANY HOUSTON DIVISION

# SPACE TRANSPORTATION SYSTEM ENGINEERING AND OPERATIONS SUPPORT

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INDEPENDENT ORBITER ASSESSMENT ASSESSMENT OF INSTRUMENTATION SUBSYSTEM FMEA/CIL

**18 FEBRUARY 1988** 

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# Independent Orbiter Assessment Assessment of the Instrumentation Subsystem FMEA/CIL

### 1.0 EXECUTIVE SUMMARY

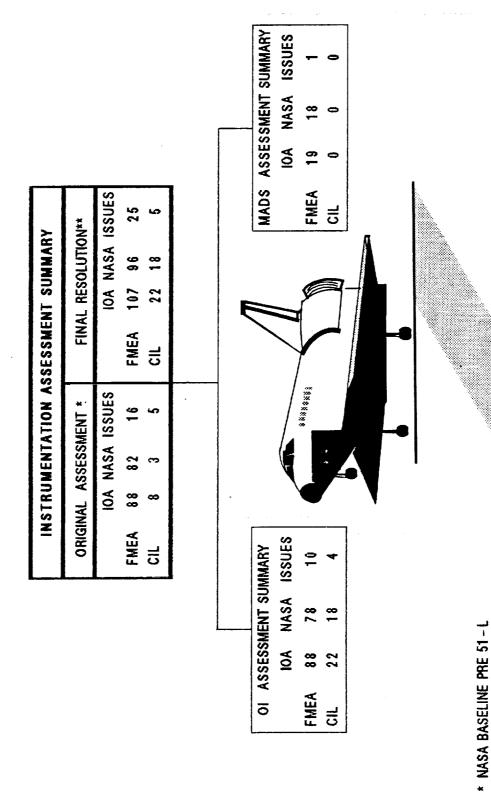
The McDonnell Douglas Astronautics Company (MDAC) was selected in June 1986 to perform an Independent Orbiter Assessment (IOA) of the Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL). Direction was given by the STS Orbiter and GFE Projects Office to perform the hardware analysis using the instructions and ground rules defined in NSTS 22206, Instructions for Preparation of FMEA and CIL, 10 October 1986, with changes 1, 2, 3, and 4.

The IOA effort first completed an analysis of the Instrumentation hardware, generating draft failure modes and potential critical items. To preserve independence, this analysis was accomplished without reliance upon the results contained within the NASA FMEA/CIL documentation. The IOA results were then compared to the NASA FMEA/CIL baseline. A resolution of each discrepancy from the comparison is provided through additional analysis as required. This report documents the results of that comparison for the Orbiter Instrumentation hardware.

The IOA product for Instrumentation analysis consisted of one hundred-seven failure mode "worksheets" that resulted in twenty-two critical items being identified. Comparison was made to the pre-51L NASA baseline with fourteen Post-51L FMEAs added, which consists of ninety-six FMEAs and eighteen CIL items. The comparison determined if there were any results which had been found by IOA but were not in the NASA baseline. This comparison produced agreement on all but twenty-five FMEAs which caused differences in five CIL items. Reference Figure 1.

The issues arose due to differences between the NASA and IOA FMEA/CIL preparation instructions. NASA had used an older ground rules document which has since been superseded by the NSTS 22206 used by the IOA. After comparison, there were no discrepancies found that were not already identified by NASA, and the remaining issues may be attributed to differences in ground rules.

# INSTRUMENTATION FMEA/CIL ASSESSMENT OVERVIEW



\*\* FINAL NASA BASELINE AS OF 1 JANUARY 88

Figure 1 - INSTRUMENTATION ASSESSMENT OVERVIEW

INSTRUMENTATION SUBSYSTEM OVERVIEW INSTRUMENTATION OPERATIONAL INSTRUMENTATION

Figure 2a - INSTRUMENTATION SUBSYSTEM OVERVIEW

Figure 2b - OPERATIONAL INSTRUMENTATION DETAILED SYSTEM REPRESENTATION OVERVIEW 4

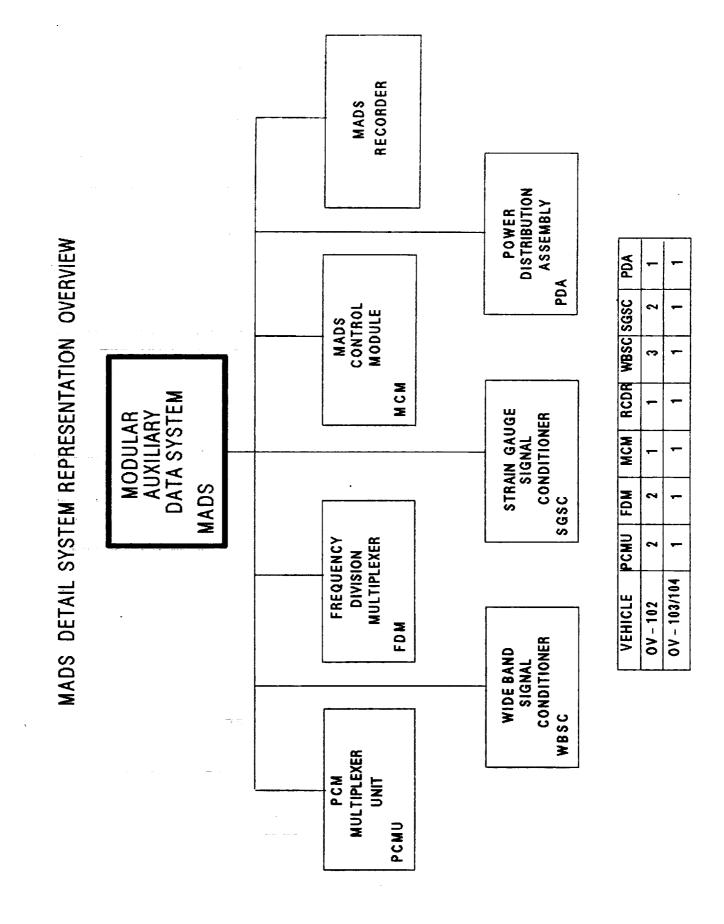


Figure 2c - MADS DETAIL SYSTEM REPRESENTATION OVERVIEW

### 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 FMEA/CIL reevaluation results 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 issues4.4 Forward findings to Project Manager

# Instrumentation Ground Rules and Assumptions

The Instrumentation ground rules and assumptions used in the IOA are defined in Appendix B.

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### 3.0 SUBSYSTEM DESCRIPTION

### 3.1 Design and Function

The subsystem consists of the hardware required for data acquisition, conditioning, timing, formatting, and routing for checkout and display as needed, and for recording or downlinking by telemetry as required.

# 3.1.1 Operational Instrumentation

- Sensors and transducers acquire data representing measurements or status of individual parameters throughout the vehicle and convert quantities sensed to electrical signals.
- Signal conditioners normalize or standardize the sensor outputs either to range for analog measurements or to set levels for discretes (ON/OFF, HIGH/LOW). There are 13 Dedicated Signal Conditioners (DCSs) handling approximately 1200 individual measurement channels.
- 3. Reference junctions provide a reference potential for a known temperature for thermocouple sensors.
- 4. The seven OI Multiplexer/Demultiplexers (MDMs) format incoming data from signal conditioners and feed it into the OI data buses, which in turn route the formatted data to the active PCMMU.
- 5. The active Pulse Code Modulation Master Unit accepts incoming data from the OI MDMs, combines that data with GPC downlist data and payload data (if any) from the PDI. The PCMMU formats the data into a serial bit stream and routes it to the communications subsystem for further processing/routing. (A "cold standby" PCMMU is available as a backup.)
- 6. The Master Timing Unit (MTU) is a very stable and accurate source of timing for Orbiter and payload operations. It provides time in IRIG B GMT and IRIG B MET formats, and also provides synchronizing/timing signals for many Orbiter LRUs.
- 7. The Orbiter Timing Buffer (OTB) amplifies and splits one IRIG B GMT signal and one IRIG B MET signal to produce eight GMT and four MET outputs for use by the Orbiter.
- 8. The Payload Timing Buffer (PTB) performs the same functions as the OTB, but for payload users.

- 9. Two operational tape recorders are used to alternately record and dump OI data and voice. They are identical 14-track wideband units capable of recording analog or digital data and voice.
- 10. The Payload Recorder (PLR) is identical to the two OPS recorders, and is used to record payload data.

# 3.1.2 Modular Auxiliary Data System

- 1. Sensors and transducers perform the same function for MADS as for OI.
- 2. Strain Gage Signal Conditioners (SGSCs) accept the outputs of completion bridges and condition the signals for handover to the MADS PCM MUX.
- 3. The PCMU accepts the outputs from the SGSCs and multiplexes, encodes, and formats the data for output to the T-O umbilical or to the MADS Control Module (MCM) for further routing to the MADS recorder.
- 4. Wideband Signal Conditioners (WBSCs) handle highfrequency signals and with wide variations in output amplitude, such as from transducers sensing vibratory, acoustic, and POGO phenomena.
- outputs. Each individual channel measurement signal modulates a voltage-controlled oscillator (VCO) subcarrier signal. The individual modulated VCO subcarriers are summed and the composite FDM output is passed to the MADS Control Module (MCM) for eventual routing to the MADS recorder.
- 6. The MCM controls power to the various MADS LRUs and selects recorder speeds, modes, tape direction, tape tracks, and PCM Mux formats and data rates.

# 3.2 Interfaces and Locations

The Instrumentation hardware is located through the Orbiter. The precise location for each component is shown in Table A.

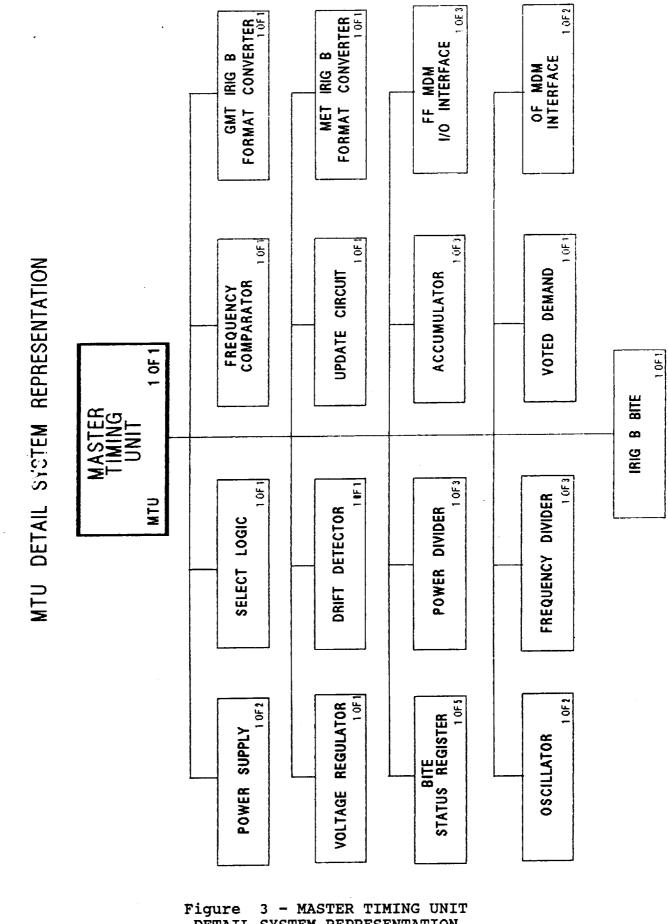
### 3.3 Hierarchy

Figures 2a, 2b, and 2c, illustrate the hierarchy of the instrumentation subsystem. Figures 3 - 10 are detailed system diagrams for specific references.

(a & Barriera (a	OI						
OI NOMENCLA	TURE	INSTALLED OI LOCATION NOMENCLATURE		INSTALLED LOCATION			
	OF1 AV BAY 1 OF2 AV BAY 2 OF3 AV BAY 3		PDI		AV BAY 1		
DSCs		OF4 FWD RCS MODULE OA1 AV BAY 4 OA2 AV BAY 5 OA3 AV BAY 6 OM1 MID FUSELAGE OM2 MID FUSELAGE OL1 LEFT OMS POD OL2 LEFT OMS POD OR1 RIGHT OMS POD OR2 RIGHT OMS POD	PCMMUs 1 2		AV BAY 1 AV BAY 2		
! !	OM2 OL1		MTU		AV BAY 3B		
	OR1 OR2		RCDRs	OPS 1 OPS 2 P/L	AV BAY 2 AV BAY 2 AV BAY 1		
į	OF1 OF2	AV BAY 1 AV BAY 2 AV BAY 3 FLTDECK AV BAY 4 AV BAY 5 AV BAY 6			AV BAY I		
MDMs	OF3 OF4 OA1 OA2 OA3		OTB PTB		BEHIND PANEL L16 BEHIND PANEL L16		

MADS					
MADS INSTALLED LOCATION					
WBSC	MID BODY				
SGSC	MID BODY				
PCMU	MID BODY				
FDM	MID BODY				
PDA	MID BODY				
мсм	CABIN MIDDECK				
RCDR	CABIN MIDDECK				

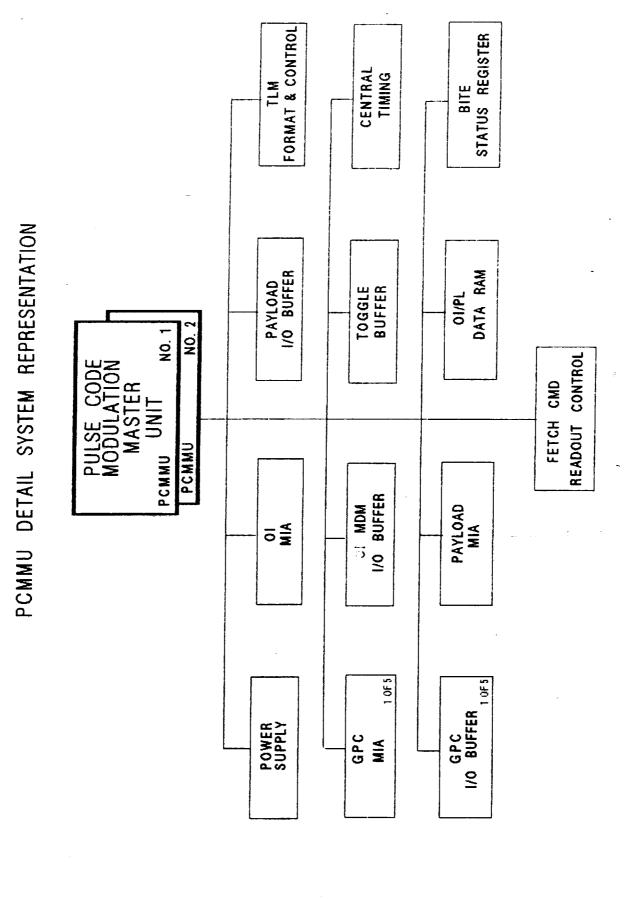
TABLE A - INSTRUMENTATION EQUIPMENT LOCATION



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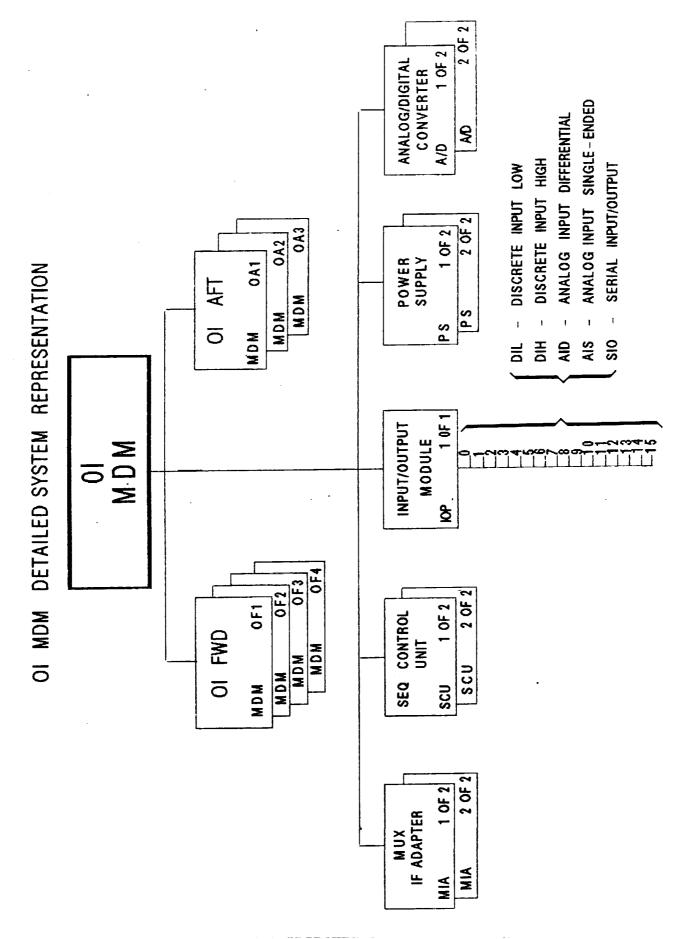
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Figure 3 - MASTER TIMING UNIT DETAIL SYSTEM REPRESENTATION 11



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Figure 4 - PCMMU DETAILED REPRESENTATION



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Figure 5 - OI MDM DETAILED REPRESENTATION

