INDEPENDENT ORBITER ASSESSMENT

ANALYSIS
OF THE
AUXILIARY POWER
UNIT

12 DECEMBER 1986

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY
HOUSTON DIVISION

SPACE TRANSPORTATION SYSTEM ENGINEERING AND OPERATIONS SUPPORT

WORKING PAPER NO. 1.0-WP-VA86001-14

INDEPENDENT ORBITER ASSESSMENT ANALYSIS OF THE AUXILIARY POWER UNIT

12 December 1986

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

PREPARED BY: Jeffrey E. Barnes
J.E. Barnes
APU Lead
Independent Orbiter
Assessment

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

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

CONTENTS

List of Figures

List of Tables

Independent Orbiter Assessment
Analysis of the Auxiliary Power Unit

1.0 EXECUTIVE SUMMARY

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

The APUs are required to provide power to the Orbiter hydraulics systems during ascent and entry flight phases for aerosurface actuation, main engine gimballing, landing gear extension, and other vital functions. For analysis purposes, the APU system was broken down into ten functional subsystems.

The IOA analysis process utilized available APU hardware drawings and schematics for defining hardware assemblies, components, and hardware items. Each level of hardware was evaluated and analyzed for possible failure modes and effects. Criticality was assigned based upon the severity of the effect for each failure mode.

Figure 1 presents a summary of the failure criticalities for each of the ten analysis breakdown subsystems of the APU. A summary of the number of failure modes, by criticality, is also presented below with Hardware (HW) criticality first and Functional (F) criticality second.

Summary of IOA Failure Modes By Criticality (HW/F)

Criticality:	1/1	2/1R	2/2	3/1R	3/2R	3/3	TOTAL
Number :	37	84	-	93	1	86	301

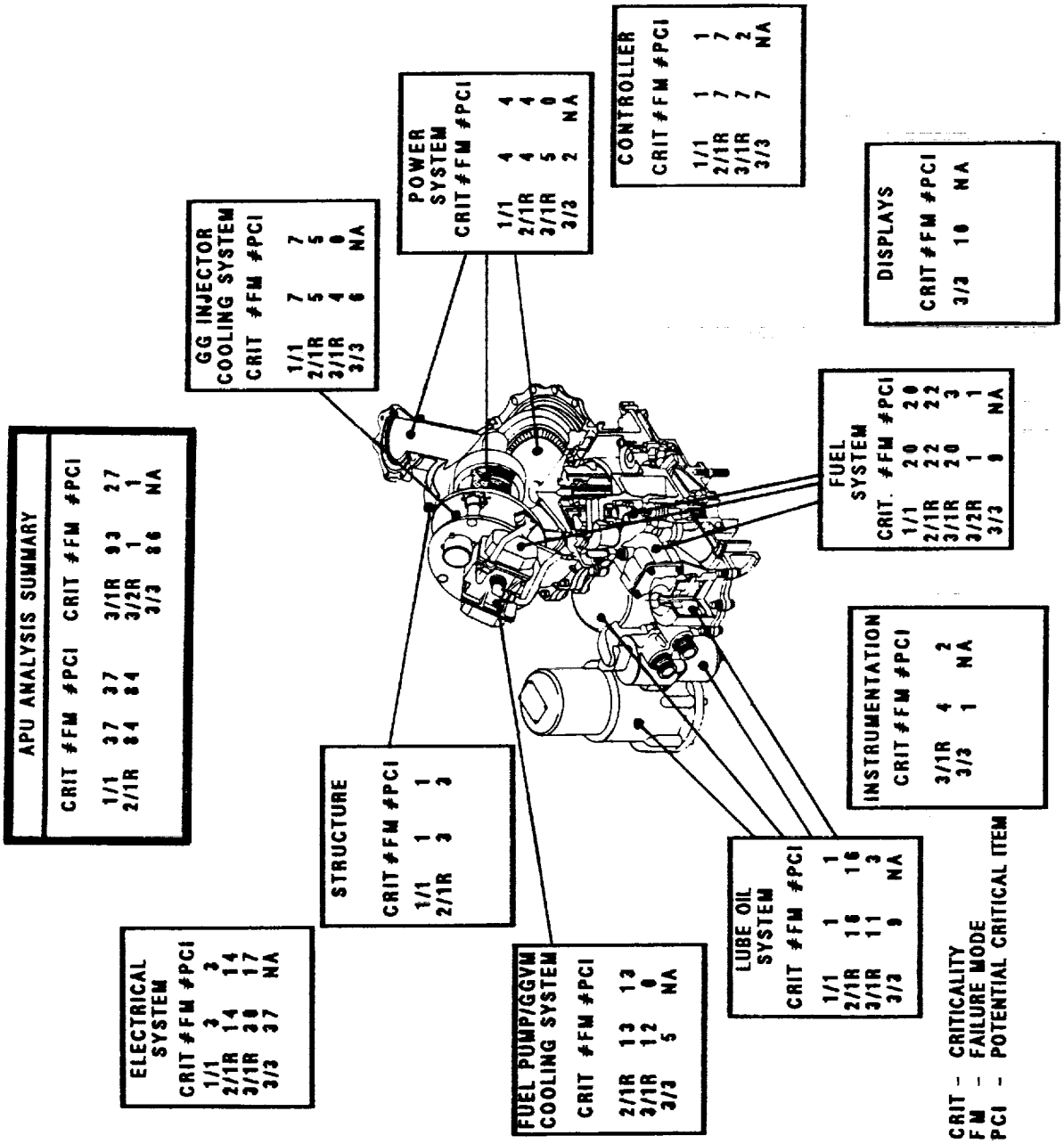

Figure 1 - APU OVERVIEW ANALYSIS SUMMARY

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

Summary of IOA Potential Critical Items (HW/F)						
Criticality:	1/1	2/1R	2/2	3/1R	3/2R	TOTAL
Number :	37	84	-	27	1	149

The preponderance of 1/1 items are failures that allow the APU hydrazine fuel to escape into the Orbiter aft compartment, creating a severe fire hazard, and failures that cause loss of the gas generator injector cooling system.

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

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

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

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

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

2.4 APU Ground Rules and Assumptions

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

Due to resource and schedule constraints and lack of adequate data, the Controller analysis was done to a functional level only; the criticalities of failures in key controller functions were assessed. This matches the analysis level of the NASA FMEA/CIL.

The APU gas generator injector cooling system and fuel pump/GGVM cooling system failure criticalities were assigned based on a sudden deorbit with hot APUs, which is the flight situation in which these systems are of critical importance. It was assumed that a worst case ATO would produce the same situation, as well. This produced several 1/1 criticalities due to the lack of redundancy in the gas generator injector cooling system.

3.0 SUBSYSTEM DESCRIPTION

3.1 Design and Function

The Auxiliary Power Unit (APU) subsystem converts chemical energy stored in liquid hydrazine to mechanical shaft power. The Orbiter has three completely independent APUs, with each APU driving one hydraulic pump.

Each APU subsystem consists of the following:

- A fuel supply and distribution system
- An auxiliary power unit and controller
- An exhaust duct assembly
- A fuel thermal control system
- A fuel pump seal cavity drain line
- A fuel pump/valve module cooling system
- A gas generator injector cooling system

The hydrazine is delivered to the APU gas generator via the fuel pump. The catalyst in the gas generator causes the hydrazine to decompose. The hot gases make two passes through the turbine, which in turn provides mechanical power to the APU gearbox. Through gear reduction, power is provided to drive the APU fuel pump, lube oil pump, and hydraulic oil pump.

Three water tanks and associated lines are provided to cool the fuel pumps and gas generator valve modules after APU shutdown on-orbit and to cool the gas generator injectors should an emergency hot start be required.

The hydrazine fuel supply is stored in the fuel tank and is pressurized with nitrogen during servicing. The pressure provides start capability until the fuel pump is running and acts against the tank diaphragm to positively expel fuel to the APU. The fuel pump provides a constant flow of hydrazine to the valve module after the initial bootstrap start.

Two parallel fuel isolation valves are manually actuated by the crew during APU activation and deactivation. During nonoperating periods, they isolate the fuel supply to prevent further fuel flow. Each valve has a reverse-flow pressure-relief feature to prevent system damage due to expansion of fuel trapped between the valves and the APU.

The APU turbine speed is controlled by the Gas Generator Valve Module (GGVM). The valve module consists of two flapper-type valves in series. The primary or modulating valve downstream of the pump is normally open and allows flow to the secondary or shutoff valve. The secondary valve is normally in by-pass, which directs hydrazine flow back to the pump inlet. In the powered state, it allows hydrazine

flow to the gas generator. The APU controller cycles these valves to maintain proper turbine speed. The gas generator is a container for a granular catalyst. When hydrazine comes in contact with the catalyst, decomposition occurs, and the hot gases produced are directed to the turbine.

The dual-pass turbine assembly converts hot gas kinetic energy into mechanical shaft power at the desired speeds to operate the hydraulic pump, lube oil pump, and fuel pump.

The speed-reducing gearbox contains gears, bearings, seals, and a scavenger lubrication system. The gearbox is pressurized with nitrogen to prevent vaporization of the lubricant. A lube oil pump circulates the lube oil to the hydraulic water boiler for cooling. The gearbox has a pressurization system consisting of a small GN2 bottle and solenoid shutoff valve actuated by the controller.

The APU controller provides speed control, logic for APU startup and shutdown, signal conditioning, heater control, gearbox pressure control, and malfunction detection capability.

The exhaust duct assembly directs the APU exhaust products overboard through an exit at the upper aft fuselage skin. Exhaust duct assemblies 1 and 2 are located on the port side and duct 3 is on the starboard side of the aft fuselage at the base of the vertical stabilizer.

The fuel tank, fuel line, fuel pump, and lube oil line heaters are sized to maintain the fuel and lube oil above minimum temperature during any Orbiter mission. The gas generator heaters provide a means of preheating the catalyst to > 190 degrees F for controlled decomposition. Insulation for the APU prevents excessive temperatures in the fuel system as a result of entry heating.

The fuel pump and gas generator valve modules are maintained below 200 degrees F after APU shutdown by a water spray system consisting of two water tanks and associated lines, switches, thermostats, and timers. This system is only required on-orbit when convective cooling is insufficient to cool these components.

A single water tank with lines to all three APUs is provided to cool the gas generator injector should an APU restart be required before the gas generator can cool naturally. Control is via the APU controller.

3.2 Interfaces and Locations

Figure 2 depicts the APU interfaces. The APU and APU Controller receive electric power from various Orbiter Aft Load Controllers, Aft Power Controllers, Control Buses, and Essential Buses. APU gauges are powered by Panel Bus Main B 015.

All three APUs are mounted on the 1307 bulkhead, in the Orbiter aft compartment. APU's 1 and 2 are located in close proximity toward the port side of the bulkhead. APU 3 is slightly further away, toward the starboard side.

The APU fuel tanks are mounted on the sides of the aft compartment, about 7 feet aft of the 1307 bulkhead. Tanks 1 and 2 are on the port side, in close proximity. Tank 3 is on the starboard side. Figure 3 shows the locations of the three APUs and associated fuel tanks, fuel lines, and the lube oil lines.

APU lube oil cooling is provided by the Orbiter Water Spray Boilers, one for each APU.

The Controllers for APU 1, 2 and 3 are mounted on freon coldplates in Aft Avionics Bays 4, 5 and 6, respectively.

The APUs are controlled during flight by flight crew switches only - no uplink commands are possible. Many APU functions can be controlled from the ground prelaunch by way of the Launch Aft MDM, however.

3.3 Functional Breakdown

For analysis purposes, the APU was broken down into the following functional subsystems:

1. Power System
2. Fuel System
3. Lube Oil System
4. Gas Generator Injector Cooling System
5. Fuel Pump/GGVM Cooling System
6. Structure
7. Electrical System
8. Displays
9. Instrumentation
10. Controller

These subsystems are described below.

1. The Power System consists of the components involved in generating shaft power from the exothermic reaction - the gas generator, turbine wheel, exhaust duct, gearbox, gas generator bed heaters, and the turbine speed sensors.