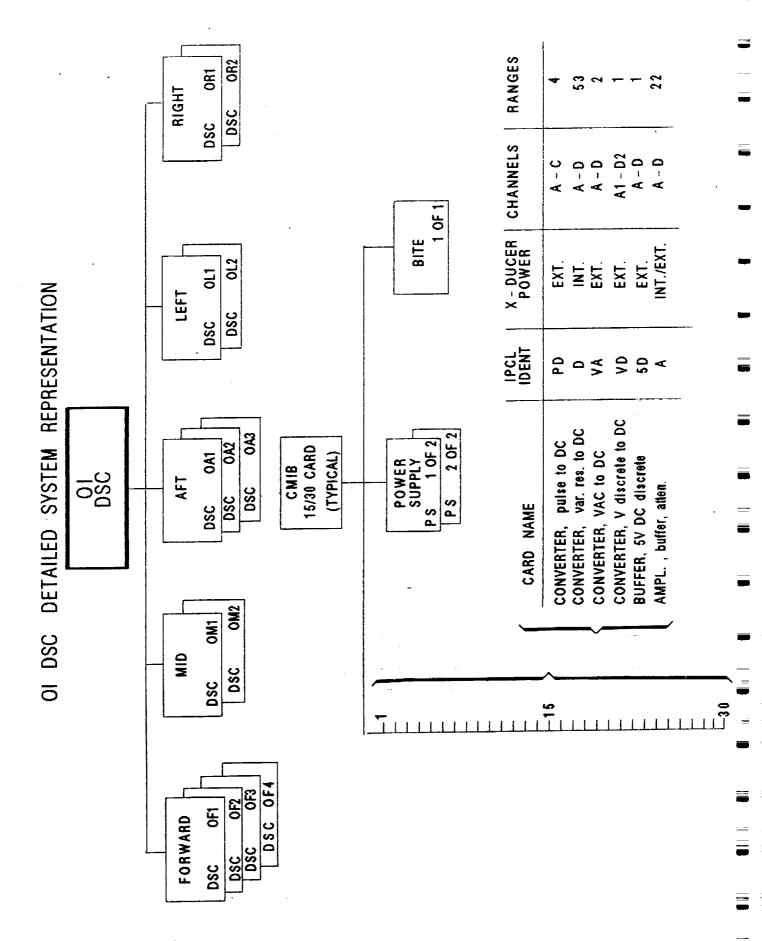
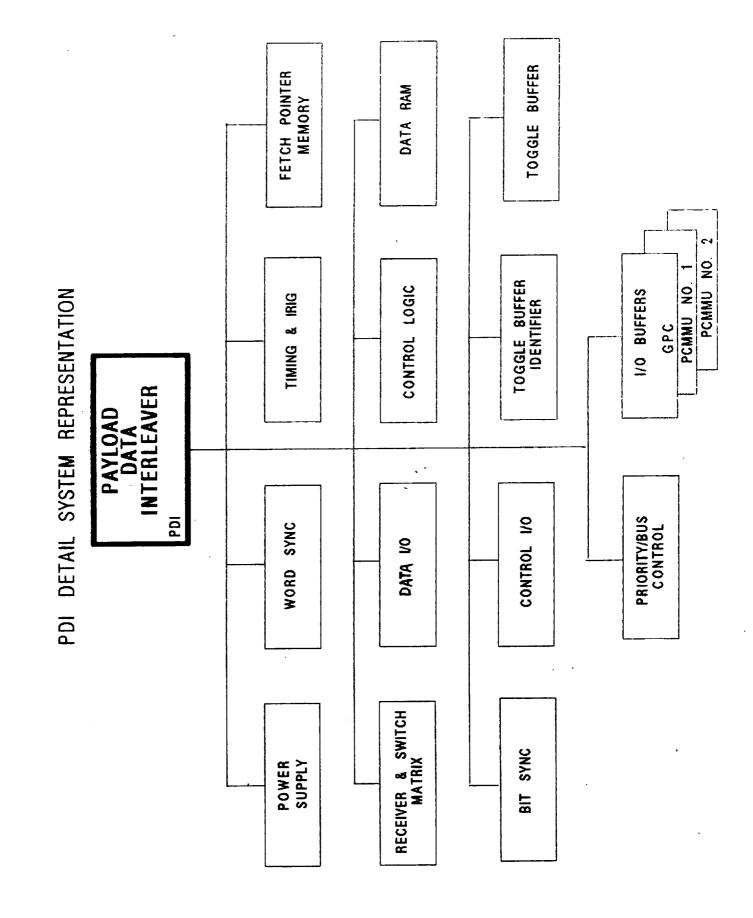
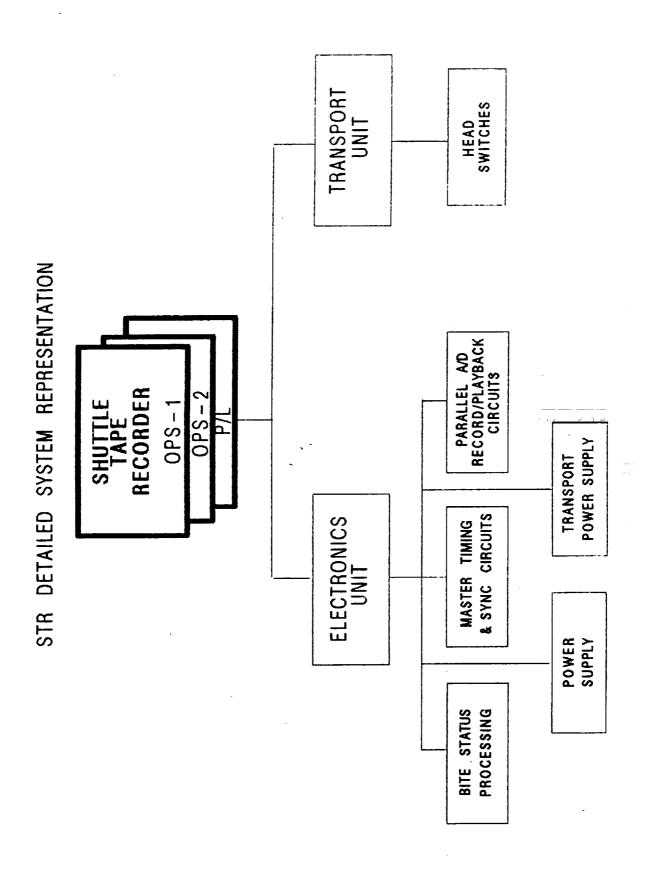


Figure 6 - DSC DETAILED REPRESENTATION



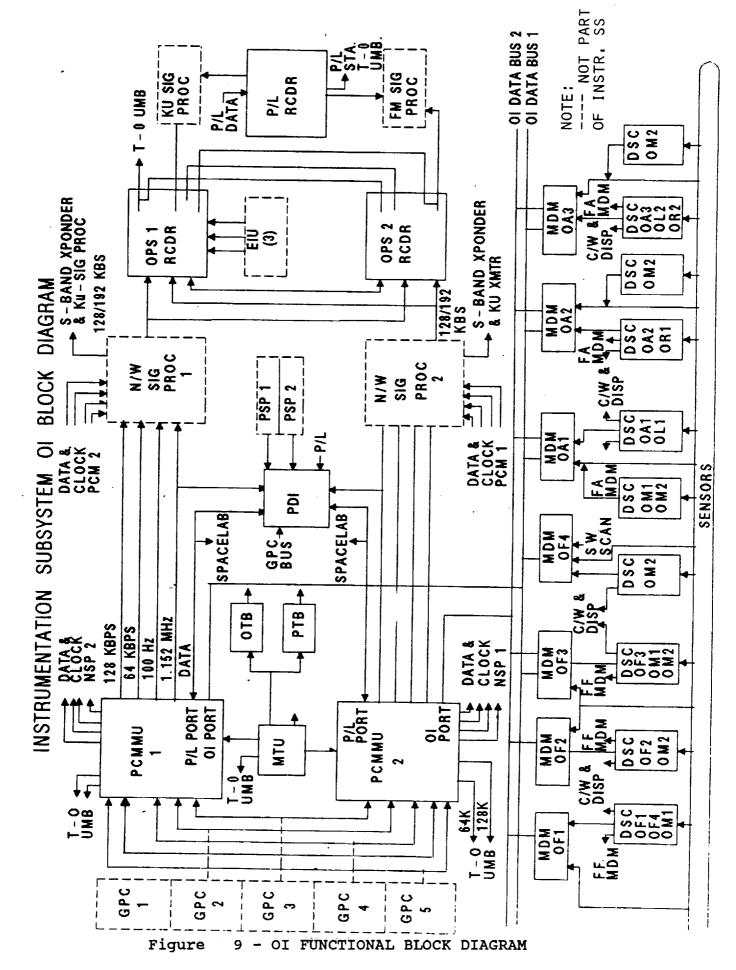
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Figure 7 - PDI DETAILED REPRESENTATION



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Figure 8 - STR DETAILED REPRESENTATION



- 4

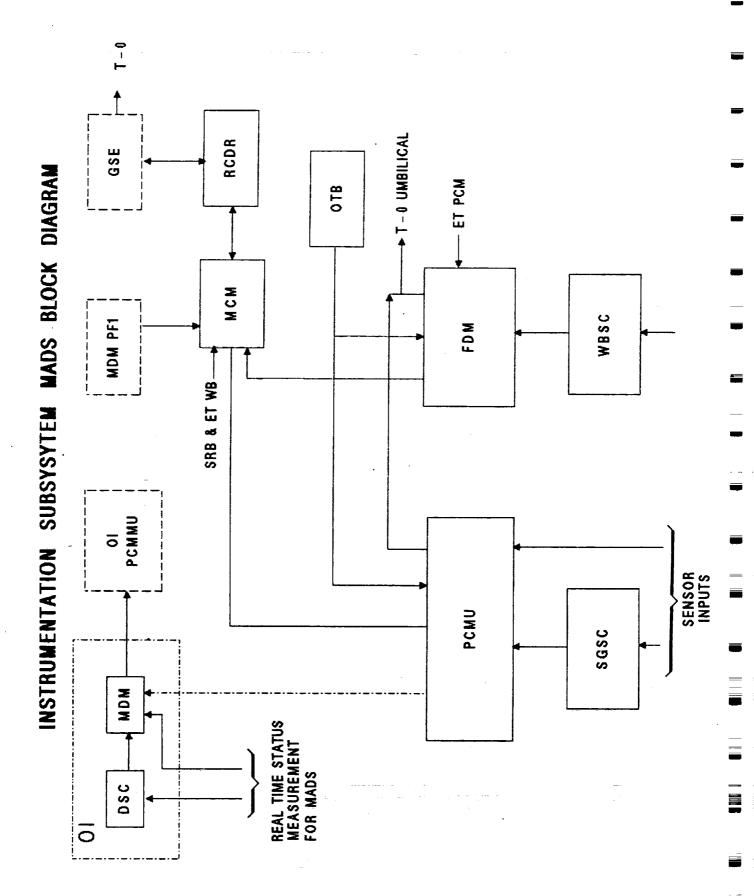


Figure 10 - MADS FUNCTIONAL BLOCK DIAGRAM

### 4.0 ASSESSMENT RESULTS

The IOA analysis of the Instrumentation hardware initially generated eighty-eight failure mode worksheets and identified eight Potential Critical Items (PCIs) before starting the assessment process. These analysis results were compared to a NASA baseline which was frozen as of 1 January 1988, with fourteen post 51L FMEAs included in a total of ninety-six FMEAs and eighteen CIL items, which were generated using the referenced FMEA/CIL instructions. Upon completion of the assessment, eighty-two of the one-hundred-seven FMEAs were in agreement. Of the twenty-five that remained, four are 2/2 criticality and not currently on the NASA CIL list, one CIL is assigned a different criticality and seven new FMEAs were generated which had no NASA match. The remaining fourteen FMEAs are of a different criticality than the NASA interpretation. None of these fourteen FMEAs affect the CIL listing.

A summary of the quantity of NASA FMEAs assessed, versus the recommended IOA baseline, and any issues identified are presented in Table I.

Table I SUMMARY OF IOA FMEA ASSESSMENT						
Component	NASA	IOA	Issues			
MTU	4	4	-			
PCMMU	11	11	_			
MDM	9	14	5			
DSC	10	15	5			
PDI	4	4	-			
OPS REC	9	9	-			
P/L REC	7	7	_			
ÓТВ	3	3	-			
PTB	5	5	_			
MADS	18	19	1			
SENSORS	16	16	-			
TOTAL	96	107	11			

A summary of the quantity of NASA CIL items assessed, versus the recommended IOA baseline, and any issues identified are presented in Table II.

Table II	SUMMARY OF	IOA CIL AS	SESSMENT
Component	NASA	IOA	Issues
MTU	3	3	-    -
PCMMU	7	7	_
MDM	5	9	4
DSC	<b>-</b> .	-	_
PDI	3	3	_
OPS REC	_	_	_
P/L REC	_	-	_
OTB	-	-	_
PTB	_	-	_
MADS	-	_	_
SENSORS	_	_	_
TOTAL	18	22	4
	+	+	+

Appendix C presents the detailed assessment worksheets for each failure mode identified and assessed. Appendix D highlights the NASA Critical Items and corresponding IOA worksheet ID. Appendix E contains IOA analysis worksheets supplementing previous analysis results reported in Space Transportation System Engineering and Operations Support (STSEOS) Working Paper No. 1.0-WP-VA86001-017, Analysis of the Instrumentation, 19 December 1986. Appendix F provides a cross reference between the NASA FMEA and corresponding IOA worksheet(s). IOA recommendations are also summarized.

Table III presents a summary of the IOA recommended failure criticalities for the Post 51-L FMEA baseline. Further discussion of each of these subdivisions and the applicable failure modes is provided in subsequent paragraphs.

Table III SUMMARY OF IOA RECOMMENDED FAILURE CRITICALITIES							
Criticality: MTU PCMMU MDM DSC PDI OPS P/L OTB PTB	1/1	2/1R - - 2 - - - -	2/2 3 4 5 - - -	3/1R - - 3 4 - - -	3/2R 1 3 4 6 4 - 5 -	3/3 - 4 - 5 - 9 2	TOTAL 4 11 14 15 4 9 7 3
MADS SENSOR	-	<del>-</del>	<del>-</del>	<b>-</b>	<b>-</b>	19 16	19 16
TOTAL	·	2	12	7	23	63	107

Of the failure critical items is presented in

lyzed, twenty-two were determined to be ry of the IOA recommended critical items

The scheme for assigning IOA assessment (Appendix C) and analysis (Appendix E) worksheet numbers is shown in Table V.

	Table V IOA WORKSHEET NUMBERS
Component	IOA ID Number
MTU PCMMU MDM DSC PDI Ops Rec P/L Rec OTP PTB MADS Sensors	131-134 121-128, 231-233 112-118 101-111, 302-305 161-164 171-177 181-186 151-153 141-144, 154 201-214, 221-222, 241-256 218, 261-301

# 4.1 MTU Assessment Results

The IOA assessment produced four FMEAs, three of which were given a 2/2 criticality as CILs.

# 4.2 PCMMU Assessment Results

The IOA assessment produced eleven FMEAs, four of which were given 2/2 criticality and three given 3/2R criticality as CILs.

# 4.3 MDM Assessment Results

The IOA assessment produced fourteen FMEAs, of which two were given 2/1R, five 2/2, and two 3/1R criticality as CILs. One of the IOA 2/1R CILs was an issue with the NASA 2/2 criticality.

# 4.4 DSC Assessment Results

The IOA assessment produced fifteen FMEAs, of which none were given CIL status.

# 4.5 PDI Assessment Results

The IOA assessment produced four FMEAs, of which three were given 3/2R criticality as CILs.

# 4.6 Operations Recorder Assessment Results

The IOA assessment produced nine FMEAs, none of which were of CIL criticality.

# 4.7 Payload Recorder Assessment Results

The IOA assessment produced seven FMEAs, none of which were of CIL criticality.

# 4.8 OTB Assessment Results

The IOA assessment produced three FMEAs, none of which were of CIL criticality.

### 4.9 PTB Assessment Results

The IOA assessment produced five FMEAs, none of which were of CIL criticality.

### 4.10 MADS Assessment Results

The IOA assessment produced nineteen FMEAs, none of which were of CIL criticality.

# 4.11 Sensors Assessment Results

The IOA assessment produced sixteen FMEAs, none of which were of CIL criticality.

### 5.0 REFERENCES

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

- JSC-11174, Space Shuttle Systems Handbook, Rev. C, 9-12-85
- JSC-18611, INCO/COMM Systems Brief, Rev. C, PCN-3, 8-15-83
- 3. Shuttle Flight Operations Manual Volume 4E Instrumentation, 7-85
- 4. JSC-12820, STS Operational Flight Rules, PCN-1, 2-14-86
- 5. NSTS 22206, Instructions for Preparation of Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL), 10-10-86
- 6. Schematic VS70-974099 (OI)
- 7. Schematic VS72-978099, EO A14 (MADS)
- 8. Schematic VS72-978102 (MADS)
- 9. Schematic VS72-941102 (FASCOS)
- 10. Main Engine ICD 13M 15000 (FASCOS)
- 11. NSTS 08171, Operations and Maintenance Requirements and Specifications Document (OMRSD), 10-15-86
- 12. TD203, Communications/Instrument Workbook COM/IN2102,
  2-85 (Crew Training Workbook)
- 13. MC476-0130, Specification, Master Unit, Pulse Code Modulation, Rev. D, 4-30-82

# APPENDIX A

Aerodynamics Coefficient Instrumentation Package ACIP Abort Once Around AOA **ARPCS** Atmospheric Revitalization Pressure Control System AV Avionics Backup Flight System BFS Calibr Calibration CCTV Closed Circuit Television Critical Items List CIL Criticality CRIT Development Flight Instrumentation DFI Decommutator Format Load DFL Deck Dk DOD Department of Defense DSC Dedicated Signal Conditioner EIU Engine Interface Unit Enable Ena ET External Tank F Functional Flight Acceleration Safety Cutoff System FASCOS FDM Frequency Division Multiplexer Flt Flight **FMEA** Failure Modes and Effects Analysis Forward Fwd **GMT** Greenwich Meridien Time **GPC** General Purpose Computer GSE Ground Support Equipment In-Flight Maintenance IFM Instrumentation and Communication Officer -INCO/COMM Communications INST Instrumentation IOA Independent Orbiter Assessment Inches per second ips Interrange Instrumentation Group B-format IRIG B LRU Line Replacement Unit MADS Modular Auxiliary Data System Man Manual MCM MADS Control Module McDonnell Douglas Astronautics Company MDAC Multiplexer/Demultiplexer MDM MET Mission Elapsed Time MIA Multiplexer Interface Adapter Master Timing Unit MTU MUX Multiplex NA Not Applicable NASA National Aeronautics and Space Administration NSP Network Signal Processor (Communications Subsystem) Operational Aft OA

Operational Forward

OF

### **ACRONYMS**

OI Operational Instrumentation Operational Maintenance Requirements and OMRSD Specifications Document Orbital Maneuvering System OMS Operations, Operational OPS Orbiter Timing Buffer OTB Potential Critical Item PCI Pulse Code Modulation PCM PCM Master Unit (OI) PCMMU PCM Multiplexer Unit (MADS) PCMU Power Distribution Assembly PDA PDI Payload Data Interleaver Payload PL,P/L Panel Pnl Acceleration/Vibration Along Thrust Axis POGO PTB Payload Timing Buffer PWR Power QC Quality Control Return to Launch Site RTLS Shuttle Flight Operations Manual SFOM Strain Gage Signal Conditioner SGSC SM Systems Management Single Point of Failure SPF Solid Rocket Booster SRB Space Shuttle Systems Handbook SSSH Shuttle Tape Recorder STR STS Space Transportation System SW Switch SYS System T-0 Time Zero Trans-Atlantic Abort Landing TAL TFL Telemetry Format Load Thermal Protection System TPS Voltage-Controlled Oscillator VCO

Wideband Signal Conditioner

WBSC

### APPENDIX B

# DEFINITIONS, GROUND RULES, AND ASSUMPTIONS

- B.1 Definitions
- B.2 Project Level Ground Rules and Assumptions
- B.3 Subsystem-Specific Ground Rules and Assumptions

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# 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

<u>CREDIBLE (CAUSE)</u> - 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

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

<u>EARLY MISSION TERMINATION</u> - 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

<u>MAJOR MODE (MM)</u> - 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

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

OPS - software operational sequence

<u>PRIMARY MISSION OBJECTIVES</u> - 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

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

<u>LANDING/SAFING PHASE</u> - 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.

### APPENDIX B DEFINITIONS, GROUND RULES, AND ASSUMPTIONS

B.3 Instrumentation Subsystem - Specific Ground Rules and Assumptions

1. Sensors and transducers and associated individual or integral signal conditioners used within a subsystem will be analyzed by specialists assessing that subsystem.

Rationale: The subsystem analyst is the person best qualified to identify credible failure modes/causes and to assess the effects/criticalities of those failures.

2. Human error (e.g., misconfiguration by crew or ground) will not be considered.

Rationale: Possible misconfigurations are out of scope for this analysis.

3. Inadvertent misconfigurations (e.g., accidental body contact by crew member with a switch in zero-g operations) will not be considered.

Rationale: Most critical switches have guards, or are lever-lock type. Possible inadvertent misconfigurations are out of scope for this analysis.

4. Hardware items have been properly qualified, have passed applicable acceptance testing, and have been properly installed in the Orbiter. Exception: if analysis of LRU/subassembly/piece-part failure history discloses multiple failures for a particular item, that item will be individually examined for design/QC deficiencies, and will be flagged for special attention.

transmit

Rationale: Baseline assumption is that program controls have resulted in hardware that is properly qualified and installed.

5. The criticality of an Instrumentation SS hardware item will be assigned on the basis of the highest criticality of any parameter or measurement traversing it.

Rationale: Instrumentation exists as a service to other subsystems and to give insight into their status; the criticality of any path(s) within it is determined by the criticality of measurements utilizing it.

### APPENDIX C DETAILED ASSESSMENT

This section contains the IOA assessment worksheets generated during the assessment of this subsystem. The information on these worksheets facilitates the comparison of the NASA FMEA/CIL (Pre and Post 51-L) to the IOA detailed analysis worksheets included in Appendix E. Each of these worksheets identifies the NASA FMEA being assessed, corresponding MDAC Analysis Worksheet ID (Appendix E), hardware item, criticality, redundancy screens, and recommendations. For each failure mode, the highest assessed hardware and functional criticality is compared and discrepancies noted as "N" in the compare row under the column where the discrepancy occurred.

### LEGEND FOR IOA ASSESSMENT 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

a care was

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

### Redundancy Screens A, B and C:

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

#### NASA Data:

Baseline = NASA FMEA/CIL

New = Baseline with Proposed Post 51-L Changes

#### CIL Item :

X = Included in CIL

#### Compare Row:

N = Non compare for that column (deviation)

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SUBSYSTEM MDAC ID: ITEM: CRITICAL				11 PO	7 WER	Αì					on Circu:	ГT	MI	OM OA:	1, 2	:, 3 <sub>;</sub>	7	
LEAD ANA	LYS	ST:	:	T.	EMM	101	1S											
ASSESSME	NT:	:														-		-
•		FI	CAL LIGH V/FUI	ľ			RE A		AN	CY	SCREI	ENS	S C			CIL	4	
NASA IOA	]	3	/2R /3	]		[	P	]	[	P	]	[	P	]		[	]	*
COMPARE	[		/N	]		[	N	3	[	N	]	[	N	]		[	]	
RECOMMEN	DA:	ric	ons:		(If	d.	ff	eren	t	fro	om NAS	SA)	)	-				
	[	3	/1R	]		[	P	· ]	[	F	]	[	P	]		[ A D/DI		
* CIL RE	ΓEI	<b>T</b>	ON I	RAT	'IONA	LI	€:	(If	ap	pl:	icable			DEQUAT		[	]	
REMARKS: DISAGREE ALL INSIGOA2, OA3 BECAUSE OBE LOST	GHT CONI	r : DUI E (	INTO LD RI DF TI	CR ESU HE	ITIC LT I	AI N INI	LC LC DAN	PU M SS O IT RP	EA F C	SUI CRI OU?	REMENT EW/VEI PUTS	SNN PS HIC	MEN HA CLE OR	T BEG ANDLEI E. FA	CAUS D BY	MDN SCI	Ms REE	OA1

ASSESSMENT DATE: 1 ASSESSMENT ID: E NASA FMEA #: 0	EPDC/INSTR-118	NASA DATA BASELINE NEW	BASELINE [ X ]							
MDAC ID: 1	118 ´									
ITEM: S	SWITCH, TOGGLE 3P	2T								
LEAD ANALYST: I	r. Emmons									
ASSESSMENT:										
CRITICALIT FLIGHT	redundanc	Y SCREENS	CIL ITEM							
	C A	в с								
NASA [ 2 /2 ] IOA [ 3 /1R ]	] [ ] [ ] [ P ] [	P ] [ P ]	[ X ] *							
COMPARE [ N /N ]	] [и] [	и ] [и]	[ א ]							
RECOMMENDATIONS:	(If different f	rom NASA)	tana arawa ara							
[ 2 /1R ]	] [P] .[	F ] [ P ] (A	[ DD/DELETE)							
* CIL RETENTION RA	ATIONALE: (If app	licable) ADEQUATE INADEQUATE								
REMARKS:			-							
CRITICAL APU AND F	FUEL CELL MEASURE	MENTS ARE HANDLED LD THREATEN CREW/V	BY THE EHICLE							
SAFETY, BECAUSE CF	RITICAL CONDITION	S/FAILURES COULD B	E MASKED.							
RECOMMEND UPGRADIN	NG TO 2/1R. FAIL	S SCREEN B BECAUSE	THERE WOULD							
	HOSE MASKED CONDI	TIONS DURING FLIGHT	т.							

ASSESSMENT DATE: ASSESSMENT ID: NASA FMEA #:	1/28/87 INSTR-121 05-4-2204	00-1	NASA DATA: BASELINE [ ] NEW [ X ]					
SUBSYSTEM: MDAC ID:	INSTRUMEN			(PCMMU)				
LEAD ANALYST:	A. W. ADD	ois						
ASSESSMENT:								
FLIGH	r	EDUNDANCY SCR	,	CIL ITEM				
HDW/FU	NC A	. В	С					
NASA [ 2 /1R IOA [ 3 /2R	] [ P	[ P ] [ NA]	[ P ] [ P ]	[ X ] * [ ]				
COMPARE [ N /N	] [	] [N]	[ ]	[ N ]				
RECOMMENDATIONS:	(If dif	ferent from N	ASA)					
[ /	] [	] [ NA]	[ ]	[ ] ADD/DELETE)				
* CIL RETENTION	RATIONALE:	(If applicab	le) ADEQUATE INADEQUATE					
REMARKS: SCREEN B SHOULD NASA FMEA ASSIGN CAUSE LOSS OF FA CREW/VEHICLE SAF FLIGHT RULES CAL PCMMU.	S CRIT 2/1 ULT DETECT ETY. AGRE	R BECAUSE LOS ION PARAMETER E WITH NASA C	IS IN INACTIVES OF BOTH PCM S THAT COULD RIT. NOTE:	E STANDBY. MU'S COULD AFFECT PRESENT				

ASSESSMENT DATE: ASSESSMENT ID: NASA FMEA #:	1/28/87 INSTR-122 05-4-220400-2	NASA DATA BASELINE NEW	
SUBSYSTEM: MDAC ID:	INSTRUMENTATION 122	ATION MASTER UNIT (	PCMMU)
LEAD ANALYST:	A. W. ADDIS		
ASSESSMENT:			
CRITICALI FLIGHT HDW/FUN	1	CY SCREENS  B C	CIL ITEM
NASA [ 2 /1R IOA [ 3 /2R	] [ P ] [	P ] [ P ] NA] [ P ]	[ X ] *
COMPARE [ N /N	] [ ] [	и] [ ]	[ N ]
RECOMMENDATIONS:	(If different	from NASA)	
	] [ ] [	NA] [ ] (A	[ ] DD/DELETE)
* CIL RETENTION R	RATIONALE: (If ap	plicable) ADEQUATE INADEQUATE	[ X ] [ ]
NASA HAS UPGRADED PREMISE THAT LOSS DETECTION PARAMET	) THIS TYPE OF FA S OF BOTH PCMMUS PERS THAT COULD A	UNIT IS IN INACTIV LILURE MODE FROM 3/2 COULD CAUSE LOSS OF FFECT CREW/VEHICLE SENT FLIGHT RULES C	E STANDBY. R TO 2/1R OI FAULT SAFETY.

MINIMUM DURATION FLIGHT ON LOSS OF FIRST PCMMU.

ASSESSMENT DATE: ASSESSMENT ID: NASA FMEA #:	1/28/87 INSTR-123 05-4-220400-2	NASA DATA: BASELINE [ ] NEW [ X ]					
	INSTRUMENTATION 123 PULSE CODE MODU		UNIT (PCMMU)				
LEAD ANALYST:	A. W. ADDIS						
ASSESSMENT:							
CRITICAL: FLIGHT	ITY REDUNDA	ANCY SCREENS	CIL ITEM				
HDW/FUI	NC A	в с	_ :: := : =				
NASA [ 2 /1R IOA [ 3 /2R	] [ P ] ] [ P ]	[ P ] [ P ] [ NA]	[ X ] * [ ]				
COMPARE [ N /N	] [ ]	[ N ] [ ]	[ и ]				
RECOMMENDATIONS:	(If different	from NASA)					
[ /		[ NA] [ ]	[ ] (ADD/DELETE)				
* CIL RETENTION 1	RATIONALE: (If a	applicable) ADE INADE	QUATE [ X ]				
PREMISE THAT LOSS DETECTION PARAMET	D THIS TYPE OF F S OF BOTH PCMMUS FERS THAT COULD CRIT. NOTE: PF	FAILURE MODE FR COULD CAUSE I AFFECT CREW/VE RESENT FLIGHT R	OM 3/2R TO 2/1R ON OSS OF FAULT HICLE SAFETY. ULES CALL FOR				

ASSESSME ASSESSME NASA FME	NT I	D:	INST	/87 R-124 -2204				N	IASA I BASEI		[	x	]	
SUBSYSTEM: INSTRUMENTATION MDAC ID: 124 ITEM: PCMMU FORMAT CONT								WITCH	I					
LEAD ANA	LYST	:	A. W	. ADE	ois									
ASSESSME	NT:													•
	<b>F</b>	REDUNDANCY SCREENS			EENS				CIL ITEM					
		LIGH W/FU		A	<b>\</b>	В	}	C	С					
NASA IOA	[ 2 [ 2	/2 /2	]	[	]	[	]	[	]		]	X X	]	*
COMPARE	[	/	1	1	]	ĺ	]	[	3		[		]	
RECOMMEN	DATI	ons:	(1	fdif	fere	ent fr	om N	ASA)			ifii k	£ 7 + £1	T : 3.2.	
	[	/	]	[	]	[	]	[	]	(A	[ DD/	/DF	] ELF	CTE
* CIL RE REMARKS:			RATIO	NALE:	(If	appl	icab	P	ADEQUA ADEQUA		[		]	٠

ASSESSM ASSESSM NASA FM	D:	1/28/ INSTR 05-4-	-125		NASA DATA: BASELINE [ ] NEW [ X ]								
MDAC ID: 125					NSTRUMENTATION 25 CMMU FORMAT CONTROL SWITCH								
LEAD AN	ALY	ST	•							-			
ASSESSM	ENT	:											
	CR		ICAL LIGH	ITY I	R	EDUN	DANCY	SCR	EENS			CII	
	]	HDV	/FU	NC	A		B		(	3			
NASA IOA	[	2 2	/2 /2	]	[	]	[	]	[	]		[	] <b>*</b> ]
COMPARE	Ι		/	]	[	]	[	]	, [	3		(	]
RECOMME	'NDA	ric	ONS:	(If	dif	fere	nt fr	om N	ASA)				gradien d
	[		/	]	[	]	C	]	[	]	(A	[ DD/I	] ELETE)
* CIL F	ETE	NT:	ION 1	RATION	ALE:	(If	appl	icab	1	ADEQU ADEQU		[	]
REMARKS NO DIFE		CES	5.										

ASSESSMENT ID:				8/87 TR-120 4-220				. 1	NASA DAT BASELIN NI	1E [	) x ]	
MDAC ID: 1				INSTRUMENTATION 126 PCMMU FORMAT CONT				WITC	Ŧ			
LEAD ANA	LYST	:	A.	W. AD	DIS							
ASSESSMENT:												
		ICAL LIGH	ITY				DANCY SCREENS			CIL ITEM		
		W/FU		i	A	. <b>B</b>		С				
NASA IOA	[ 2 [ 2	/2 /2	]	. [	]	]	]	[ [	]	[	] * ]	
COMPARE	C	/	]	[	]	[	]	[	]	[	]	
RECOMMEN	DATI	ons:	(	If di	ffere	ent fr	om N	(ASA)				
	[	1	]	[	]		]	[	1	[ (ADD/	] DELETE	
* CIL RE REMARKS:		•	RATI	ONALE	: (If	appl	icab	1	ADEQUATI ADEQUATI		]	

ASSESSMENT DATE: ASSESSMENT ID: NASA FMEA #:	1/28/87 EPDC/INST 05-6R-220	TR-127 0401-1	!	NASA DATA: BASELINE [ X ] NEW [ ]								
MDAC ID:	EPDC/INST 127 PCM POWER		CRITICA	LITY 3								
LEAD ANALYST:	T. EMMONS	5										
ASSESSMENT:	ASSESSMENT:											
CRITICALI FLIGHT HDW/FUR			DANCY SCI	REENS C	CI	L EM						
NASA [ 3 /2R IOA [ 3 /3	] [ ]	? ] ? ]	[ P ]	[ P ] [ P ]	[	] * ]						
COMPARE [ /N	] [	]	[ ]	[ ]	[	]						
RECOMMENDATIONS: (If different from NASA)												
[ , , , /	] [	]	[ ]	[ ]	[ (ADD/	] DELETE)						
* CIL RETENTION FREMARKS: AGREE WITH NASA I		·		ADEQU INADEQU	JATE [ JATE [	]						

ASSESSMENT DATE: ASSESSMENT ID: NASA FMEA #:	1/28/87 EPDC/INSTR-128 05-6R-220402-1	NASA DATA: BASELINE NEW										
SUBSYSTEM: MDAC ID: ITEM:	EPDC/INSTRUMENT: 128 SWITCH TOGGLE,											
LEAD ANALYST:	T. EMMONS											
ASSESSMENT:	ASSESSMENT:											
	ITY REDUNDA	NCY SCREENS	CIL ITEM									
FLIGHT HDW/FUI	NC A	в с	TIEM									
NASA [ 2 /1R IOA [ 2 /2	] [ P ] ] [ ]	[ P ] [ P ] [ ] [ ]	[ X ] *									
COMPARE [ /N	] [N]	[иј" [иј	נ ז									
RECOMMENDATIONS:	•											
[ /	] . [ ]	[ ] [ ](A)	[ ] DD/DELETE)									
* CIL RETENTION	* CIL RETENTION RATIONALE: (If applicable)											
* · · · · · · · · · · · · · · · · · · ·	en e	ADEQUATE INADEQUATE										
REMARKS: LATEST NASA FEMA ASSIGNS CRIT 2/1R ON PREMISE SUBSEQUENT FAILURE IN A CRITICAL SUBSYSTEM COULD CAUSE LOSS OF CREW/VEHICLE, BECAUSE PCMMU HANDLES OI DATA, AND CRITICAL SUBSYSTEM FAILURES COULD BE CANCELED. AGREE WITH NASA FMEA.												