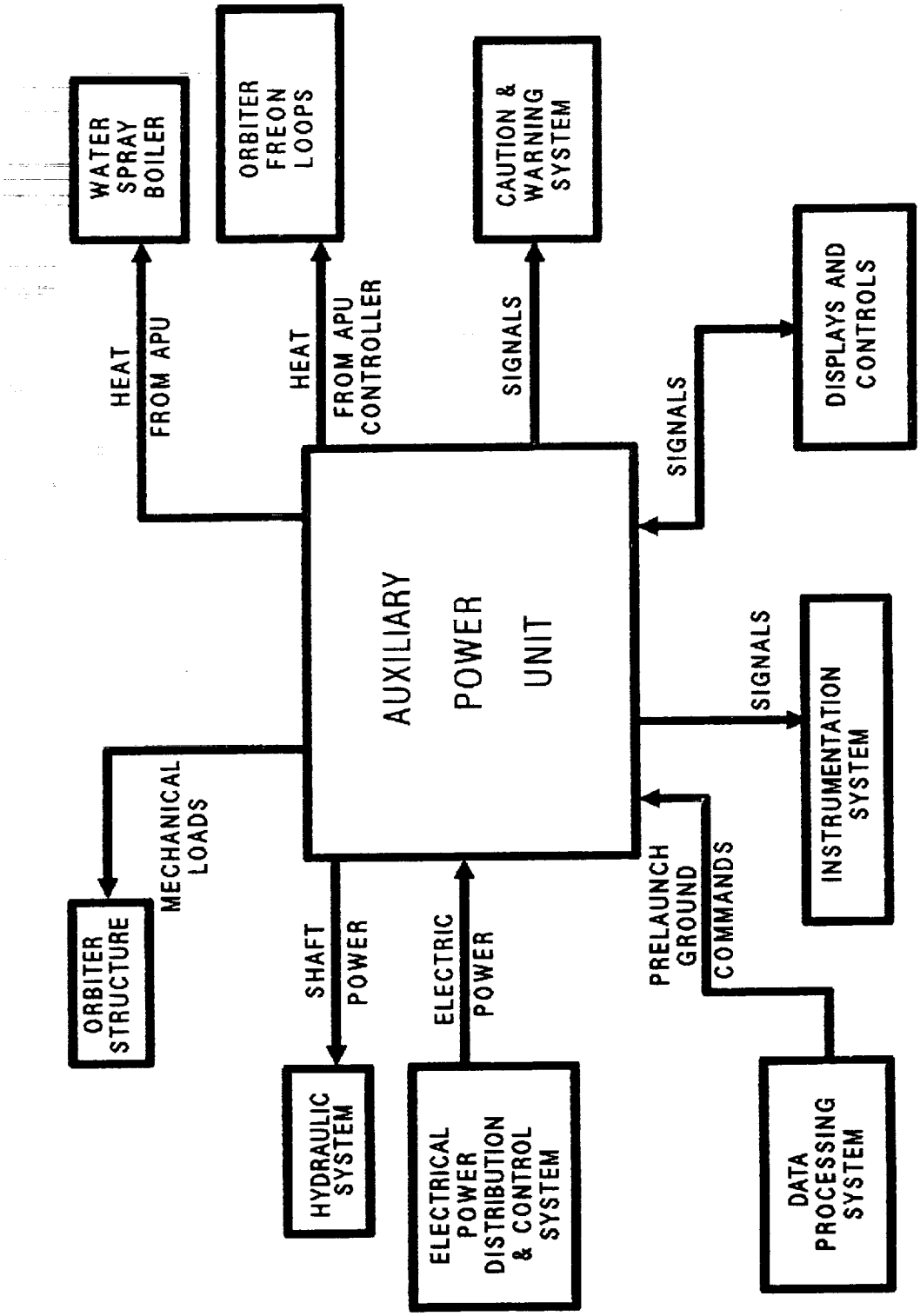

Figure 2 - APU INTERFACES

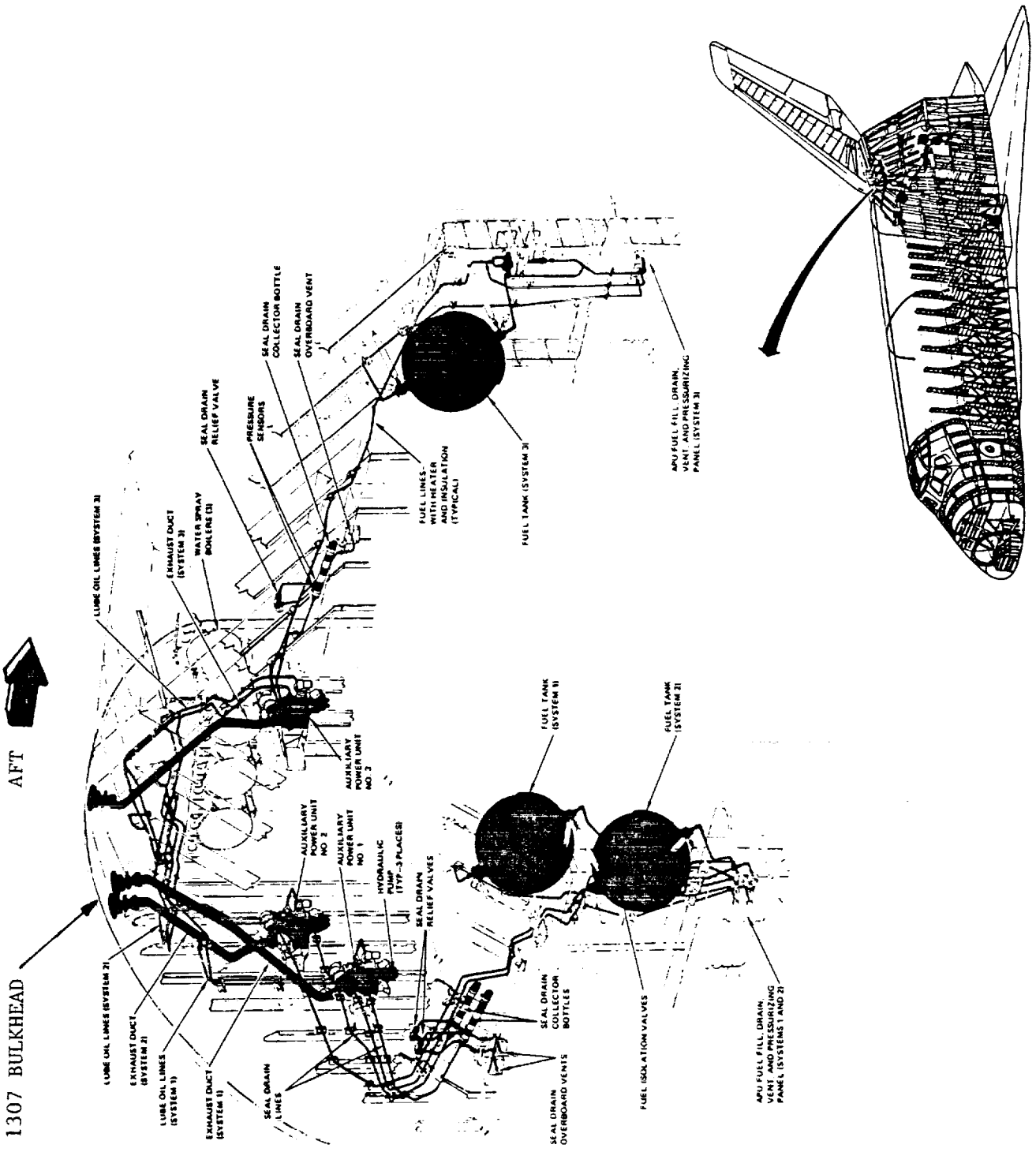

Figure 3 - APU LOCATION

********** PROCESS IPS TEMP # 0211594 FILE = 1N STAR **********

TITLE = Independent Orbiter Assessment (IOA) analysis of t
he auxiliary power unit

ABSTRACT = The results of the Independent Orbiter Assessment
(IOA) of the Failure Modes and Effects Analysis
(FMEA) and Critical Items List (CIL) are
presented. The IOA approach features a top-down
analysis of the hardware to determine failure
modes, criticality, and potential critical items.
To preserve independence, this analysis was
accomplished without reliance upon the results
contained within the NASA FMEA/CIL documentation.
This report documents independent analysis results
corresponding to the Orbiter Auxiliary Power Unit
(APU). The APUs are required to provide power to
the Orbiter hydrualics systems during ascent and
entry flight phases for aerosurface actuation,
main engine gimballing, landing gear extension,
and other vital functions. For analysis purposes,
the APU system was broken down into ten functional
subsystems. Each level of hardware was evaluated
and analyzed for possible failure modes and
effects. Criticality was assigned based upon the
severity of the effect for each failure mode. A
preponderance of 1/1 criticality items were
related to failures that allowed the APU
hydrazine fuel to escape into the Orbiter aft
compartment, creating a severe fire hazard, and
failures that caused loss of the gas generator
injector cooling system.

TRACE	PHRASE
A J H	INDEPENDENT ORBITER ASSESSMENT
A Z H	AUXILIARY POWER UNIT
A J H	INDEPENDENT ORBITER ASSESSMENT
Z Z P Z Z	FAILURE MODES AND EFFECTS ANALYSIS
A H Z	CRITICAL ITEMS LIST
Z Z	APPROACH FEATURES
Z Z	TOP-DOWN ANALYSIS
Z Z	FAILURE MODES
Z A H	POTENTIAL CRITICAL ITEMS
A Z N	NASA FMEA/CIL DOCUMENTATION
Z N A Z	REPORT DOCUMENTS INDEPENDENT ANALYSIS
J A Z H	ORBITER AUXILIARY POWER UNIT
A P Z Z Z P A N	ASCENT AND ENTRY FLIGHT PHASES FOR AEROSURFACE ACTUATION
A Z Z	MAIN ENGINE GIMBALLING
N Z Z	LANDING GEAR EXTENSION
Z Z	ANALYSIS PURPOSES
A H	FUNCTIONAL SUBSYSTEMS
Z P Z	LEVEL OF HARDWARE

PARM='1N-0211594-0211616' PARM_FILE='1N' FIRSTNO=0211594 LASTNO=0211616;

****

**** IPS MACHINE AIDED INDEXING ****

****

NUMBER OF RECORDS IN RANGE = 23

Required Terms

MJS

Space Shuttle Orbiters
Failure Modes
Spacecraft Reliability
(Characterize particular subsystem)

MNS

Aerospace Safety Assessments

Others

Component Reliability
Spacecraft Components
System Failures

2. The Fuel System consists of all components involved in storing fuel, and supplying it to the gas generator - the fuel tank, fuel lines, valves, fuel pump, and heaters.