ASSESSMENT DATE: ASSESSMENT ID: NASA FMEA #:	INSTR-131 BASELINE							
SUBSYSTEM: MDAC ID: ITEM:	131	INSTRUMENTATION 131 MASTER TIMING UNIT (MTU)						
LEAD ANALYST:	A. W. AC	DDIS		•				
ASSESSMENT:								
CRITICAL		REDUNDA	NCY S	CREENS		CIL ITEM		
FLIGHT HDW/FUI		A	В		С	LIEN		
NASA [ 2 /1R IOA [ 2 /2	] [	P ]	[ P ] [ ]	] [	F ]	[ X ] * [ X ]		
COMPARE [ /N	] [	N ]	[и]	] [	и ј	[ ]		
RECOMMENDATIONS:	(If di			•				
[ 2 /2	) (	1	[ ]	ז`, נ	] (AI	[ DD/DELETE)		
* CIL RETENTION	RÁTIONALE	E: (If a	pplic					
					ADEQUATE ADEQUATE	[ X ]		
REMARKS: INVESTIGATIONS CONASA ON MTU CRIT FUNCTION. AGREE OPS AND MTU FAILS	. THESE WITH NAS	ARE SPF SA FMEA	's TH BECAU	HAT COU USE LOS	LD CAUSE I S OF MTU I	INION WITHIN LOSS OF MTU PREVENTS BFS		

ASSESSMENT DATE: ASSESSMENT ID: NASA FMEA #:	INSTR-132	2	ASA DATA: BASELINE NEW								
SUBSYSTEM: MDAC ID: ITEM:	132	INSTRUMENTATION 132 MASTER TIMING UNIT (MTU)									
LEAD ANALYST:	A. W. ADI	DIS									
ASSESSMENT:											
CRITICAL FLIGH		REDUNDANC	SCREENS		CIL						
HDW/FU		A 1	з с		ITEM						
NASA [ 2 /1R IOA [ 2 /2	] [1	P ] [ 1	? ] [ F ] [	]	[ X ] * [ X ]						
COMPARE [ /N	] [ 1	и] [1	и] [и	]	[ ]						
RECOMMENDATIONS:	(If di	fferent f	com NASA)								
[ 2 /2	] [	1. [	] [	] (AI	[ ] DD/DELETE)						
* CIL RETENTION	RATIONALE	: (If app	A	DEQUATE							
REMARKS:			INA	DEQUATE	[ ]						
INVESTIGATIONS CONTINUE TO RECONCILE DIVERSITY OF OPINION WITHIN NASA ON MTU CRIT. THESE ARE SPF'S THAT COULD CAUSE LOSS OF MTU											
FUNCTION. AGREE	WITH NASA	A FMEA BEG	CAUSE LOSS	OF MTU	PREVENTS BFS						

OPS AND MTU FAILS SCREEN C BECAUSE OF SPF's.

•	ASSESSMENT DATE: ASSESSMENT ID: NASA FMEA #:	INSTR-13	3			NASA DATA: BASELINE NEW						
		133										
	LEAD ANALYST:	A. W. AD	DIS									
	ASSESSMENT:											
	CRITICAL: FLIGH	ITY T	REDUNDA	NCY	SCREENS	5	CIL ITEM					
	HDW/FU		A	В		C						
	NASA [ 2 /1R IOA [ 2 /2	] [	P ]	[ P	] [	F ]	[ X ] * [ X ]					
	COMPARE [ /N	] [	ו א	[ N	] [	N ]	[ ]					
	RECOMMENDATIONS:	(If di	fferent	fro	om NASA)							
	[ 2 /2	] [	1	[	] [	] (AI	[ ] DD/DELETE)					
	* CIL RETENTION RATIONALE: (If applicable)  ADEQUATE [ X ] INADEQUATE [ ]											
	REMARKS: INVESTIGATIONS CONASA ON MTU CRIT FUNCTION. AGREE OPS AND MTU FAIL	. THESE WITH NAS	ARE SPE A FMEA	's ' BEC	THAT COU AUSE LOS	JLD CAUSE I SS OF MTU I	LOSS OF MTU					

ASSESSMENT DATE: 1/28/87 ASSESSMENT ID: EPDC/INSTR-134 NASA FMEA #: 05-6R-221201-1 NEW [ ]										
SUBSYSTEM: EPDC/INSTRUMENTATION MDAC ID: 134 ITEM: POWER AND CONTROL CIRCUIT, MTU (2)	134									
LEAD ANALYST: T. EMMONS	T. EMMONS									
ASSESSMENT:										
CRITICALITY REDUNDANCY SCREENS CIL FLIGHT ITEM HDW/FUNC A B C										
HDW/FUNC A B C										
NASA [3/1R] [P] [P] [P] [] * IOA [3/2R] [P] [P] [P] []										
COMPARE [ /N ] [ ] [ ] [ ]										
RECOMMENDATIONS: (If different from NASA)										
[3/2R] [] [] [] (ADD/DELETE)										
* CIL RETENTION RATIONALE: (If applicable)										
* CIL RETENTION RATIONALE: (II applicable)  ADEQUATE [ ]										
INADEQUATE [ ]										
REMARKS:										
NASA FMEA 05-6R-221201-1, PRE-51L BASELINE, ASSIGNS CRIT 3/1R, BUT WRITE-UP DOES NOT SUPPORT THAT CRIT ("LOSS OF MTU WILL NOT	T									
AFFECT CREW/VEHICLE" AND "POSSIBLE LOSS OF MISSION"). RECOMME	END									
CRIT 3/2R.										

ASSESSME ASSESSME NASA FME SUBSYSTE MDAC ID:	INSTI 05-4- INSTI 141	INSTR-141 05-4-221400-1 INSTRUMENTATION 141												
ITEM:			PAYLO	DAD T	IMING	BUI	FFER	(PTB)	)					
LEAD ANA	LYS'	T:	A. W	. ADD	IS									
ASSESSME	ENT:													
		TICAL FLIGH		R	EDUNI	DANC	NCY SCREENS					CIL ITEM		
		DW/FU		A		1	3	(	C					
NASA IOA	[	3 /3 3 /3	]	[	]	[	]	[	]		[	]	*	
COMPARE	[	/	]	ξ	]	[	]	ľ	3		[	]		
RECOMMEN	IDAT:	ions:	<b>(I</b> :	f dif	ferer	it fi	com N	ASA)		. 2 - 122				
	[	/	]	[	)	[	]	[	]	(Al	[ DD/	DEL	ETE	
* CIL RE			RATIO	NALE:	(If	app]	licab	1		UATE UATE	[	]		

ASSESSME ASSESSME NASA FME	NT ID:	1/28/8 INSTR- 05-4-2	: [ X ] [ ]	<u> </u>				
SUBSYSTEMDAC ID:		142	MENTATIO D TIMING		(PTB)			
LEAD ANA	LYST:	A. W.	ADDIS					
ASSESSME	NT:							
	CRITICAL FLIGH		REDUND	ANCY SC	REENS		CIL ITEM	
	HDW/FU		A	В		11111		
NASA IOA	[ 3 /3 [ 3 /3	]	[ ]	[ ]	[	]		*
COMPARE	[ /	]	[ ]	[ ]	[	1	[ :	j
RECOMMEN	DATIONS:	(If	differen	t from	NASA)			
pu <u>s</u> ti i šie	[, , , ,	]	[ ]	[ ]	[	] (A	[ DD/DEI	j Lete)
* CIL RE REMARKS:	TENTION	RATIONA	LE: (If	applica	AL	EQUATE EQUATE	[ ]	] ]

ASSESSME ASSESSME NASA FME	NT	ID:	1/28/ INSTR 05-4-	-143			NASA DATA: BASELINE [ X ] NEW [ ]							
SUBSYSTE MDAC ID: ITEM:			INSTR 143 PAYLO				FFER	(PTB)						
LEAD ANA	LYS	T:	A. W.	ADD	IS									
ASSESSME	NT:													
		TICAL FLIGH	ITY	R	EDUND	ANCY	scr	EENS			CII			
		DW/FU		A		F	3	(	<b>.</b>		111	1F1		
NASA IOA	[	3 /3 3 /3	]	( (	]	[	]	[	]		[	] <b>*</b>		
COMPARE	[	/	]	[	]	[	]	[	]		[	]		
RECOMMEN	DAT	ions:	(Îf	dif	feren	t fr	om N	ASA)			-	e e seege c		
	[	/	]	[	]	[	]	[	]	(A)		] ELETE)		
* CIL RE			RATION	ALE:	(If	app1	Licab	7	ADEQU.		[	]		

ASSESSME ASSESSME NASA FME	NT I	ID:	EPDO	5/88 C/INST 1-2214			NASA DATA: BASELINE [ X ] NEW [ ]							
SUBSYSTE MDAC ID:	M:		144	C/INS			, PA	YLOAD T	IMING	BUFFER				
LEAD ANA	LYS	r:	A.W	ADDI	S									
ASSESSME	NT:													
		TICAL FLIGH		<b>. .</b>	EDUN	DANCY	SCR	EENS		CII				
		DW/FU	_	A		E	3		С					
NASA IOA	[ ;	3 /3 3 /3	]	[	]	[	]	]	] ]	[	] * ]			
COMPARE	[	/	]	[	]	. [	]	[	]	[	]			
RECOMMEN	DAT:	ions:	(:	f dif	fere	nt fr	om N	ASA)						
	[	/	]	[	]	[	]	[	] .	[ (ADD/1	] DELETE)			
* CIL RE	TEN	rion	RATIO	NALE:	(If	appl	icab		ADEQUAT ADEOUAT	_	]			

**REMARKS:** 

ASSESSMENT DATE: ASSESSMENT ID: NASA FMEA #:		00-1		N	ASA DAT BASELIN NE		[ ]
MDAC ID:	INSTRUMEN 151 ORBITER T			(OTB)			
LEAD ANALYST:	A. W. ADD	IS					
ASSESSMENT:							
CRITICALI FLIGHT		EDUNDA	ANCY SC	REENS		CIL	
HDW/FUN			В	c	!	TIE	.rı
NASA [ 3 /3 IOA [ 3 /3	] [	]	[ ]	]	]	[	] * ]
COMPARE [ /	] [	]	[ ]	[	]	[	3
RECOMMENDATIONS:	(If dif	ferent	t from	NASA)			_
[ /	] [	]	[ ]	. [	] (	[ ADD/D	] ELETE)
* CIL RETENTION F REMARKS: NO DIFFERENCES.	RATIONALE:	(If a	applica	A	DEQUATE DEQUATE		]

ASSESSME ASSESSME NASA FME	NT I	D:	INST	/87 R-152 -2215		-	NASA DATA: BASELINE ( NEW (							
SUBSYSTE MDAC ID:			152	RUMEN TER T		ON G BUF	FER	(OTB)	-					
LEAD ANA	LYST	:	A. W	. ADD	is									
ASSESSME	NT:													
	CRIT	ICAL LIGH		R	EDUN	IDANCY	SCR	EENS	आस्त्र इस जाला ।	CIL	_			
	HD	W/FU	NC	A		В		2						
NASA IOA	[ 3 [ 3	/3 /3	]	[	]	]	]	]	] ]	[	] *			
COMPARE	[	/	1	[	]	[	]	[	]	[	]			
RECOMMEN	DATI	ons:	(I	f dif	fere	ent fr	om N	ASA)						
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* CIL RE			RATIC	NALE:	(If	appl	icab	2	ADEQUATI ADEQUATI		]			
NO DIFFE	ERENC	ES.							, .					

ASSESSME ASSESSME NASA FME	NТ	ID:	1/28, INST 05-4	R-153				1	NASA BASE		[ ]	( ] ]
SUBSYSTE MDAC ID: ITEM:	M:		INST 153 ORBI			ON G BUI	FER	(OTB)	)			
LEAD ANA	LYS	T:	A. W	. ADI	ois							
ASSESSME	NT:											
	CRI	TICAL FLIGH		I	REDUN	DANC	SCR	EENS			CII	
	H	IDW/FU		7	4	I	3	(			<b></b>	
NASA IOA	[	3 /3 3 /3	]	[	]	[	]	[	]		[	] <b>*</b> ]
COMPARE	[	/	]	[	]	[	]	C	]		[	]
RECOMMEN	DAT	NONS:	(1	f di	fere	nt fi	com N	ASA)				
	. [		]	[	]	[	]	[	]	(A	[ DD/I	] DELETE)
* CIL RE	TEN	ITION	RATIO	NALE:	(If	appl	licab	1	ADEQU ADEQU		]	]
REMARKS:	REN	ICES.						,				

	ASSESSME ASSESSME NASA FME	TK	ID	:		/INST			NASA DATA: BASELINE [ X ] NEW [ ]							
	SUBSYSTE MDAC ID: ITEM:				154	·		ŒNTAI		, PA	/LOAD	TIM	ING	BUFF	ER	
	LEAD ANA	LYS	ST:		A.W.	ADD	s									
=	ASSESSME	NT:	:													
į		CR:		CAL IGH	ITY T	I	REDUN	IDANCY	SCR	EENS			CI			
ž		I		_	NC	2	1	E	3	С						
- - -	NASA IOA	[	3	/3 /3	]	[	]	[	]	[	]		[	] *		
<u>.</u> Š	COMPARE	[		/	]	[	]	[	]	[	]		[	]		
•	RECOMMEN	IDA!	rio	ns:	(I	f di	ffere	ent fr	om N	ASA)						
		ָּנ	÷ .	/ 	] [[]	[	]	[	]	[	].	(A	[ DD/1	] DELET	E)	
1	* CIL RE	ON	RATIO	NALE	(If	appl	.icab	1	ADEQUA ADEQUA		[.	]				
j	REMARKS:															

ASSESSMENT DATE: ASSESSMENT ID: NASA FMEA #:	INSTR-161	BASI	BASELINE [ ] NEW [ X ]						
SUBSYSTEM: MDAC ID: ITEM:	INSTRUMENTATIO 161 PAYLOAD DATA I								
LEAD ANALYST:	A. W. ADDIS		.2						
ASSESSMENT:									
CRITICAL FLIGH		DANCY SCREENS	CIL ITEM						
HDW/FU		ВС	e de la come						
NASA [ 2 /2 IOA [ 3 /2R	] [ ] ] ]	[ NA] [ P ]	[ X ] * [ ]						
COMPARE [ N /N	] [ N ]	[и] [и]	[ N ]						
RECOMMENDATIONS:	(If differen	nt from NASA)	· · · · · · · · · · · · · · · · · · ·						
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* CIL RETENTION	RATIONALE: (If	applicable) ADEQU INADEQU							
FOR WHICH PDI IS	MISSION CRITIC		ARRIED ON FLIGHTS PITUTION REQUIRES PICALITY.						

	/28/87 NSTR-162 5-4-221300-1	NASA DATA: BASELINE [ ] NEW [ X ]
MDAC ID: 16	NSTRUMENTATION 62 AYLOAD DATA INTERLEAVER	R (PDI)
LEAD ANALYST: A.	. W. ADDIS	-
ASSESSMENT:		
CRITICALITY FLIGHT HDW/FUNC		CIL ITEM
NASA [ 2 /2 ] IOA [ 3 /2R ]	[ ] [ ] [ P ] [ NA]	[ ] [ X ] * [ P ]
COMPARE [ N /N ]	[и] [и]	[ N ]
RECOMMENDATIONS:	(If different from NAS	SA)
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* CIL RETENTION RAT	TIONALE: (If applicable	ADEQUATE [ X ] INADEQUATE [ ]
FOR WHICH PDI IS MI	D AVAILABILITY OF SPARE ISSION CRITICAL, BUT PE CTIVITY. AGREE WITH NA	PDI CARRIED ON FLIGHT SUBSTITUTION REQUIRE

ASSESSMENT I ASSESSMENT I NASA FMEA #:	rn:	TNSTR-	, • .							-	SA DATA: BASELINE NEW		x	]	
SUBSYSTEM: MDAC ID: ITEM:		ON INTE	ERI	.EAVE	R (	PE	PI)								
LEAD ANALYS	r:	A. W.	Αľ	DI	S										
ASSESSMENT:															
V11222 V11222													L EM	ſ	
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COMPARE [ 1	N /N	]	[	N	]	[	N	]	[	N	]	[	N	)	
RECOMMENDAT	cons:	(If	di	ff	ere	nt f	rc	m NA	SA)	ı					
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REMARKS: IOA CRIT COI FOR WHICH PI OFF-NOMINAL	DI IS	MISSI	NC	CR	ITI	CAL,	E	BUT P	E E	PDI SU	CARRIEI BSTITUTI	) ( :0N	N I F	FI	

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LEAD ANA	LYST	:	в. но	WARD									
ASSESSME	NT:												
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	HD	W/FU	NC	A		В		(	С				
NASA IOA	[ 3 [ 3	/3 /3	]	[ [ P	]	[ [ P	]	[ :	P ]		[	]	*
COMPARE	[	/	]	[ 1	]	[ N	]	[ ]	N ]		[	]	
RECOMMEN	DATI	ons:	(If	dif	fer	ent fro	om :	NASA)					
	[	1.	]	[	]	[	]	[	1 .	(AI	[ DD/D	ELE	TE)
* CIL RE		ION		IALE:	(I	f appli	ca		ADEQU ADEQU	JATE JATE	[	]	
REMARKS: NO DIFFE RATED FO						ENT. 1	HE	SCRE	ens s	SHOULE	) NC	тв	E

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SUBSYSTE MDAC ID: ITEM: OPS 2 ST			INSTR 172 SWITC	-				.NDBY/	'PLAYBA	CK FOR	OPS 1
LEAD ANA	LYST	:	в. но	WARD	l						
ASSESSME	NT:				w ,						
·	CRIT	ICAL LIGH		R	EDUN	DANCY	SCR	EENS		CIL	
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COMPARE	[	/	1	[	]	[	]	[	]	[	]
RECOMMEN	DATI	ONS:	(If	dif	fere	nt fr	om N	(ASA)	,		,
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* CIL RE			RATION	ALE:	(If	appl	icab	P	ADEQUATI	-	]

ASSESSME ASSESSME NASA FME	NT I		1/28, INSTI 05-4	R-173				1			x ]			
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LEAD ANA	LYST	:	в. н	OWARD	)									
ASSESSME	NT:													
CRITICALITY REDUNDANCY SCREENS CIL FLIGHT ITEM														
NASA IOA	[ 3	/3	]	[	]	[	]	[	]	[	] *			
COMPARE	[ N	/N	]	[	]	ĺ	]	[	]	ľ	]			
RECOMMEN	DATI	ons:	(I:	f dif	fere	nt fr	om N	ASA)						
	[	/	]	. [	]	[	]	[	]	{ (ADD/	] DELETE	)		
* CIL RE	TENT:	ION 1	RATIO	VALE:	(If	appl	icab		ADEQUA ADEQUA		] .			
REMARKS:	וו חז	አ የፓቲኮ	a cetei	כ משנ	/2 C	ם דיייד כי	אי דתי	יטיו	ACDEE	א ניידע או	ACA EMI	Fλ		

ASSESSMENT DATE: ASSESSMENT ID: NASA FMEA #:		02-1		NASA DATA BASELINE NEW	[ X ]										
SUBSYSTEM: MDAC ID: ITEM:	INSTRUMENT 174 SWITCH, MO		MAINT O	PS 1 & 2 S	TRS										
LEAD ANALYST:	B. HOWARD														
ASSESSMENT:	ASSESSMENT:  CRITICALITY REDUNDANCY SCREENS CIL														
FLIGHT															
NASA [ 3 /3 IOA [ /	] [	] [	] [	]		*									
COMPARE [ N /N	] [	] [	] [	1	[ ]										
RECOMMENDATIONS:	(If dif	ferent fr	om NASA	)											
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* CIL RETENTION REMARKS:		,	· I	ADEQUATE NADEQUATE											
IOA SHOULD HAVE	ASSIGNED 3,	/3 CRITIC	ALITY.	AGREE WIT	H NASA	FMEA.									

ASSESSMEN ASSESSMEN NASA FME	NT I	D:	1/26/3 INSTR- 05-4-3	-1752				N	IASA D. BASEL	INE		]	
SUBSYSTEM MDAC ID:	M:		INSTRU 175 EVENT				ops R	ECOF	RDER C	ONTI	ROL I	MODE	
LEAD ANA	LYSI	? <b>:</b>	A.W.	ADDIS	5								
ASSESSME	NT:												
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	HC	W/FU	NC	A		В	1	C					
NASA IOA	[ 3	/3	]	[ [	]	[	]	[	]		[	] <b>*</b> ]	
COMPARE	[	/	]	[	]	[	J	[	]		[	]	
RECOMMEN	DATI	ONS:	(If	dif	ferer	nt fr	om NA	SA)					
	[		]	[	J.	[	]	[	]	(AI	[ D/D/	] ELETE	)
* CIL RE	TENT	'ION I	RATION	ALE:	(If	appl	icabl	À	DEQUA'		[	]	
REMARKS:									× · · · ·			,	

ASSESSMENT DATE: ASSESSMENT ID: NASA FMEA #:	EPDC/INSTR-17	NASA DATA 6 BASELINE 1 NEW												
SUBSYSTEM: MDAC ID: ITEM:	EPDC/INSTRUMENT 176 POWER AND CONT	NTATION TROL CIRCUIT, OPS RCDF	2 1, (2)											
LEAD ANALYST:	T. EMMONS													
ASSESSMENT:														
CRITICALITY REDUNDANCY SCREENS CIL FLIGHT ITEM														
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FLIGHT HDW/FUNC A B C NASA [3/3] [] [] [] * IOA [3/3] [P] [P] [P] []														
COMPARE [ /	] [N]	[и] [и]	[ ]											
RECOMMENDATIONS:	(If differen	nt from NASA)	e e e											
[ /	] [ .]	[ ] [ ]	[ ] ADD/DELETE)											
* CIL RETENTION	RATIONALE: (If	applicable)												
	** :	ADEQUATE INADEQUATE												
REMARKS: NO DIFFERENCE IN 3/3 CRIT.	CRITICALITY.	THE SCREEN SHOULD NOT	BE RATED FOR											

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SUBSYST				INSTR 176 EVENT				PS	RECORDE	R OPE	RATION	IAL	MODE
LEAD AN	ALYS	ST:	:	A.W.	ADDI	:s							
ASSESSM	ENT:	:											
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* CIL R	ETEI	NT:	ION 1	RATION	ALE:	(If	appl:	ica	AD	EQUAT:	•	]	

REMARKS:

ASSESSMENT DATE: ASSESSMENT ID: NASA FMEA #:		7	NASA DATA: BASELINE NEW	[]
SUBSYSTEM: MDAC ID: ITEM:	EPDC/INSTRUMENT 177 POWER AND CONT		OPS RCDR	2, (2)
LEAD ANALYST:	T. EMMONS			
ASSESSMENT:				
CRITICAL FLIGH	T	DANCY SCREENS		CIL ITEM
HDW/FU	NC A	В	C	
NASA [ / IOA [ 3 /3	] [ ] ] [ P ]	[ ] [ [ P ]	] P ]	[ ] *
COMPARE [ N /N	] [N]	[и]	N ]	נ ז
RECOMMENDATIONS:	(If differe	nt from NASA)		
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* CIL RETENTION	RATIONALE: (If		ADEQUATE ADEQUATE	[ ]
REMARKS: NO DIFFERENCE IN	CRITICALITY.	THE SCREENS	SHOULD NOT	BE RATED

ASSESSME ASSESSME NASA FME	NT	ID:	INS	6/88 TR-1773 4-22100		-		1	NASA DA' BASELII N		<b>K</b> ]
SUBSYSTE MDAC ID: ITEM:	M:		177	TRUMENT			ANOI	MALY S	SEQUENCI	E TALI	KBACK
LEAD ANA	LYS	T:	A.W	. ADDIS	5						
ASSESSME	NT:										
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COMPARE	[	/	1	[	]	[	]	[	1	[	]
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* CIL RE	TEN	TION	RATI	ONALE:	(If	appl	.ica	i	ADEQUATI		]
DEMARKS.								T144	TOUZONI	<b>∟</b> [	j

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SUBSYSTE MDAC ID:		INSTRU 181 SHUTTI		,			co	RI	ER-	-PAY	LO	AD					
LEAD ANA	LYST:	B. HOW	VAR	D													
ASSESSME	NT:																
	CRITICAI FLIGH			RE	EDUI	NDA	NC	Y	SCI	REEN	5		÷ ÷		CII		
	HDW/FU			A				В			С					214	
NASA IOA	[ 3 /3 [ 3 /2F	]	[	P	]		[	P	]	[	P	]			]	]	*
COMPARE	[ /N	1	[	N	]		[	N	]	•	N	]	-		[	]	erent ye. Ye.
RECOMMEN	DATIONS:	(If	di	.ff	ere	ent	f	rc	om 1	NASA	)						
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* CIL RE	TENTION	RATIONA	\LE	:	(II	f a	pp	11	cal	·			UAT UAT		]	]	
REMARKS: LOSS OF VIA PLAY OBJECTIVE	BACK OR									D DA'	ΓA	то	GR	OUI	ND,	EIT	HER

ASSESSME ASSESSME NASA FME	3-1									[ 2	K ]								
SUBSYSTE MDAC ID: ITEM:				18	2			TATIO		/L	STR	MOI	DΕ	SE	LEC	T			
LEAD ANA	LYS	T:		в.	HOV	IAV	RD												
ASSESSME	ENT:	;																	
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ASSESSME ASSESSME NASA FME	NT I	D:	INS	STR-	18	3 10	)1-	1						NA E	SAS	DA SELI N	NE	: [ [	x	]	
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LEAD ANA	LYST	<b>':</b>	в.	HOW	AR	D															
ASSESSME	ENT:																				
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REMARKS: LOSS OF CAUSE LO	ALL									PI	ERA	TE/	ΈI	RAS	SE	FUN	CT	ION	С	OU	ıTD

ASSESSME	SSESSMENT DATE: 1/28/87 SSESSMENT ID: INSTR-184 ASA FMEA #: 05-4-221102-1 UBSYSTEM: INSTRUMENTATE DAC ID: 184													]		SA DA BASELI N		[ X	]	
SUBSYSTE MDAC ID:				184	4					·/1	<sub>-</sub>	STR	SF	Έ	ΕD	CON	ro	L		
LEAD ANA	LYS	ST:	:		,					•										
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REMARKS:	!												I			EQUAT			j	
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ASSESSMENT DATE: ASSESSMENT ID: NASA FMEA #:	1/28/87 EPDC/INSTR-185 05-6R-221101-1	NASA DATA: BASELINE [ X ] NEW [ ]
	EPDC/INSTRUMENTATION 185	RCUIT PAYLOAD RECORDER (2)
LEAD ANALYST:	T. EMMONS	
ASSESSMENT:		
CRITICAL FLIGH	ITY REDUNDANCY SO	CREENS CIL ITEM
HDW/FU		С
NASA [ 3 /3 IOA [ 3 /2R	] [ ] [ ] ] [ P ] [ P ]	[ ] [ ] * [ P ] [ ]
COMPARE [ /N	] [N] [N]	[ N ]
RECOMMENDATIONS:	(If different from	NASA)
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* CIL RETENTION	RATIONALE: (If application	able) ADEQUATE [ ] INADEQUATE [ ]
	CREW OR VEHICLE. BUT	ATION. LOSS OF PAYLOAD DATA COULD CAUSE LOSS OF MISSION

ASSESSMI ASSESSMI NASA FMI	ENT	ID		INS	6/88 TR-185 4-2211		L			NASA   BASE		[ ]	x ]	
SUBSYSTIMDAC ID: ITEM: SOURCE				185	TRUMEN			PAY:	LOAD	RECOR	DER	CON'	rro:	C.
LEAD AN	ALY	ST:		A.W	. ADDI	s								
ASSESSMI	:													
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NASA IOA	[	3	/3 /3	]	[	]	[	]	]	]		[	]	*
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RECOMME	NDA'	TIO	NS:	(	If dif	fere	ent fr	om 1	NASA)					-
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ASSESSMENT DATE: ASSESSMENT ID: NASA FMEA #:	1/26/88 INSTR-186X 05-4-221104-1	NASA DATA: BASELINE [ X ] NEW [ ]					
SUBSYSTEM: MDAC ID: ITEM:	INSTRUMENTATIO 186 EVENT INDICATO		RECORDER I	MODE TALKBACK			
LEAD ANALYST:	A.W. ADDIS						
ASSESSMENT:							
CRITICAL FLIGH HDW/FU	T	ANCY SCREEN B	rs C	CIL ITEM			
NASA [ 3 /3 IOA [ 3 /3	] [ ]	[ ] [	]	[ ] *			
COMPARE [ /	] [ ]	[ ] [	]	[ ]			
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* CIL RETENTION :	RATIONALE: (If		ADEQUATE NADEQUATE	[ ]			

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SUBSYSTE MDAC ID:	TRUMEN E-BAND			CONDI	TIONI	er (w	IBSC)		-				
LEAD ANA	LYST	!:	A. V	. ADD	IS								
ASSESSME	ENT:												
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NASA IOA	[ 3 [ 3	/3	]	[	]	[	]	[	]		[	] * ]	
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* CIL RE	ONALE:	(If	appl	licab	1	ADEQU ADEQU			]				

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SUBSYSTE MDAC ID:	M:	EPDC/IN 202 POWER A				WBSC EQU	IPMEN	T (1)		
LEAD ANA	LYST:	T. EMMC	ns							
ASSESSME	NT:									
	CRITICAI FLIGH HDW/FU	IT	REDUNI A	DANCY :	SCREENS	s c	CIL			
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NASA IOA	[ 3 /3	] [		[	] [	]	[	] *		
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* CIL RE	TENTION	RATIONAI	LE: (If	appli		ADEQUATE IADEQUATE	[ r	]		
REMARKS:							L	J		

NO DIFFERENCES.

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SUBSYSTEMDAC ID:		INSTRU 211 WIDE B				SWIT	CH						
LEAD ANA	ALYST:	A. W.	ADD1	S									
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	HDW/FU						С						
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* CIL RI	ETENTION	RATIONA	LE:	(If	appl	icable	A	DEQUATE DEQUATE		]			
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NO DIFFERENCES IN CRITICALITY ASSIGNMENT.

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ASSESSMENT DATE: ASSESSMENT ID: NASA FMEA #:		2-1			DATA ELINE NEW	[ X	]	
SUBSYSTEM: MDAC ID: ITEM:	INSTRUMENTA 213 MADS STRAIN		ONTROL	. SWITC	сн	<u></u>		
LEAD ANALYST:	A. W. ADDIS	;						
ASSESSMENT:								
CRITICAL: FLIGH	ITY REI	UNDANCY	SCREE	:NS		CIL ITEM		
HDW/FUI		В		С			_	
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LEAD ANA	LYS	ST	:	T. El	MONS	;							
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LEAD AN	<b>:</b>	A. V	. ADI	•							
ASSESSMI											
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NO DIFFERENCES.											

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SUBSYSTEM: MDAC ID: ITEM:		INSTRU 221 FREQUE				MULTI	PLE	XER				
LEAD ANALY	ST:	A. W.	ADDI									
ASSESSMENT	<b>!:</b>											
CR	RITICALI FLIGHT		RE	EDUND	ANCY	SCREE	ens			CIL		
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NASA [ IOA [	3 /3 3 /3	]	[	]	[	]	[	]		[	] <b>*</b> ]	
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REMARKS: NO DIFFERE	ENCES.							~		•	•	

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LEAD ANA	ALYST:	A. W.	ADD:	IS		1 100				
ASSESSMI	ent:		-							
	CRITICAL		R	EDUND	ANCY SCRE	ENS	distribution and the		CIL	
	FLIGH HDW/FU		_ <b>A</b>		В		С		ITE	171
NASA IOA		]	[	]		[	]	•	]	] * ]
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REPORT DATE 02/18/88 C-71

ASSESSME ASSESSME NASA FME	NT	II		INS	TR-	37 -231 23040	00 <b>-</b> 1					NASA D BASEL			]
SUBSYSTE MDAC ID: ITEM:	M:			INS 231 PCM		JMENT JX	ITAT	ON			4 2 99				
LEAD ANA	LYS	T:	:	A.	W.	ADD:	[S			*					
ASSESSME	NT:														
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SUBSYSTE MDAC ID:			232	TRUMEN MODE				. з этвээг <b>Н</b>	श्वर मार्थ क्रम्या था		a. m
LEAD ANA	LYS	ST:	A. '	w. ADD	IS		f *;		-:	ু † মূল	ं इंड
ASSESSME	NT:	:									
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NO DIFFERENCES.

ASSESSME ASSESSME NASA FME	NT I	D:	INST	3/87 TR-233 3-2304	-		Ŋ		DATA LINE NEW	[ ]	K ]		
SUBSYSTE MDAC ID:	M:		233	RUMEN RECOR		ON ODE SW	ІТСН						
LEAD ANA	LYST	<b>:</b>	A. W	. ADD	is								
ASSESSME	NT:												
		'ICAL 'LIGH		R	EDUN	IDANCY	SCR	EENS			CII		
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NASA IOA	[ 3	/3 /3	]	[	]	[	]	[	]		[	] <b>*</b>	
COMPARE	[	/	]	[	]	[	]	[	]		[	]	
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REMARKS:	RENC	ES.							j		-	٠	

ASSESSME ASSESSME NASA FME	NT	ID:	1/28, INSTI 05-4	R-241		·		1	NASA D BASEL	INE		x ]	
SUBSYSTE MDAC ID:			INSTI 241 MADS				LE (M	CM)					
LEAD ANA	LYS	T:	A. W	. ADE	ois								
ASSESSME	NT:												
CRITICALITY REDUNDANCY SCREENS CIL ITEM													
	H	IDW/FU		A		I	3		C		11.	en.	
NASA IOA	[	3 /3 3 /3	]	[	]	[ [	]	[	]		[	]	*
COMPARE	[	/	]	[	]	[	]	[	]		[	]	
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ASSESSME ASSESSME NASA FME	TN	ID:		/INST				. <i>I</i> V	BASE		[ }	<b>(</b> ]
SUBSYSTE MDAC ID: ITEM:			242	•		NTATIO		т, мс	M (1)	)		
LEAD ANA	LYS	T:	т. Е	MMONS	}							
ASSESSME	NT:											
		TICAL FLIGH		F	EDUN	IDANCY	SCR	EENS			CII	
		DW/FU		A		В			?			;F1
NASA IOA	]	3 /3 3 /3	]	[	]	[	]	[ [	]		[	] * ]
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* CIL RE			RATIO	NALE:	(If	appl	icab	A	DEQUA			]

NASA FMEA #: 05-6R-230601-1 NEW [ ]	
SUBSYSTEM: EPDC/INSTRUMENTATION MDAC ID: 243 ITEM: CIRCUIT, ET POWER DISTRIBUTION	
LEAD ANALYST: T. EMMONS	
ASSESSMENT:	
CRITICALITY REDUNDANCY SCREENS CIL FLIGHT ITEM	
HDW/FUNC A B C	
NASA [ 3 /3 ] [ ] [ ] [ ] [ ] [ ] IOA [ 3 /3 ] [ ] [ ] [ ] [ ]	*
COMPARE [ / ] [ ] [ ] [ ]	
RECOMMENDATIONS: (If different from NASA)	
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* CIL RETENTION RATIONALE: (If applicable)  ADEQUATE [ ] INADEQUATE [ ] REMARKS:	

NO DIFFERENCES.

ASSESSME ASSESSME NASA FME	ID	:		rr-	251	0-1			1	NASA DA BASEL 1		[ ]	x ]		
SUBSYSTE MDAC ID: ITEM:	M:			INS' 251 MAD				ИС							
LEAD ANA	LYS	T:		A. 1	W.	ADDI	S			1					
ASSESSME	NT:														
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	H			JNC		A		В		(	2			<b>DI</b> 1	
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REMARKS: NO DIFFE	REN	ICE	s.												