3. The Lube Oil System includes the lube oil lines, pump, couplings, accumulators, and heaters.

4. The Gas Generator Injector Cooling System includes all valves, water tanks, water lines, couplings, and heaters associated with this cooling system.

5. The Fuel Pump/GGVM Cooling System includes all valves, water tanks, water lines, nitrogen lines, couplings, and heaters associated with this cooling system.

6. The Structures analyzed include the APU turbine and gearbox housings.

7. The Electrical System includes circuitry specifically associated with the APU, including the APU switches.

8. Displays include all APU gauges and talkbacks.

9. Instrumentation includes all APU transducers except for the turbine speed sensors, which are covered under the Power System.

10. The APU Controller was analyzed to the functional level only. The analysis examines the consequences of loss of the Controller's important functions.

Figure 4 presents a highly simplified breakdown of the APU components, reflecting the functional subsystems described above (except for the structures, electrical, displays, and instrumentation subsystems).

Figure 5 presents the top-level hierarchy used in the APU analysis.

Figures 6 through 15 present the breakdown hierarchy of the ten APU subsystems described on Page 9.

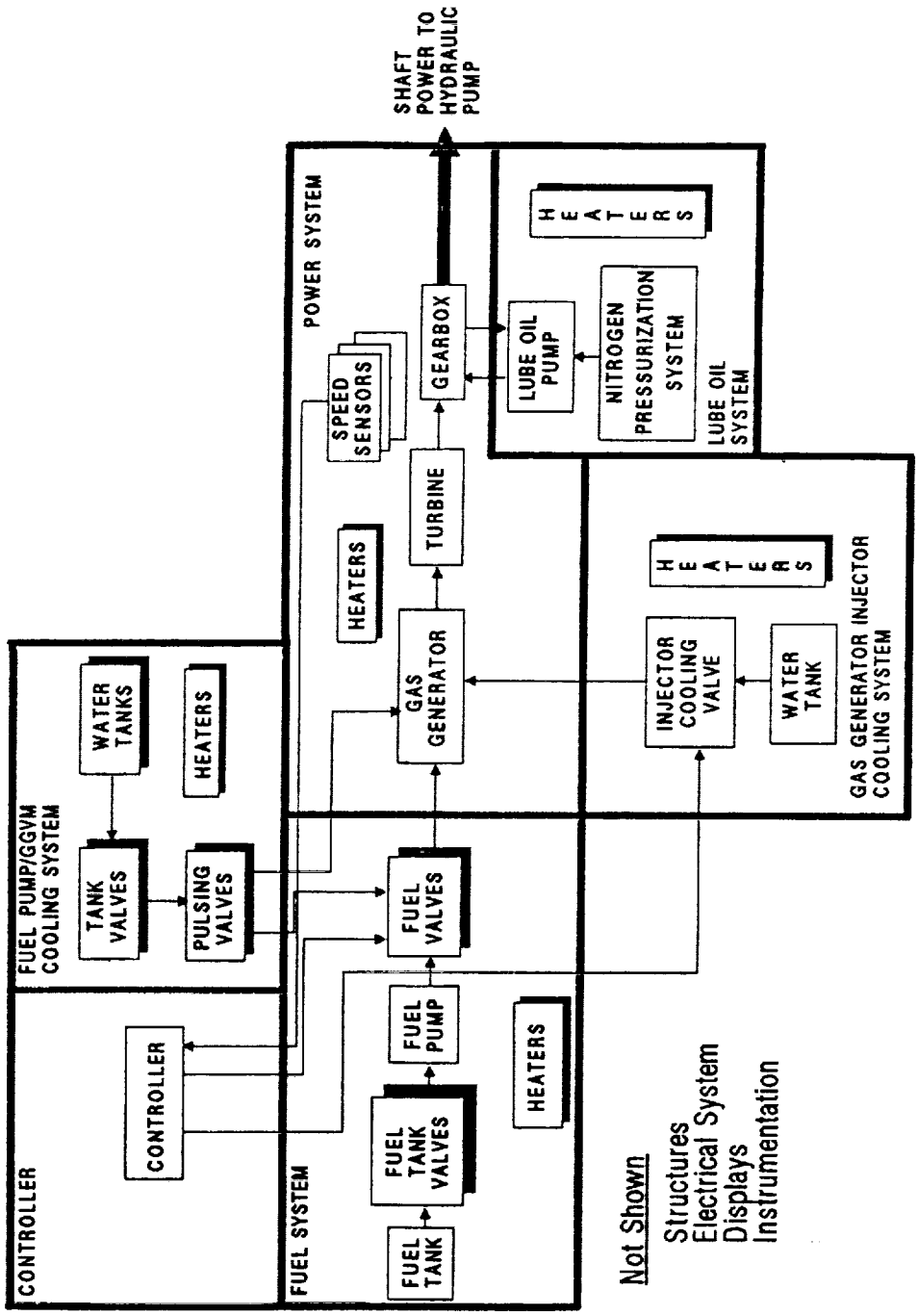

Figure 4 - APU FUNCTIONAL BREAKDOWN

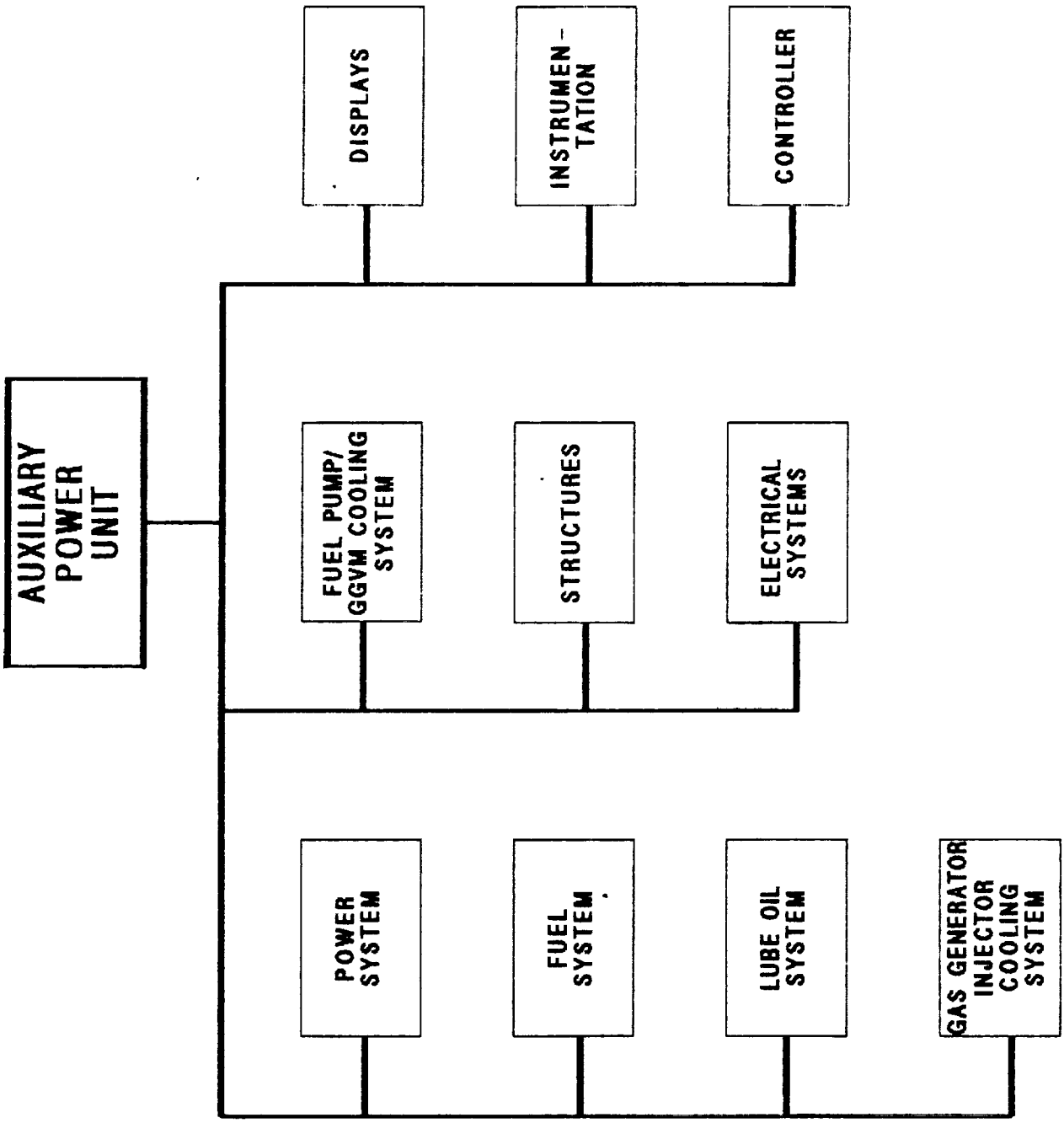

Figure 5 - APU TOP LEVEL HIERARCHY

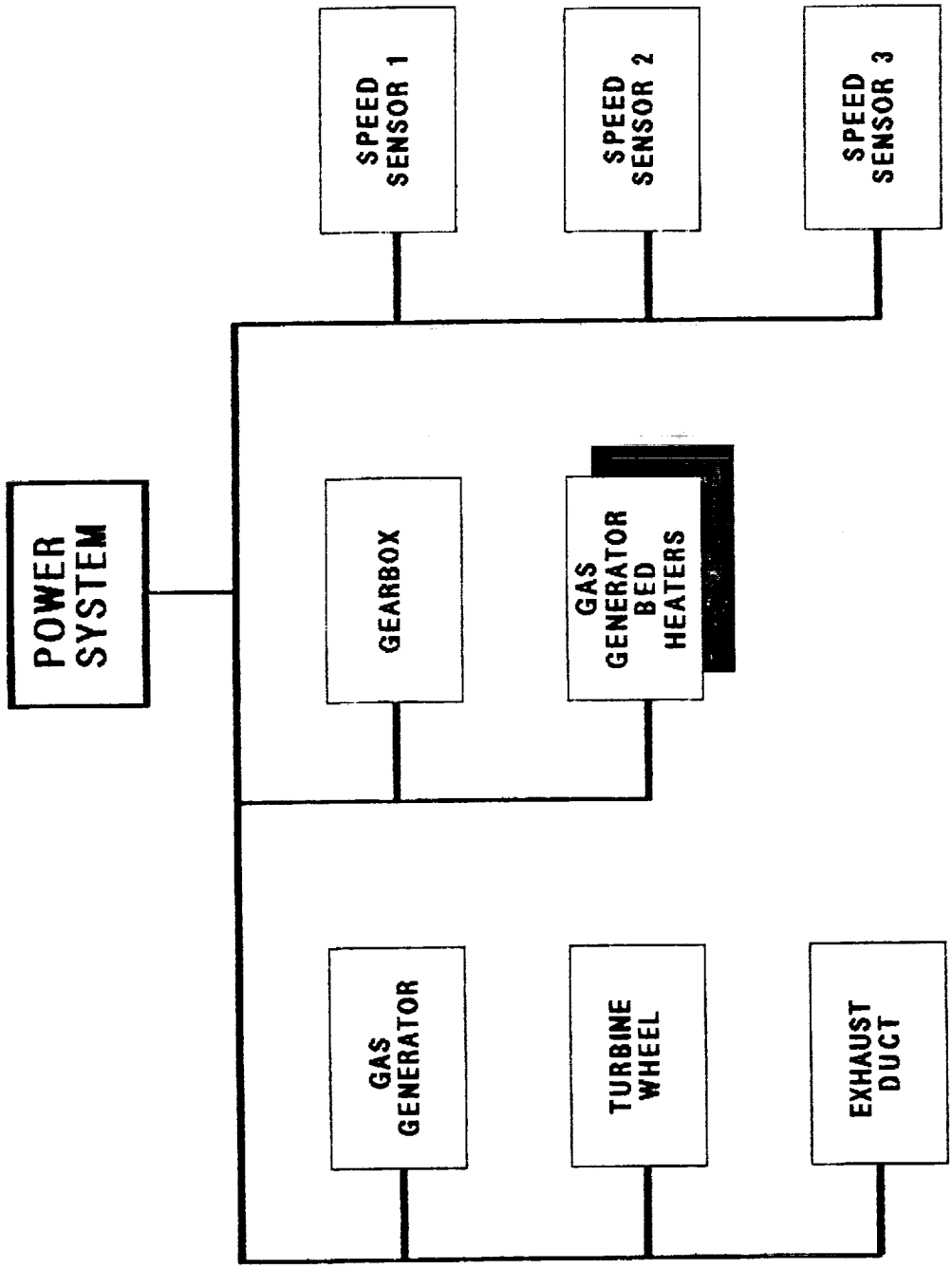

Figure 6 - POWER SYSTEM HIERARCHY

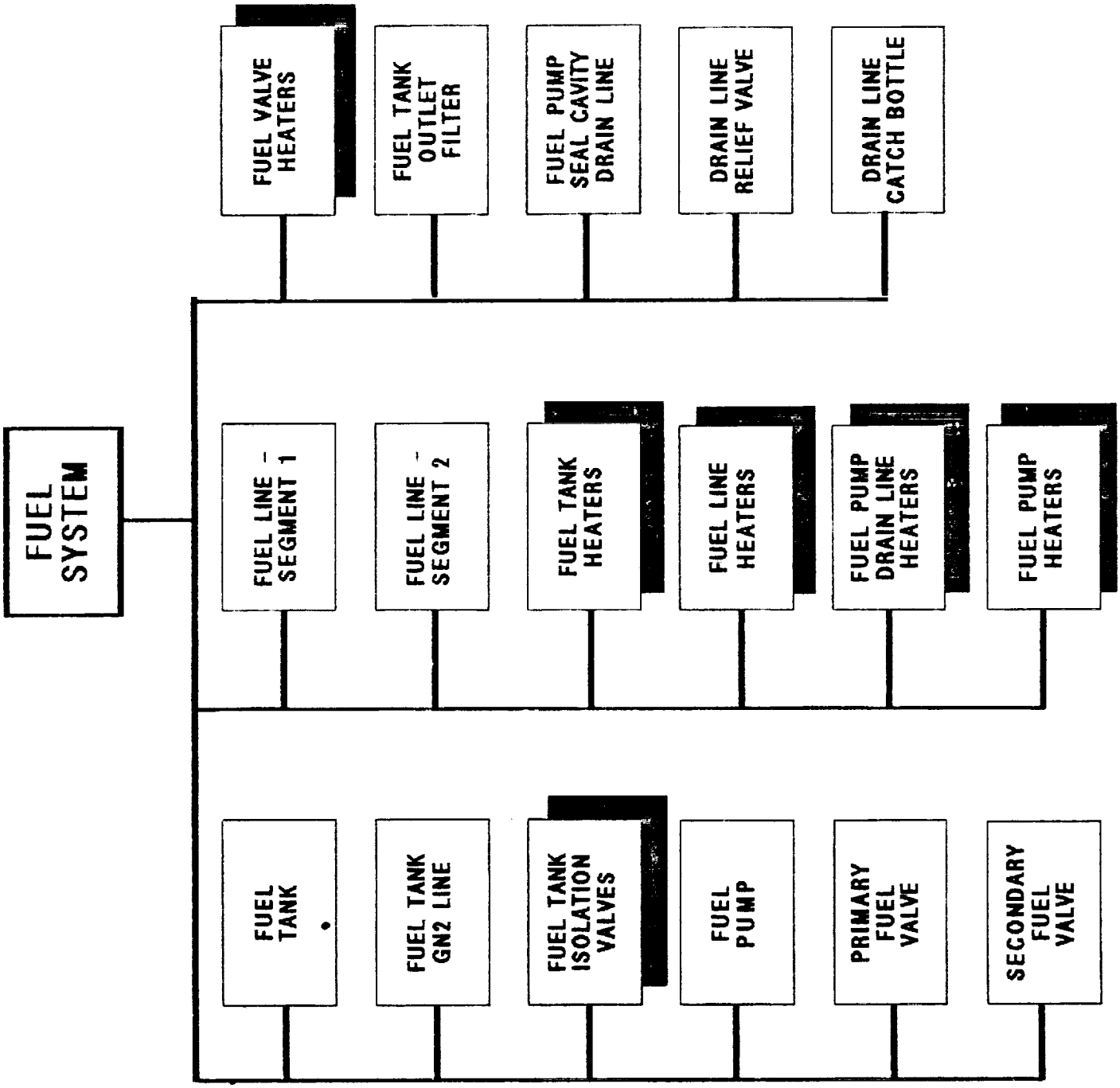

Figure 7 - FUEL SYSTEM HIERARCHY

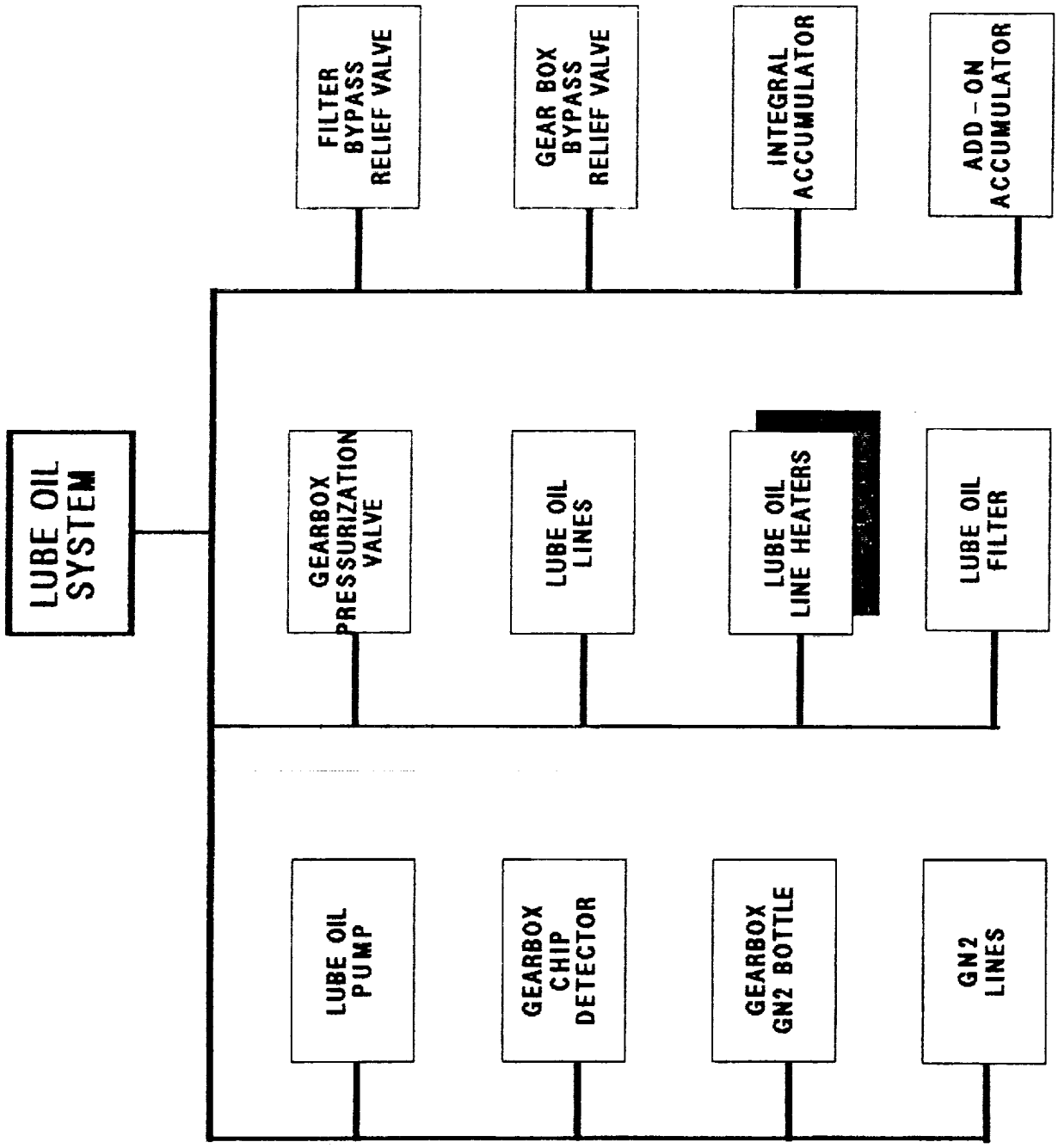