ASSESSME ASSESSME NASA FME	NT ID		1/28/ INSTR 05-4-	-252	00-1				ASA DA' BASELII N	_	; ]
SUBSYSTE MDAC ID:	M:		INSTR 252 MADS			ON					
LEAD ANA	LYST:		A. W.	ADD:	IS						
ASSESSME	NT:										
	CII										
-	HDW	IGH /FUI		A		В	i	C	!	***	414
NASA IOA	[ 3	/3 /3	]	]	]	]	]	[	]	[	] * ]
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* CIL RE			RATION	ALE:	(If	appl	icab	A	DEQUAT		]

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SUBSYSTE MDAC ID: ITEM:				253		ENTAT								
LEAD ANA	LYS	ST	:	A. 1	W. A	DDIS								
ASSESSME	NT:	:												
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ASSESSME ASSESSME NASA FME	NT II		INST	/87 R-254 -2308				1	NASA DAT BASELIN NE	E [ 3	K ]
SUBSYSTE MDAC ID:	M:		254	RUMEN RECC		ON FORM	MAT C	ONTRO	DL		
LEAD ANA	LYST	:	A. W	. ADE	ois						,
ASSESSME	NT:										
	CRIT	ICAL LIGH		F	EDUN	DANC	SCR	EENS		CII	
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NASA IOA	. , ,			[	]	[	]	[	]	[	] *
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REMARKS:											

NO DIFFERENCES.

ASSESSME ASSESSME NASA FME	NT I	ID:	INS	3/87 [R-255 1-2308	02-1	L		N		DATA LINE NEW	[	<b>x</b> ]	
SUBSYSTE MDAC ID:	M:		255	TRUMEN			AT C	ONTRO	)L				
LEAD ANA	LYST	r:	A. V	N. ADD	IS								
ASSESSMENT:													
CRITICALITY REDUNDANCY SCREENS CIL FLIGHT ITEM													
		DW/FU		A		В		C	:		11	EFI	
NASA IOA	[ 3	3 /3 3 /3	]	]	]	[	]	[	]		[	]	*
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NO DIFFE	REN	CES.											

ASSESSME ASSESSME NASA FME	NT ID:	1/28/8 EPDC/I 05-6R-	NSTR-	-256 01-1			ASA DATA BASELINI NEV	E [ 2	K ]
SUBSYSTE MDAC ID:	M:	256		UMENTAT		ET, M	MADS RCI	OR (:	1)
LEAD ANA	LYST:	T. EMM	ONS						
ASSESSME	NT:								
	CRITICAL FLIGH HDW/FU	T	RE A	DUNDANC! I	SCREI	ENS C		CII ITI	
NASA IOA	[ 3 /3 [ 3 /3	]	[	] [	]	[	]	[	] *
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* CIL RE	TENTION	RATIONA	LE:	(If app	licable	AI	DEQUATE DEQUATE	[	]

NO DIFFERENCES.

ASSESSME ASSESSME NASA FME	NT	ID	:	INST	'R−26	51 0500-1			1		DATA LINE NEW	[ 2	к ] ]	
SUBSYSTE MDAC ID: ITEM:	M:			261		ENTATI CE JUN		IS						
LEAD ANA	LYS	T:		A. W	. AI	DDIS								
ASSESSME	NT:													
CRITICALITY REDUNDANCY SCREENS FLIGHT														
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NASA IOA	[	3	/3 /3	]	[	]	[	]	[	]		]	]	*
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	[		/	]	[	]	[	]	[	]	(A	[ DD/I	] DELE	TE)
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NO DIFFE	REN	ICE	s.											

ASSESSME ASSESSME NASA FME	NT I		INST	/87 R-262 -2305					NASA DA' BASELII N		· ]	
SUBSYSTE MDAC ID: ITEM:	M:		262	RUMEN RENCE		ON ICTION	is					
LEAD ANA	LYST	•	A. W	. ADI	ois							
ASSESSME	NT:											
	CRIT	ICAL LIGH		F	REDUN	IDANCY	SCR	EENS		CII		
		W/FU		P	1	E	}	C	2	111	31.1	
NASA IOA	[ 3	/3 /3	]	[ [	]	[	]	[	] .	[	] *	
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REMARKS:								TNF	ADEQUAT	c [	1	

NO DIFFERENCES.

ASSESSME ASSESSME NASA FME	ENT	I	D:	IN	STR-	263	00-1	L		1	NASA BASI	DATA ELINE NEW	[ ]	х <u>ј</u>	
SUBSYSTE MDAC ID:				26	3 ·			ON TRANSD	UCER	2					
LEAD ANA	LYS	ST	<b>:</b> .	A.	W.	ADD:	IS								
ASSESSME	ENT	:													
	CR		ICAL			R	EDUN	IDANCY	SCR	REENS			CI:		
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NASA IOA	[	3	/3 /3	]		[	]	[	]	[	]		[	]	*
COMPARE	[		/	]		[	]	[	]	[	]		[	]	
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SUBSYST: MDAC ID ITEM:			INSTE 264 ACCEI									
LEAD AN	ALYST	r:	A. W.	ADD	IS							
ASSESSM	ENT:											
		rical FLIGH		R	EDUN	IDANCY	SCR	EENS			CII	
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* CIL RETENTION REMARKS: NO DIFFERENCES	. :	NALE: (If	appl	icab.	A	ADEQUAT		]					

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			LITY	R	EDU	NDANCY	SCR	EENS			CII	
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REMARKS: NO DIFFE	REN	ÇES.							-2120	====	L	1

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SUBSYSTE MDAC ID:			270	RUMEN ERATU			RS		e e e g			<u> </u>
LEAD ANA	LYST	:	A. W	. ADD	ois							
ASSESSME	NT:											
	CRIT			Ŕ	EDUN	IDANC	Y SCR	EENS	*	_	CII ITE	
	-	LIGH W/FU		A		1	В	(	С		111	ru.
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ASSESSME	TN	:											
CRITICALITY REDUNDANCY SCREENS FLIGHT													L EM
	1			JNC	A		F	3	(	2		111	SM .
NASA IOA	[	3	/3 /3	]	]	]	[	]	_			[	] *
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* CIL RE				RATIO	ONALE:	(II	appl	licab		ADEQU ADEQU	ATE ATE	[	]

ASSESSMENT DATE ASSESSMENT ID: NASA FMEA #:	: 1/28/87 EPDC/INST 05-6R-213			NASA DA BASELI N		<b>K</b> ]
SUBSYSTEM: MDAC ID: ITEM:	EPDC/INST 272 FUSE, FPC			1)		
LEAD ANALYST:	T. EMMONS					
ASSESSMENT:						
CRITICA FLIG		EDUNDANC	SCREE	NS	CII	
HDW/F		. 1	3	. <b>C</b> _	116	214
NASA [ 3 /3 IOA [ 3 /3	] [	] [	]	[ ]	[	] *
COMPARE [ /	, <b>1</b>	] [	]	[ ]	[	]
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ASSESSME	NT:												
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			INC	A		. <b>B</b>	-	(	C				
NASA	[ :	3 /3	]	[	]	[ r	]	[	]		[	]	*
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COMPARE	[	/	]	[	]	[	]	[	]		[	]	
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ASSESSME	NT:											
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ASSESSME	NT:											
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		DW/FU		1	4	I	3	•	C ·			
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COMPARE	[	/	]	[	]	[	]	[	]		[	]
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SUBSYSTEM: MDAC ID: ITEM:	301	RUMENTAT:		ing s	YSTEM	ī		
LEAD ANALYST:	A.W.	ADDIS						
ASSESSMENT:								
	ALITY GHT	REDU	NDANCY	SCR	EENS		CII	
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NO DIFFERENCES	•							

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REMARKS: IOA 107 BEING RI	WA										Y I	ΟA		2 10			IS

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* CIL RE	TE	NT:	ION I	RAT	CION	ΑL	E:	(	If	ap	pl:	icab]			DEQI DEQI				]	
REMARKS: IOA 108 BEING RE OF ARPCS MEANS OF MISSION	STO	OR P/: ET:	ED A DT A ECTI	S I ND ON	CAB: OF	IN IN	STI Pi	R- AR	-303 RTIA	X. L	PR:	DSC ( ESSU)	Y I OF3 RE,	OA H	EPI ANDI XYGI	D&C LES	10 M1	08 A EASU LOSS	REI	MENTS

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	F	_	LIGHT V/FUN	1C		A			В			С		. #	I EM		
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REMARKS: IOA 109 V BEING RES OF ARPCS MEASUREMI	STO DI ENT	RI P/I IS	ED AS OT AI AND	IOA ND CA LOSS	INS BIN OF	TTE PA UU	R-30 ARTI NLIK	4X. AL E F	PR REDI	DSÇ ESSU UNDA	OF3 URE,	OA HA OZ F(	EPD&C ANDLES KYGEN. OR MONI	109 MEAS ERI	ANI SURE RONE	) O :	ENT
CABIN PRI	ESS	U	RE CO	DULD (	CAUS	SE	MIS	SIC	) NC	<b>TERM</b>	IINA'	rI(	ON.				

ASSESSMENT DATE: ASSESSMENT ID: NASA FMEA #:	1/29/88 INSTR-30 05-5-B03	)5X 3-7-1	NASA DATA: BASELINE NEW					
SUBSYSTEM:	INSTRUME							
LEAD ANALYST:	A.W. ADD	ois						
ASSESSMENT:								
CRITICAL FLIGH		REDUNDANC	Y SCREENS	5	CIL ITEM			
<del></del>	NC	A	В	С	112.			
NASA [ 2 /2 IOA [ 3 /1R	] [	P ] [ P ] [	F ] [ F ] [	P ] P ]	[ X ] *			
COMPARE [ N /N	] [	] [	] [	. ]	[ ]			
RECOMMENDATIONS:	(If di	ifferent f	rom NASA)					
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	* CIL RETENTION RATIONALE: (If applicable)  ADEQUATE [ X ]  INADEQUATE [ ]							
REMARKS: IOA 111 WAS INADVERTENTLY OVERWRITTEN BY IOA EPD&C 111 AND IS BEING RESTORED AS IOA INSTR-305X. THESE MDM'S PROCESS/ROUTE CRITICAL APU STATUS DATA. ERRONEOUS OUTPUT FALSELY INDICATING A HEATER STUCK ON COULD PROMPT MANUAL SHUTDOWN OF AN APU, REQURING ABORT. FAILS SCREEN B BECAUSE FAILED MDM CHANNEL COULD NOT BE DETECTED. NOTE: NASA FMEA WRITEUP IS INCONSISTENT WITH								

2/2 CRIT AND ASSIGNS SCREENS FOR THAT 2/2 CRIT.

ASSESSMENT DATE: ASSESSMENT ID: NASA FMEA #:	INSTR-30				NASA DATA BASELINE NEW					
SUBSYSTEM: MDAC ID: ITEM:	INSTRUMEN 306 MDM OF3	NTATION	ſ							
LEAD ANALYST:	A.W. ADD	[S								
ASSESSMENT:	ASSESSMENT:									
CRITICALITY REDUNDANCY SCREENS CIL FLIGHT ITEM										
HDW/FU		A	В		C	1154				
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* CIL RETENTION	RATIONALE	(If a	ppli		·					
en en samen en				IN	ADEQUATE ADEQUATE	[ ]				
INADEQUATE [ ] REMARKS: IOA 116 WAS INADVERTENTLY OVERWRITTEN BY IOA EPD&C 116 AND IS BEING RESTORED AS IOA INSTR-306X. FOR PRESENT FUEL CELLS, MDM- DF3 HANDLES CRITICAL FUEL CELL MEASUREMENTS FOR WHICH THERE IS NO REDUNDANT PATH (SE IOA 306X). LOSS OF THESE MEASUREMENTS WOULD REQUIRE MISSION TERMINATION.										

ASSESSMENT DATE: ASSESSMENT ID: NASA FMEA #:	1/29/88 INSTR-307 NONE	'X	NASA DAT BASELIN NE		
MDAC ID:	INSTRUMEN 307 MDM OF3	TATION			
LEAD ANALYST:	A.W. ADDI	rs .	-		
ASSESSMENT:					
CRITICAL FLIGH	ITY R	REDUNDANCY	SCRE	ENS	CIL ITEM
	NC A	A E	3	С	LIEM
NASA [ / IOA [ 2 /2	] [	] [	]	[ ]	[ x ] *
COMPARE [ N /N	] [	] [	]	[ ]	[ N ]
RECOMMENDATIONS:	(If dif	fferent fr	om NA	SA)	
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* CIL RETENTION	RATIONALE:	: (If appl	icable	e)	
At a	o moderna area			ADEQUATE INADEQUATE	
REMARKS: 10A 117 WAS INAU BEING RESTORED A 0F3 HANDLES CRIT REDUNDANT PATH ( COULD CAUSE IMPR UNNECESSARY MISS	S IOA INST TICAL FUEL SE IOA 307 ROPER MANUA	TR-307X. CELL MEAS 7X). ERRO AL SHUTDOV	FOR PROPERTY OF THE PROPERTY O	IOA EPD&C RESENT FUEI NTS FOR WHI MEASUREMEN	117 AND IS CELLS, MDM CCH THERE IS NO

	1/29/88 INSTR-308 NONE	x		NASA DATA BASELINI NEV	
	INSTRUMEN 308 MDM OF1,		·		
LEAD ANALYST:	A.W. ADDI	S			
ASSESSMENT:					
CRITICALI FLIGHT		EDUNDA	NCY SCREE	ns	CIL ITEM
HDW/FU			В	С	TIBM .
NASA [ / IOA [ 2 /2	] [	]	[ ]	[ ]	[ x ] *
COMPARE [ N /N	] [	]	[ ]	[ ]	[ N ]
RECOMMENDATIONS:	(If dif	ferent	from NAS	<b>SA)</b>	
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* CIL RETENTION F	RATIONALE:	(If a	pplicable	ADEQUATE INADEQUATE	
IOA 118 WAS INADY BEING RESTORED AS				IOA EPD&C 1	

MDM's OF1 AND OF2 HANDLE CRITICAL FUEL CELL DELTA VOLTAGE MEASUREMENTS (SEE IOA 308). LOSS OF THESE MEASUREMENTS WOULD CAUSE MISSION TERMINATION.

## APPENDIX C ASSESSMENT WORKSHEET

ASSESSMENT DATASSESSMENT IDENASA FMEA #:	INSTR-				ASA DATA: BASELINE NEW	[	]
SUBSYSTEM: MDAC ID: ITEM:	INSTRU 309 MDM OF	MENTATI	ON		·		
LEAD ANALYST:	A.W. A	ADDIS		•			*
ASSESSMENT:							
	CALITY GHT	REDUN	DANCY S	CREENS		CIL	
HDW,	FUNC	A	В	С			
NASA [ /	' ] '2 ]	[ ]	[ ]	[	]	[ x	] * ]
COMPARE [ N ,	( אי	[ ]	[ ]	Ţ	]	[ N	]
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[ 2 ,	'2 ]	[ ]	[ ]	[ ]	`] (AI	[ A [D/D]	] ELETE)
* CIL RETENTION	N RATIONA	LE: (If	applic			_	_
	-			A INA	DEQUATE DEQUATE	[	]
REMARKS: IOA 119 WAS II	IADVERTENT	TLY OVER	WRITTEN				D IS
BEING RESTORES OF1 AND OF2 H	AS INSTR	R-309X.	FOR PR	ESENT F	UEL CELLS	SYS	STEM MDMs
(SEE IOA 309)	ERRONEC	OUS MDM	OUTPUT	COULD C	AUSE A FA	ALSE	
INDICATION OF FUEL CELL SHU						A M	ANUAL

## APPENDIX C ASSESSMENT WORKSHEET

ASSESSMENT DATE: ASSESSMENT ID: NASA FMEA #:	1/29/88 INSTR-3: 05-5-B0:	10X 3-7-2		NASA DATA BASELĪNI NĒV	
SUBSYSTEM:	INSTRUM 310 MDM OA1	ENTATIO	N	•	
LEAD ANALYST:	A.W. AD	DIS			
ASSESSMENT:					
		REDUNDA	ANCY SCRE	ENS	CIL ITEM
FLIGHT HDW/FU		A	В	С	IIEM
NASA [ 2 /2 IOA [ 2 /2	] [	P ]	[ F ] [ ]	[ P ] [ ]	[ X ] * [ X ]
COMPARE [ /	] [	и ј	[и]	[и]	[ ]
RECOMMENDATIONS:	(If d	ifferent	t from NA	SA)	·
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* CIL RETENTION I	RATIONALI	E: (If a	applicabl		
				ADEQUATE INADEQUATE	[ ]
REMARKS: IOA 120 WAS INAD BEING RESTORED AS TEMPERATURES ARE	INSTR-:	310X. (	CRITICAL . SE MDM's.	IOA EPD&C 1 APU FUEL LIN THEIR LOSS	120 AND IS NE SYSTEM S WOULD CAUSE
MISSION TERMINATE WITH ASSIGNED CRI	-				

APPENDIX D

CRITICAL ITEMS

# APPENDIX D POTENTIAL CRITICAL ITEMS

NASA FMEA	MDAC-ID	FLIGHT	ITEM	FAILURE MODE
				=
	104	3/1R	DSC OA1, OA2,	
			OA3, OM1	ERRONEOUS OUTPUT -
05-5-B03-7-1	113	3/1R	MDM OF4, OA1,	
			OA2, OA3	LOSS OF OUTPUT
05-5-B03-7-1	115	2/1R	MDM OA1, OA2, OA3	LOSS OF OUTPUT
05-6R-221501-1	117	3/3	PWR & CNTRL CIRCUIT	OPEN, SHORTED
05-6R-221504-1	118	3/1R	SWITCH, TOGGLE 3P2T	FAILS TO CLOSE
05-4-220400-1	121	3/2R	PULSE CODE MODULATION	LOSS OF OUTPUT
05-4-220400-2	122	3/2R	PULSE CODE MODULATION	ERRATIC OPERATION
05-4-220400-2	123	3/2R	PULSE CODE MODULATION	INTERMITTENT -
				OPERATION
05-4-220402-1	124	2/2	PCMMU FORMAT CNTRL SW	PHYSICAL BINDING
		·		JAMMING
05-6R-220402-1	128	2/2	SWITCH TOGGLE, 3P3T (1)	FAILS TO CLOSE
05-4-321200-1	131	2/2	MASTER TIMING UNIT	LOSS OF OUTPUT
05-4-321200-2	132	2/2	MASTER TIMING UNIT	ERRONEOUS OUTPUT _
05-4-321200-2	133	2/2	MASTER TIMING UNIT	ERRATIC OPERATION
05-4-221300-1	161	3/2R	PL DATA INTERLEAVER	LOSS OF OUTPUT
05-4-221300-1	162	3/2R	PL DATA INTERLEAVER	ERRATIC OPERATION_
05-4-221300-2	163	3/2R	PL DATA INTERLEAVER	ERRONEOUS OUTPUT
· 05-5-B03-7-1	305	3/1R	MDM OF4, OA1, OA2, OA3	ERRONEOUS OUTPUT
NONE	306	2/2	MDM OF3	LOSS OF OUTPUT
NONE	307 .	2/2	MDM OF3	ERRONEOUS OUTPUT
NONE	308	2/2	MDM OF1, OF2	LOSS OF OUTPUT
NONE	309	2/2	MDM OF1, OF2	ERRONEOUS OUTPUT
05-5-B03-7-2	310	2/2	MDM OA1, OA2, OA3	LOSS OF OUTPUT

#### APPENDIX E DETAILED ANALYSIS

This appendix contains the IOA analysis worksheets supplementing previous results reported in STSEOS Working Paper 1.0-WP-VA86001-017, Analysis of the Instrumentation Subsystem (12 December 1986). Prior results were obtained independently and documented before starting the FMEA/CIL assessment activity. Supplemental analysis was performed to address failure modes not previously considered by the IOA. Each sheet identifies the hardware item being analyzed, parent assembly and function performed. For each failure mode possible causes are identified, and hardware and functional criticality for each mission phase are determined as described in NSTS 22206, Instructions for Preparation of FMEA and CIL, 10 October 1986. Failure mode effects are described at the bottom of each sheet and worst case criticality is identified 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

HIGHEST CRITICALITY HDW/FUNC 1/26/88 DATE: 3/3 SUBSYSTEM: EPD&C/INSTRUMENTATION FLIGHT: 3/3 ABORT: MDAC ID: 144 CIRCUIT BREAKER, 5-AMP, PAYLOAD TIMING BUFFER ITEM: FAILURE MODE: OPEN (ELECTRICAL) LEAD ANALYST: A.W. ADDIS SUBSYS LEAD: K. SCHMECKPEPER BREAKDOWN HIERARCHY: 1) INSTRUMENTATION 2) OPERATIONAL INSTRUMENTATION 3) PAYLOAD TIMING BUFFER 4) CIRCUIT BREAKER 5) 6) 7) 8) 9)

CR	TT	T	CA	T.T	т	IES
~.,		-			_	

FLIGHT PHASE F	IDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/3
LIFTOFF:	3/3	TAL:	3/3
ONORBIT:	3/3	AOA:	3/3
DEORBIT:	3/3	ATO:	3/3
LANDING/SAFING:	3/3		

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

LOCATION: STANDARD SWITCH PANEL

PART NUMBER: MC454-0026-2050

CAUSES: CONTAMINATION, MECHANICAL SHOCK, MISHANDLING/ABUSE, PIECE-PART FAILURE, TEMPERATURE, VIBRATION

PIECE-PART TAILORD, IDMIDIATIOND, VIDA

EFFECTS/RATIONALE:

CIRCUIT BREAKER PROVIDES POWER AND CIRCUIT PROTECTION FOR THE PAYLOAD TIMING BUFFER. LOSS OF BUFFER FUNCTION BECAUSE OF CIRCUIT BREAKER FAILURE WOULD NOT BE CRITICAL TO MISSION OR TO CREW/VEHICLE.

DATE: 1/26/88 SUBSYSTEM: EPD&C/INSTRUMENTATION MDAC ID: 154	FL	ICALITY HDW/FUNC IGHT: 3/3 ORT: 3/3
ITEM: CIRCUIT BREAKER, 5-A FAILURE MODE: OPEN (ELECTRICAL)	MP, PAYLOAD T	IMING BUFFER
LEAD ANALYST: A.W. ADDIS SUBS	YS LEAD: K. S	CHMECKPEPER
BREAKDOWN HIERARCHY:  1) INSTRUMENTATION  2) OPERATIONAL INSTRUMENTATION  3) ORBITAL TIMING BUFFER  4) CIRCUIT BREAKER  5)  6)		
7) 8) 9)		
CRITICAL	TOTOC	Secretary Secretary
FLIGHT PHASE HDW/FUNC PRELAUNCH: 3/3 LIFTOFF: 3/3 ONORBIT: 3/3 DEORBIT: 3/3 LANDING/SAFING: 3/3		HDW/FUNC 3/3 3/3 3/3 3/3 3/3
	в [ ]	c [ ]
LOCATION: PANEL 016 PART NUMBER: MC454-0026-2030	\$14 - 14 - 15 - 15 - 15 - 15 - 15 - 15 -	
CAUSES: CONTAMINATION, MECHANICAL PIECE-PART FAILURE, TEMPERATURE, VI EFFECTS/RATIONALE: CIRCUIT BREAKER PROVIDES POWER AND ORBITAL TIMING BUFFER. LOSS OF BUF	BRATION  CIRCUIT PROTE	CTION FOR THE
CIRCUIT BREAKER FAILURE WOULD NOT B CREW/VEHICLE.  REFERENCES: VS70-750139		

HIGHEST CRITICALITY HDW/FUNC 1/26/88 DATE: INSTRUMENTATION FLIGHT: 3/3 SUBSYSTEM: ABORT: 3/3 MDAC ID: 175 EVENT INDICATOR - OPS RECORDER CONTROL MODE ITEM: FAILURE MODE: ERRATIC OPERATION, PHYSICAL BINDING/JAMMING, ERRONEOUS OUTPUT, OPEN (ELECTRICAL), FAILS TO SWITCH, SHORTED LEAD ANALYST: A.W. ADDIS SUBSYS LEAD: K. SCHMECKPEPER BREAKDOWN HIERARCHY: 1) INSTRUMENTATION 2) OI OPS RECORDER 3) CONTROL MODE TALKBACK 4) 5) 6) 7) 8) 9) CRITICALITIES HDW/FUNC ABORT HDW/FUNC FLIGHT PHASE PRELAUNCH: 3/3 3/3 RTLS: TAL: 3/3 LIFTOFF: 3/3 3/3 AOA: 3/3 ONORBIT: 3/3 ATO: 3/3 DEORBIT: LANDING/SAFING: 3/3 REDUNDANCY SCREENS: A [ ] B [ ] C [ ] LOCATION: PANEL A1 PART NUMBER: MC452-0222-0XXX CAUSES: CONTAMINATION, MISHANDLING/ABUSE, PIECE-PART FAILURE, VIBRATION EFFECTS/RATIONALE: TALKBACK INDICATES WHETHER OPS RECORDER IS IN COMMAND OR PANEL CONTROL MODE. LOSS OF INDICATION WOULD NOT BE CRITICAL TO MISSION OR TO CREW/VEHICLE.

REFERENCES: SYSTEM SCHEMATIC VS70-750119

HIGHEST CRITICALITY HDW/FUNC DATE: 1/26/88 INSTRUMENTATION 3/3 SUBSYSTEM: FLIGHT: ABORT: 3/3 MDAC ID: 176

EVENT INDICATOR, OPS RECORDER OPERATIONAL MODE ITEM: FAILURE MODE: ERRATIC OPERATION, PHYSICAL BINDING/JAMMING, ERRONEOUS OUTPUT, OPEN (ELECTRICAL), FAILS TO SWITCH, SHORTED

LEAD ANALYST: A.W. ADDIS SUBSYS LEAD: K. SCHMECKPEPER

#### BREAKDOWN HIERARCHY:

- INSTRUMENTATION
- 2)
- OPS RECORDER 3)
- 4) OPERATIONAL MODE TALKBACK

5)

6)

7)

8) 9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/3
LIFTOFF:	3/3	TAL:	3/3
ONORBIT:	3/3	AOA:	3/3
DEORBIT:	3/3	ATO:	3/3
LANDING/SAFIN	īG: 3/3		·

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

LOCATION: PANEL A1

PART NUMBER: MC452-0222-0XXX

CAUSES: CONTAMINATION, MISHANDLING/ABUSE, PIECE-PART FAILURE,

VIBRATION

#### EFFECTS/RATIONALE:

TALKBACK INDICATES WHETHER OPS RECORDER IS IN RECORD MODE; STANDBY, STOP, OR UNPOWERED; OR IN PLAYBACK OR REWIND. LOSS OF INDICATION WOULD NOT BE CRITICAL TO MISSION OR TO CREW/VEHICLE.

DATE: 1/26/88 HIGHEST CRITICALITY HDW/FUNC SUBSYSTEM: INSTRUMENTATION FLIGHT: 3/3 MDAC ID: 177 ABORT: 3/3

ITEM: EVENT INDICATOR - ANOMALY SEQUENCE TALKBACK FAILURE MODE: ERRATIC OPERATION, PHYSICAL BINDING/JAMMING, ERRONEOUS OUTPUT, OPEN (ELECTRICAL), FAILS TO SWITCH, SHORTED

LEAD ANALYST: A.W. ADDIS SUBSYS LEAD: K. SCHMECKPEPER

#### BREAKDOWN HIERARCHY:

- 1) INSTRUMENTATION
- 2) OI
- 3) OPS RECORDER
- 4) ANOMALY SEQUENCE TALKBACK

5)

6)

7)

8) 9)

#### CRITICALITIES

FLIGHT PHASE H	IDW/FUNC	ABORT	HDW/FUNC	
PRELAUNCH:	3/3	RTLS:	3/3	
LIFTOFF:	3/3	TAL:	3/3	
ONORBIT:	3/3	AOA:	3/3	
DEORBIT:	3/3	ATO:	3/3	
LANDING/SAFING:	3/3		•	

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

LOCATION:

PANEL A1

PART NUMBER: MC452-0222-0XXX

CAUSES: CONTAMINATION, MISHANDLING/ABUSE, PIECE-PART FAILURE,

**VIBRATION** 

#### EFFECTS/RATIONALE:

TALKBACK IS INTENDED TO INDICATE WHETHER OPS RECORDER IS IN ANOMALY SEQUENCE OR NOT. LOSS OF FUNCTION WOULD NOT BE CRITICAL TO MISSION OR TO CREW/VEHICLE.

HIGHEST CRITICALITY HDW/FUNC 1/26/88 DATE: 3/3 SUBSYSTEM: INSTRUMENTATION FLIGHT: 3/3 ABORT: MDAC ID: 185

EVENT INDICATOR - PAYLOAD RECORDER CONTROL SOURCE ITEM: FAILURE MODE: ERRATIC OPERATION, PHYSICAL BINDING/JAMMING, ERRONEOUS OUTPUT, OPEN (ELECTRICAL), FAILS TO SWITCH, SHORTED

SUBSYS LEAD: K. SCHMECKPEPER LEAD ANALYST: A.W. ADDIS

#### BREAKDOWN HIERARCHY:

- INSTRUMENTATION
- OI 2)
- 3) PAYLOAD RECORDER
- RECORDER CONTROL SOURCE TALKBACK 4)
- 5)
- 6)
- 7)
- 8)
- 9)

#### CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/3
LIFTOFF:	3/3	TAL:	3/3
ONORBIT:	3/3	AOA:	3/3
DEORBIT:	3/3	ATO:	3/3
LANDING/SAFING	: 3/3		,

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

LOCATION: PANEL A1

PART NUMBER: MC452-0222-0XXX

CAUSES: CONTAMINATION, MISHANDLING/ABUSE, PIECE-PART FAILURE,

VIBRATION

#### EFFECTS/RATIONALE:

TALKBACK INDICATES WHETHER PAYLOAD RECORDER IS UNDER PANEL OR MDM CONTROL. LOSS OF FUNCTION WOULD NOT BE CRITICAL TO MISSION OR TO CREW/VEHICLE.

HIGHEST CRITICALITY HDW/FUNC 1/26/88 DATE: FLIGHT: SUBSYSTEM: INSTRUMENTATION 3/3 ABORT: 3/3 MDAC ID: 186 EVENT INDICATOR - PAYLOAD RECORDER MODE TALKBACK ITEM: FAILURE MODE: ERRATIC OPERATION, PHYSICAL BINDING/JAMMING, ERRONEOUS OUTPUT, OPEN (ELECTRICAL), FAILS TO SWITCH, SHORTED SUBSYS LEAD: K. SCHMECKPEPER LEAD ANALYST: A.W. ADDIS BREAKDOWN HIERARCHY: 1) INSTRUMENTATION 2) OI 3) PAYLOAD RECORDER 4) RECORDER OPERATIONAL MODE TALKBACK 6) 7) 8) 9) CRITICALITIES HDW/FUNC ABORT FLIGHT PHASE HDW/FUNC RTLS: TAL: 3/3 PRELAUNCH: 3/3 3/3 3/3 LIFTOFF: 3/3 AOA: 3/3 ONORBIT: 3/3 ATO: 3/3 DEORBIT: LANDING/SAFING: 3/3 REDUNDANCY SCREENS: A [ ] B [ ] C [ ] LOCATION: PANEL A1 PART NUMBER: MC452-0222-0XXX CAUSES: CONTAMINATION, MISHANDLING/ABUSE, PIECE-PART FAILURE, VIBRATION EFFECTS/RATIONALE:

TALKBACK INDICATES OPERATIONAL MODE OF THE PAYLOAD RECORDER - RECORD MODE; STANDBY, STOP, OR UNPOWERED; OR IN PLAYBACK OR REWIND. LOSS OF FUNCTION WOULD NOT BE CRITICAL TO MISSION OR TO

REFERENCES: VS70-750149

CREW/VEHICLE.

HIGHEST CRITICALITY HDW/FUNC 1/27/88 DATE: FLIGHT: 3/3 SUBSYSTEM: INSTRUMENTATION ABORT: 3/3 MDAC ID: 301 VIBRATION MONITORING SYSTEM ITEM: FAILURE MODE: LOSS OF OUTPUT LEAD ANALYST: A.W. ADDIS SUBSYS LEAD: K. SCHMECKPEPER BREAKDOWN HIERARCHY: INSTRUMENTATION 1) OPERATIONAL INSTRUMENTATION VIBRATION MONITORING SYSTEM 3) 4) 5) 6) 7) 8) 9) CRITICALITIES HDW/FUNC HDW/FUNC ABORT FLIGHT PHASE RTLS: 3/3 PRELAUNCH: 3/3 3/3 TAL: 3/3 LIFTOFF: AOA: 3/3 3/3 ONORBIT: ATO: 3/3 DEORBIT: 3/3 LANDING/SAFING: 3/3 REDUNDANCY SCREENS: A [ ] B [ ] C [ ] LOCATION: VARIOUS LOCATIONS PART NUMBER: MC476-0205-0001 CAUSES: CONTAMINATION, MISHANDLING/ABUSE, PIECE-PART FAILURE, TEMPERATURE, VIBRATION EFFECTS/RATIONALE: THE VIBRATION MONITORING SYSTEM IS USED TO CONDITION TRANSDUCER SIGNALS ROUTED TO MDM's FOR FURTHER PROCESSING. LOSS OF FUNCTION WOULD NOT BE CRITICAL TO MISSION OR TO CREW/VEHICLE.

HIGHEST CRITICALITY HDW/FUNC DATE: 1/27/88

SUBSYSTEM: INSTRUMENTATION FLIGHT: 3/2R 302 ABORT: 3/2R MDAC ID:

DSCs OA1, OA2, OA3, OM1 ITEM:

FAILURE MODE: LOSS OF OUTPUT

LEAD ANALYST: A.W. ADDIS SUBSYS LEAD: K. SCHMECKPEPER

#### BREAKDOWN HIERARCHY:

- INSTRUMENTATION 1)
- 2) OI
- 3) DSC
- 4)
- 5)
- 6)
- 7)
- 8) 9)

#### CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/2R-
LIFTOFF:	3/2R	TAL:	3/2R
ONORBIT:	3/3	AOA:	3/2R
DEORBIT:	3/3	ATO:	3/2R
LANDING/SAFING	3/3		er e

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

LOCATION: OA1 AV BAY 4, OA2 AV BAY 5, OA3 AV BAY 6, OM1 MID

FUSELAGE

PART NUMBER: MC476-0131

CAUSES: TEMPERATURE, VIBRATION, CONTAMINATION, MECHANICAL SHOCK, PIECE-PART FAILURE

a. A in a mass as as

## EFFECTS/RATIONALE:

THESE DSCs SUPPLY A VOLTAGE (5 VOLTS DC) TO FLIGHT CRITICAL MDMs FF1, FF3, FF4 VIA THE AUTO/MAN ET SEP SWITCH FOR ET SEPARATION; AND TO THE SAME MDMs VIA THE AUTO-MAN/AUTO SRB SEP SWITCH FOR SRB SEPARATION. LOSS OF ALL SOURCES FOR THAT VOLTAGE AND ALL SEPARATION COMMAND CAPABILITY (KEYBOARD AND GROUND) WOULD BE CATASTROPHIC.

REFERENCES: SCHEMATIC VS70-760502 (ET & SRB SEP SW CKT), SSSH OI DSC/MDM DWG 17.1, IPCL, FSSR STS 83-0010A (LEVEL C GNC RM), INCO/COMM OI BRIEF SB48, STS 83-0026A 4.2.2, 4.2.3

DATE: 2/02/87 HIGHEST CRITICALITY HDW/FUNC

SUBSYSTEM: INSTRUMENTATION FLIGHT: 3/2R MDAC ID: 303 ABORT: 3/3

ITEM: DSC OF3

FAILURE MODE: LOSS OF OUTPUT

LEAD ANALYST: A.W. ADDIS SUBSYS LEAD: K. SCHMECKPEPER

## BREAKDOWN HIERARCHY:

- 1) INSTRUMENTATION
- 2) OI
- 3) DSC
- 4)
- 5)
- 6)
- 7)
- 8) 9)

#### CRITICALITIES

HDW/FUNC	ABORT	HDW/FUNC
3/3	RTLS:	3/3
3/2R	TAL:	3/3
3/2R	AOA:	3/3
3/3	ATO:	3/3
3/3		
	3/3 3/2R 3/2R 3/3	3/3 RTLS: 3/2R TAL: 3/2R AOA: 3/3 ATO:

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

LOCATION: AV BAY 3
PART NUMBER: MC476-0131

CAUSES: TEMPERATURE, VIBRATION, CONTAMINATION, LOSS OF INPUT, MECHANICAL SHOCK, PIECE-PART FAILURE

#### EFFECTS/RATIONALE:

CRITICAL AIR REVITALIZATION PRESSURE CONTROL SYSTEM TELEMETRY DATA IS PROCESSED BY DSC OF3 (CABIN DP/DT AND PARTIAL PRESSURE, OXYGEN). THE DP/DT MEASUREMENT IS USED BY C&W FOR KLAXON INPUT. NO REDUNDANT DSC PATH IS PROVIDED. LOSS OF MEASUREMENTS COULD CAUSE LOSS OF MISSION BECAUSE POTENTIALLY CATASTROPHIC FAILURES COULD BE CONCEALED.

REFERENCES: SSSH PRESSURE CONTROL SYSTEM 6.1, IPCL, SSSH OI DSC/MDM DWG 17.1, INCO/COMM OI BRIEF SB48

DATE: 1/23/87 HIGHEST CRITICALITY HDW/FUNC

SUBSYSTEM: INSTRUMENTATION FLIGHT: 3/2R MDAC ID: 304 ABORT: 3/3

ITEM: DSC OF3

FAILURE MODE: ERRONEOUS OUTPUT

LEAD ANALYST: A.W. ADDIS SUBSYS LEAD: K. SCHMECKPEPER

### BREAKDOWN HIERARCHY:

- 1) INSTRUMENTATION
- 2) OI
- 3) DSC
- 4)
- 5)
- 6).
- 7)
- 8) 9)

#### CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/3
LIFTOFF:	3/2R	TAL:	3/3
ONORBIT:	3/2R	AOA:	3/3
DEORBIT:	3/3	ATO:	3/3
LANDING/SAFING:	3/3		•

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

LOCATION: AV BAY3
PART NUMBER: MC476-0131

CAUSES: CONTAMINATION, MECHANICAL SHOCK, PIECE-PART FAILURE, TEMPERATURE, VIBRATION

## EFFECTS/RATIONALE:

CRITICAL AIR REVITALIZATION PRESSURE CONTROL SYSTEM TELEMETRY DATA IS PROCESSED BY DSC OF3 (CABIN DP/DT AND PARTIAL PRESSURE, OXYGEN). THE DP/DT MEASUREMENT IS USED BY C&W FOR KLAXON INPUT. NO REDUNDANT PATH IS PROVIDED. ERRONEOUS MEASUREMENTS COULD CAUSE MISSION TERMINATION.

DATE: 1/23/87 HIGHEST CRITICALITY HDW/FUNC

SUBSYSTEM: INSTRUMENTATION FLIGHT: 3/1R MDAC ID: 305 ABORT: 3/1R

ITEM: MDM OF4, OA1, OA2, OA3

FAILURE MODE: ERRONEOUS OUTPUT

LEAD ANALYST: A.W. ADDIS SUBSYS LEAD: K. SCHMECKPEPER

#### BREAKDOWN HIERARCHY:

- 1) INSTRUMENTATION
- 2) OI
- 3) MDM
- 4)
- 5)
- 6)
- 7)
- 8) 9)

### CRITICALITIES

	O4/4 T T O4/				
FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC		
PRELAUNCH:	3/3	RTLS:	3/1R		
LIFTOFF:	3/2R	TAL:	3/1R		
ONORBIT:	3/3	AOA:	3/1R		
DEORBIT:	3/1R	ATO:	3/1R		
LANDING/SAFING	: 3/3				

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

LOCATION: OF4 FLT DECK, OA1 AV BAY 4, OA2 AV BAY 5, OA3 AV

BAY 6

PART NUMBER: MC615-004-53XX, 6310

CAUSES: TEMPERATURE, VIBRATION, CONTAMINATION, MECHANICAL SHOCK, PIECE-PART FAILURE

### EFFECTS/RATIONALE:

THESE MDM'S PROCESS/ROUTE CRITICAL APU STATUS DATA (FUEL TEST LINE TEMPERATURE AND FUEL PUMP DRAIN LINE TEMPERATURE). AN ERRONEOUS OUTPUT FALSELY INDICATING A HEATER STUCK IN "ON" CONDITION COULD PROMPT MANUAL SHUTDOWN OF AN APU. TWO OF THE THREE APU'S ARE REQURIED FOR LANDING; THEREFORE SHUTDOWN OF ONE WOULD REQUIRE ABORT DURING LIFTOFF. AN ERRONEOUS OUTPUT MASKING A HEATER STUCK ON COULD RESULT IN EXPLOSION AND CAUSE LOSS OF CREW/VEHICLE. FAILS SCREEN B BECAUSE FAILED MDM CHANNEL COULD NOT BE DETECTED.

REFERENCES: SSSH OI DSC/MDM DWG. 17.1, INCO/COMM SYS BRIEF SB28, IPCL, VS70-946099

DATE: 1/15/87 HIGHEST CRITICALITY HDW/FUNC

SUBSYSTEM: INSTRUMENTATION FLIGHT: 2/2 MDAC ID: 306 ABORT: 3/3

ITEM: MDM OF3

FAILURE MODE: LOSS OF OUTPUT

LEAD ANALYST: A.W. ADDIS SUBSYS LEAD: K. SCHMECKPEPER

#### BREAKDOWN HIERARCHY:

- 1) INSTRUMENTATION
- 2) OI
- 3) MDM
- 4)
- 5)
- 6)
- 7) 8)
- 9)

#### CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/3
LIFTOFF:	2/2	TAL:	3/3
ONORBIT:	2/2	AOA:	3/3
DEORBIT:	3/3	ATO:	3/3
LANDING/SAFING:	3/3		

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

LOCATION: AV BAY 3

PART NUMBER: MC615-0004-53XX, 6310

CAUSES: TEMPERATURE, VIBRATION, CONTAMINATION, MECHANICAL SHOCK,

PIECE-PART FAILURE

## EFFECTS/RATIONALE:

FOR PRESENT FUEL CELL SYSTEM MDM OF3 HANDLES ALL FUEL CELL CURRENT MEASUREMENTS AND FC1 SUBSTACK 3, FC2 SUBSTACK 2, AND FC3 SUBSTACK 1 DELTA VOLTAGE MEASUREMENTS. THESE MEARUREMENTS ARE CRITICAL BECAUSE THEIR LOSS COULD CONTROL OXYGEN-HYDROGEN CROSSOVER IN A FUEL CELL WHICH IN TURN COULD CAUSE AN EXPLOSION AND LOSS OF VEHICLE AND CREW IF THE MALFUNCTIONING FUEL CELL WERE NOT SHUT DOWN PROMPTLY. (PRIMARY METHOD OF DETECTING FUEL CELL "HOT SPOTS", AND THEREFORE EXPLOSION HAZARD, IS IF A DELTA VOLTAGE MEASUREMENT RISES RAPIDLY AND GOES OUT OF NORMAL RANGE - ABOVE 150 MV.) NO REDUNDANT PATHS EXIST FOR THESE MEASUREMENTS. THEIR LOSS WOULD CAUSE MISSION TERMINATION.

REFERENCES: SSSH FUEL CELL 3.4, IPCL, SSSH OI DSC/MDM DWG 17.1, INCO/COMM OI BRIEF SB48, SFOM INSTR VOL. 4E, EPS INT SCHEMATICS VS70-945099, VS70-945102

REPORT DATE 02/18/88 E-

DATE: 1/15/87 HIGHEST CRITICALITY HDW/FUNC

SUBSYSTEM: INSTRUMENTATION FLIGHT: 2/2 MDAC ID: 307 ABORT: 3/3

ITEM: MDM OF3

FAILURE MODE: ERRONEOUS OUTPUT, PREMATURE OUTPUT

LEAD ANALYST: A.W. ADDIS SUBSYS LEAD: K. SCHMECKPEPER

#### BREAKDOWN HIERARCHY:

- 1) INSTRUMENTATION
- 2) OI
- 3) MDM
- 4)
- 5)
- 6)
- 7)
- 8) 9)

#### CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/3
LIFTOFF:	2/2	TAL:	3/3
ONORBIT:	2/2	AOA:	3/3
DEORBIT:	3/3	ATO:	3/3
LANDING/SAFING:	3/3		•

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

LOCATION: AV BAY 3

PART NUMBER: MC615-0004-53XX, 6310

CAUSES: TEMPERATURE, VIBRATION, CONTAMINATION, MECHANICAL SHOCK, PIECE-PART FAILURE

#### EFFECTS/RATIONALE:

FOR PRESENT FUEL CELL SYSTEM MDM OF3 HANDLES ALL FUEL CELL CURRENT MEASUREMENTS AND DELTA VOLTAGE MEASUREMENTS FOR FC1 SUBSTACK 3, FC2 SUBSTACK 2, AND FC3 SUBSTACK 1. AN ERRONEOUS OR PREMATURE OUTPUT COULD CAUSE A FALSE INDICATION OF FUEL CELL MALFUNCTION, E.G., A SUDDEN INCREASE IN INDICATED SUBSTACK DELTA VOLTAGE OR CURRENT IMBALANCE AMONG FUEL CELLS. SUCH AN APPARENT MALFUNCTION COULD PROMPT MANUAL FUEL CELL SHUTDOWN WHICH IN TURN COULD REQUIRE MISSION CONSTRAINTS THAT WOULD CAUSE MISSION LOSS.

REFERENCES: SSSH FUEL CELL 3.4, IPCL, SSSH OI DSC/MDM DWG 17.1, INCO/COMM OI BRIEF SB48, SFOM INSTR VOL. 4E, EPS INT SCHEMATICS VS70-945099, VS70-945102

HIGHEST CRITICALITY HDW/FUNC 1/15/87 DATE:

SUBSYSTEM: INSTRUMENTATION FLIGHT: 2/2 3/3 MDAC ID: 308 ABORT:

ITEM: MDM OF1, OF2 FAILURE MODE: LOSS OF OUTPUT

LEAD ANALYST: A.W. ADDIS SUBSYS LEAD: K. SCHMECKPEPER

### BREAKDOWN HIERARCHY:

- INSTRUMENTATION 1)
- 2) OI
- MDM 3)
- 4)
- 5)
- 6)
- 7)
- 8) 9)

#### CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/3
LIFTOFF:	2/2	TAL:	3/3
ONORBIT:	2/2	AOA:	3/3
DEORBIT:	3/3	ATO:	3/3
LANDING/SAFING:	3/3		

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

MDM OF1 AV BAY 1, MDM OF2 AV BAY 2 LOCATION:

PART NUMBER: MC615-0004-53XX, 6310

CAUSES: TEMPERATURE, VIBRATION, CONTAMINATION, MECHANICAL SHOCK, PIECE-PART FAILURE

#### EFFECTS/RATIONALE:

FOR PRESENT FUEL CELL SYSTEM MDMs OF1 AND OF2 HANDLE FUEL CELL SUBSTACK DELTA VOLTAGE MEASUREMENTS. EACH OF THESE MEASUREMENTS IS CRITICAL AND ITS LOSS COULD CAUSE MISSION TERMINATION BECAUSE THAT LOSS COULD CONCEAL OXYGEN-HYDROGEN CROSSOVER IN A FUDL CELL WHICH IN TURN COULD CAUSE AN EXPLOSION AND LOSS OF VEHICLE AND CREW IF THE MALFUNCTIONING FUEL CELL WERE NOT SHUT DOWN PROMPTLY. NO REDUNDANT PATHS EXIST FOR THESE MEASUREMENTS.

REFERENCES: SSSH FUEL CELL 3.4, IPCL, SSSH OI DSC/MDM DWG 17.1, INCO/COMM OI BRIEF SB48, SFOM INSTR VOL. 4E, EPS INT SCHEMATICS VS70-945099, VS70-954102

DATE: 1/15/87 HIGHEST CRITICALITY HDW/FUNC

SUBSYSTEM: INSTRUMENTATION FLIGHT: 2/2 MDAC ID: 309 ABORT: 3/3

ITEM: MDM OF1, OF2

FAILURE MODE: ERRONEOUS OUTPUT

LEAD ANALYST: A.W. ADDIS SUBSYS LEAD: K. SCHMECKPEPER

### BREAKDOWN HIERARCHY:

- 1) INSTRUMENTATION
- 2) OI
- 3) MDM

4)

5)

6)

7)

8) 9)

#### CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/3
LIFTOFF:	2/2	TAL:	3/3
ONORBIT:	2/2	AOA:	3/3
DEORBIT:	3/3	ATO:	3/3
LANDING/SAFING:	3/3		·

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

LOCATION: MDM OF1 AV BAY 1, MDM OF2 AV BAY 2

PART NUMBER: MC615-0004-53XX, 6310

CAUSES: TEMPERATURE, VIBRATION, CONTAMINATION, MECHANICAL SHOCK, PIECE-PART FAILURE

#### EFFECTS/RATIONALE:

FOR PRESENT FUEL CELL SYSTEM MDMs OF1 AND OF2 HANDLE FUEL CELL SUBSTACK DELTA VOLTAGE MEASUREMENTS. AN ERRONEOUS OR PREMATURE OUTPUT COULD CAUSE A FALSE INDICATION OF FUEL CELL MALFUNCTION, E.G., A SUDDEN INCREASE IN ANY SUBSTACK DELTA VOLTAGE AMONG FUEL CELLS. SUCH AN APPARENT MALFUNCTION COULD PROMPT MANUAL FUEL CELL SHUT DOWN WHICH IN TURN COULD REQUIRE MISSION CONSTRAINTS THAT WOULD RESULT IN MISSION LOSS.

REFERENCES: SSSH FUEL CELL 3.4, IPCL SSSH OI DSC/MDM DWG 17.1, INCO/COMM OI BRIEF SB48, SFOM INSTR VOL. 4E, EPS INT SCHEMATICS VS70-945099, VS70-954102

HIGHEST CRITICALITY HDW/FUNC DATE: 1/21/87 FLIGHT: SUBSYSTEM: INSTRUMENTATION 2/2 ABORT: 3/3 310 MDAC ID: ITEM: MDM OA1, OA2, OA3 FAILURE MODE: LOSS OF OUTPUT, OPEN, SHORTED LEAD ANALYST: A.W. ADDIS SUBSYS LEAD: K. SCHMECKPEPER BREAKDOWN HIERARCHY: INSTRUMENTATION 1) 2) OI 3) MDM 4) 5) 6) 7) 8) 9) CRITICALITIES HDW/FUNC ABORT HDW/FUNC FLIGHT PHASE RTLS: 3/3 3/3 PRELAUNCH: 2/2 TAL: 3/3 LIFTOFF: AOA: ONORBIT: 2/2 . 3/3 ATO: DEORBIT: 3/3 3/3 LANDING/SAFING: 3/3 REDUNDANCY SCREENS: A [ ] B [ ] C [ ] LOCATION: MDM OA1 AV BAY 4, MDM OA2 AV BAY 5, MDM OA3 AV BAY PART NUMBER: MC615-0004-53XX, 6410

CAUSES: TEMPERATURE, VIBRATION, CONTAMINATION, MECHANICAL SHOCK, PIECE-PART FAILURE

#### EFFECTS/RATIONALE:

CRITICAL APU MEASUREMENTS OF FUEL LINE TEMPATURE, FUEL PUMP OUTPUT TEMPATURE, AND BYPASS LINE TEMPERATURE FOR THE THREE APUS ARE PROCESSED BY MDMs OA1, OA2, AND OA3. REDUNDANT PAIRS OF MEASUREMENTS ARE NOT ROUTED VIA SEPARATE MDM PATHS FOR THESE MEASUREMENTS. THEIR LOSS WOULD CAUSE LOSS OF INSIGHT INTO APU OPERATION, WHICH COULD CAUSE MISSION ABORT, OR COULD CONCEAL MALFUNCTIONS THAT COULD CAUSE LOSS OF CREW/VEHICLE.

REFERENCES: SSSH OI DSC/MDM DWG 17.1, INCO/COMM OI BRIEF SB28, INSTRUMENTATION PROGRAM AND COMPONENT LIST (IPCL)

#### APPENDIX F

## NASA FMEA TO IOA WORKSHEET CROSS REFERENCE/RECOMMENDATIONS

This section provides a cross reference between the NASA FMEA and corresponding IOA analysis worksheet(s) included in Appendix E. The Appendix F identifies: NASA FMEA Number, IOA Assessment Number, NASA criticality and redundancy screen data, and IOA recommendations.

## Appendix F Legend

## Code Definition

- 1 IOA recommends changing the second failure mode described in the effects field.
- 2 IOA recommends deleting the IOA failure mode.

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NASA FMEA TO IOA WORKSHEET CROSS REFERENCE / RECOMMENDATIONS

APPENDIX F

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