Figure 8 - LUBE OIL SYSTEM HIERARCHY

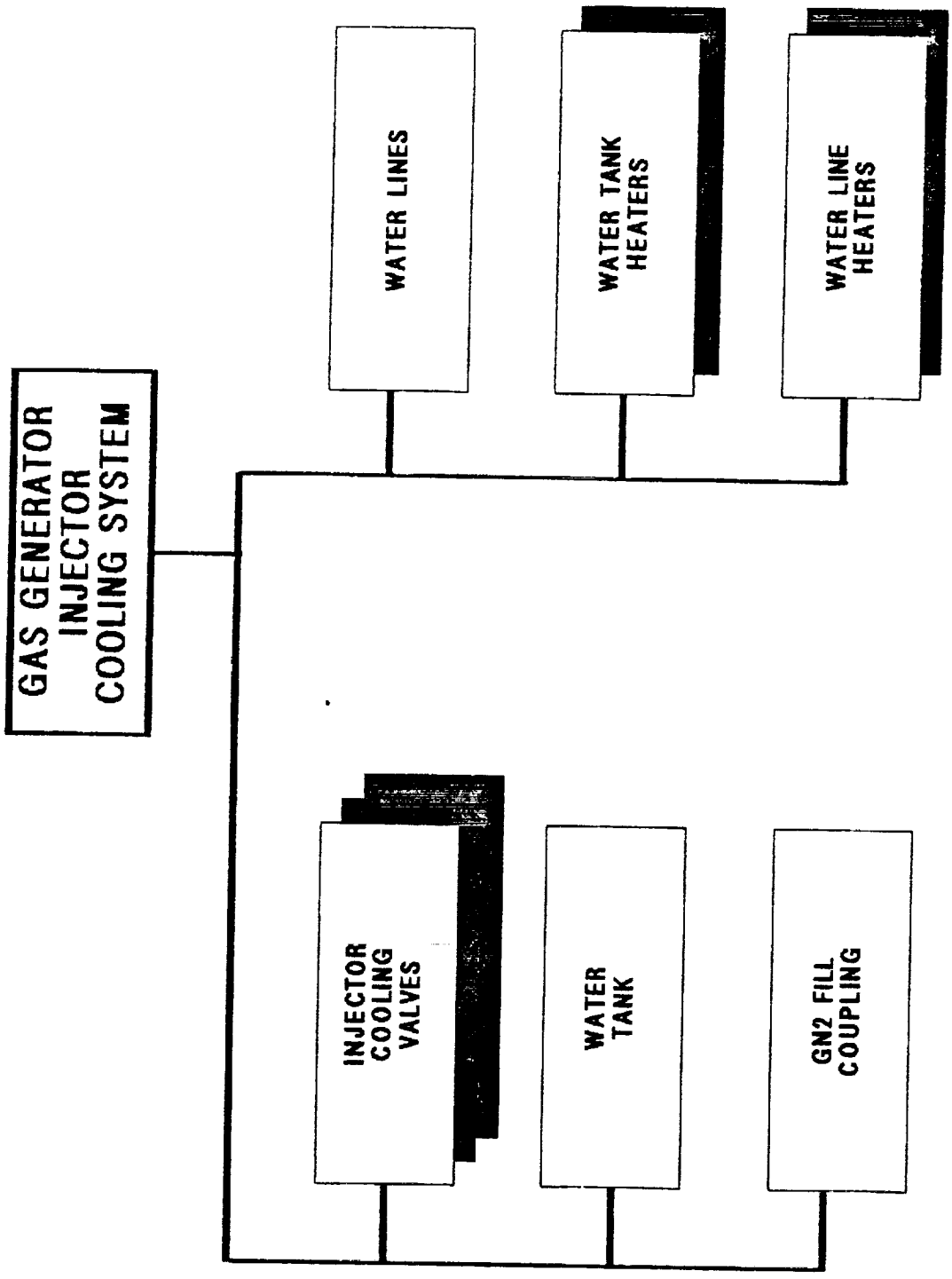

Figure 9 - GAS GENERATOR INJECTOR COOLING SYSTEM HIERARCHY

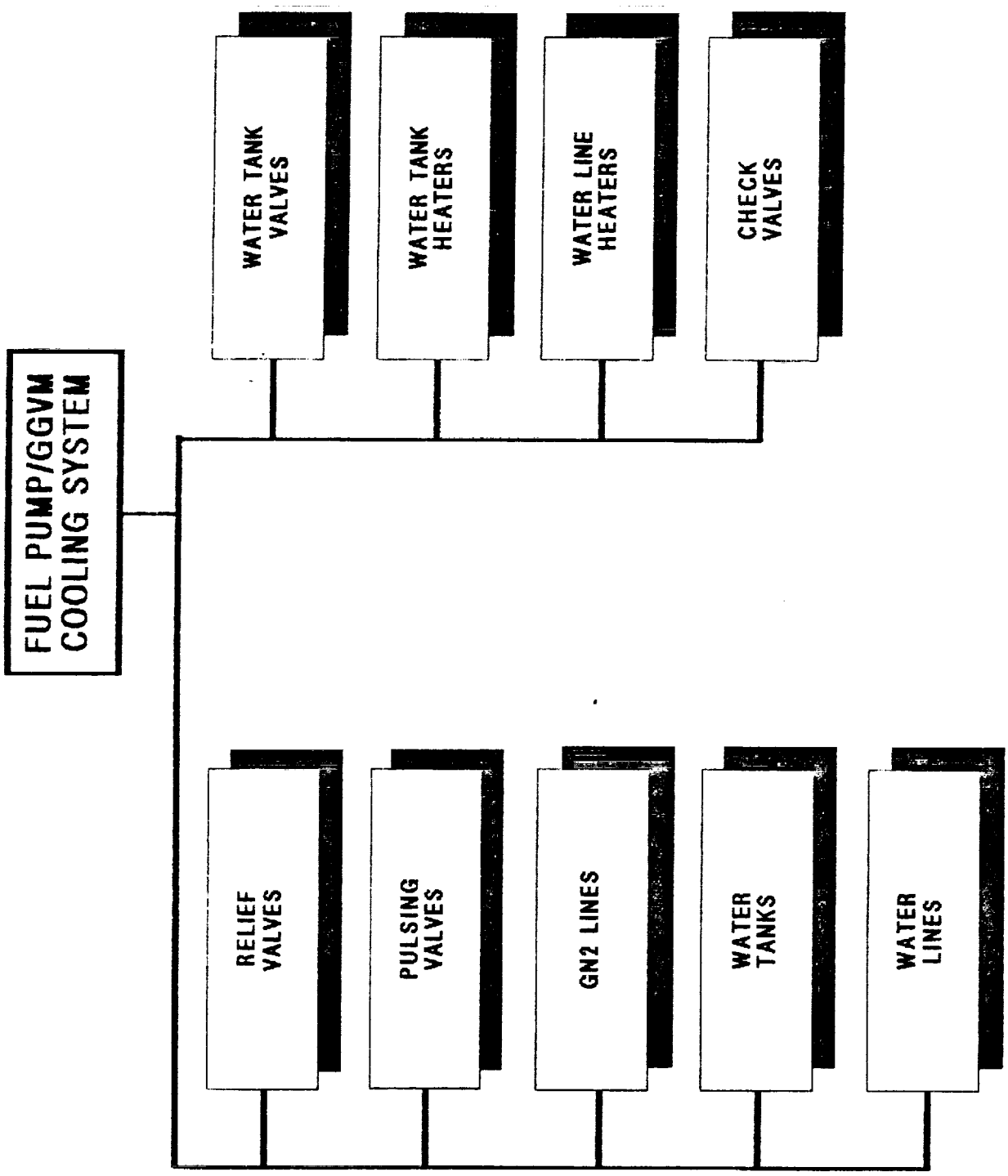

Figure 10 - FUEL PUMP/GGVM COOLING SYSTEM HIERARCHY

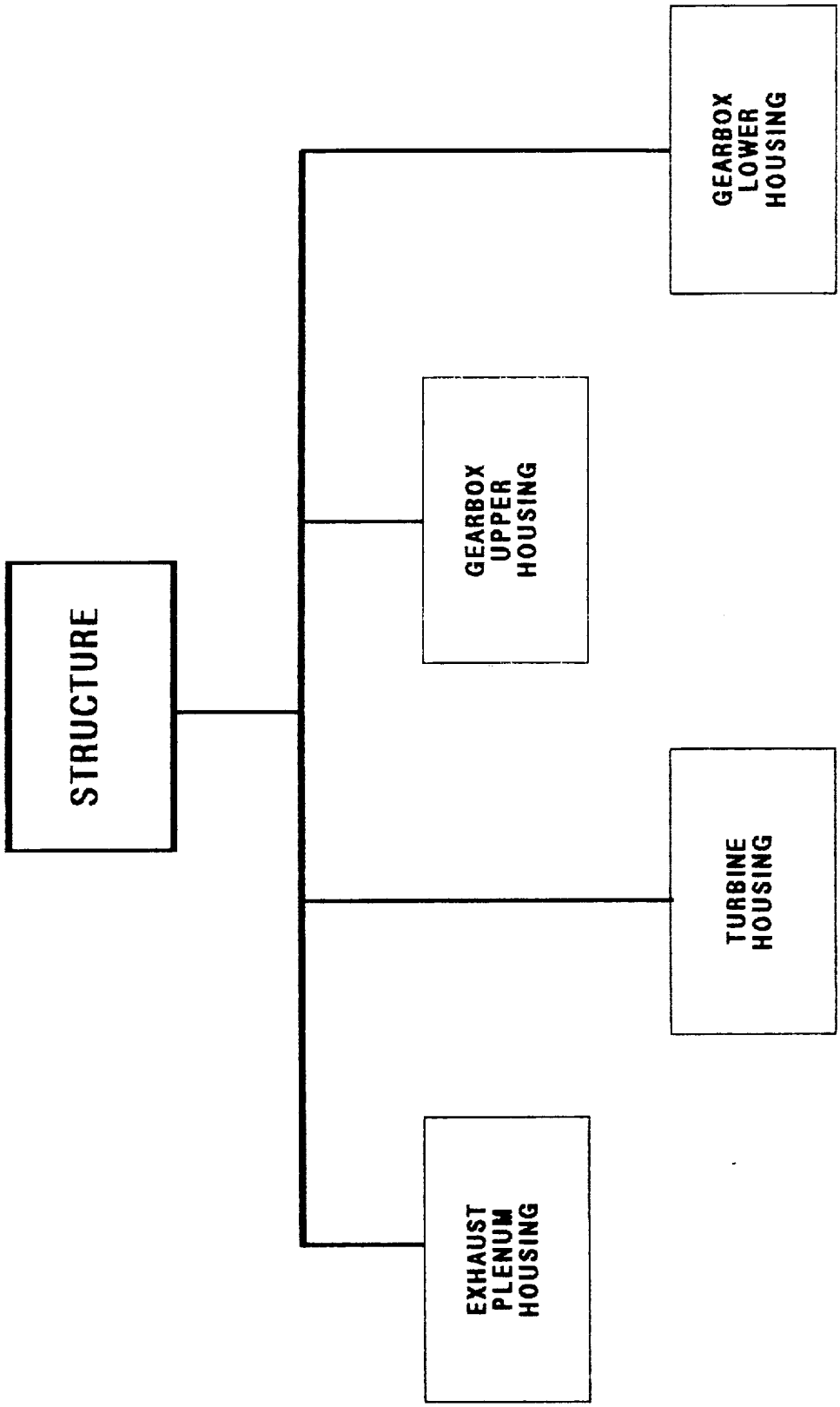

Figure 11 - STRUCTURES HIERARCHY

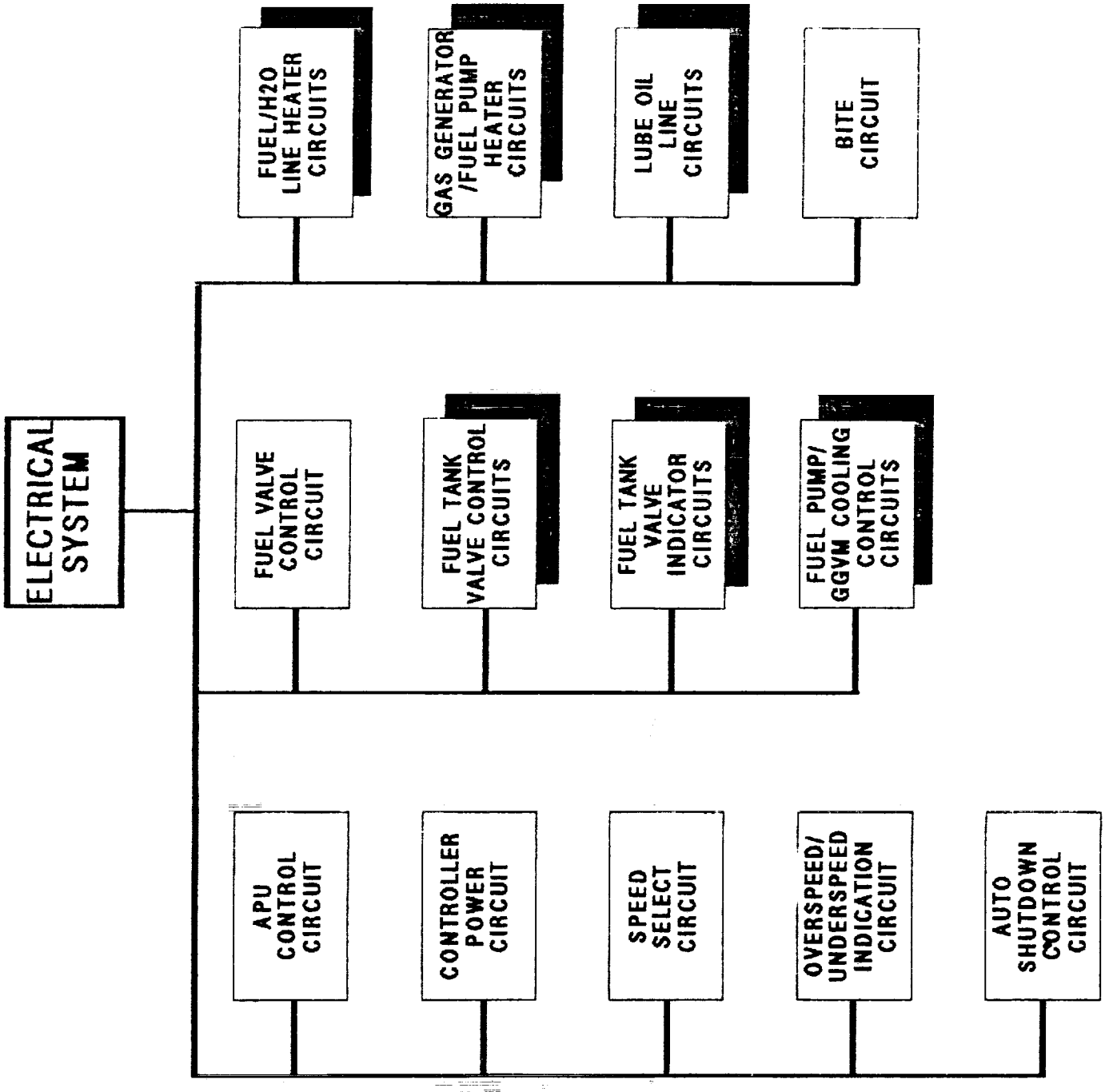

Figure 12 - ELECTRICAL SYSTEM HIERARCHY

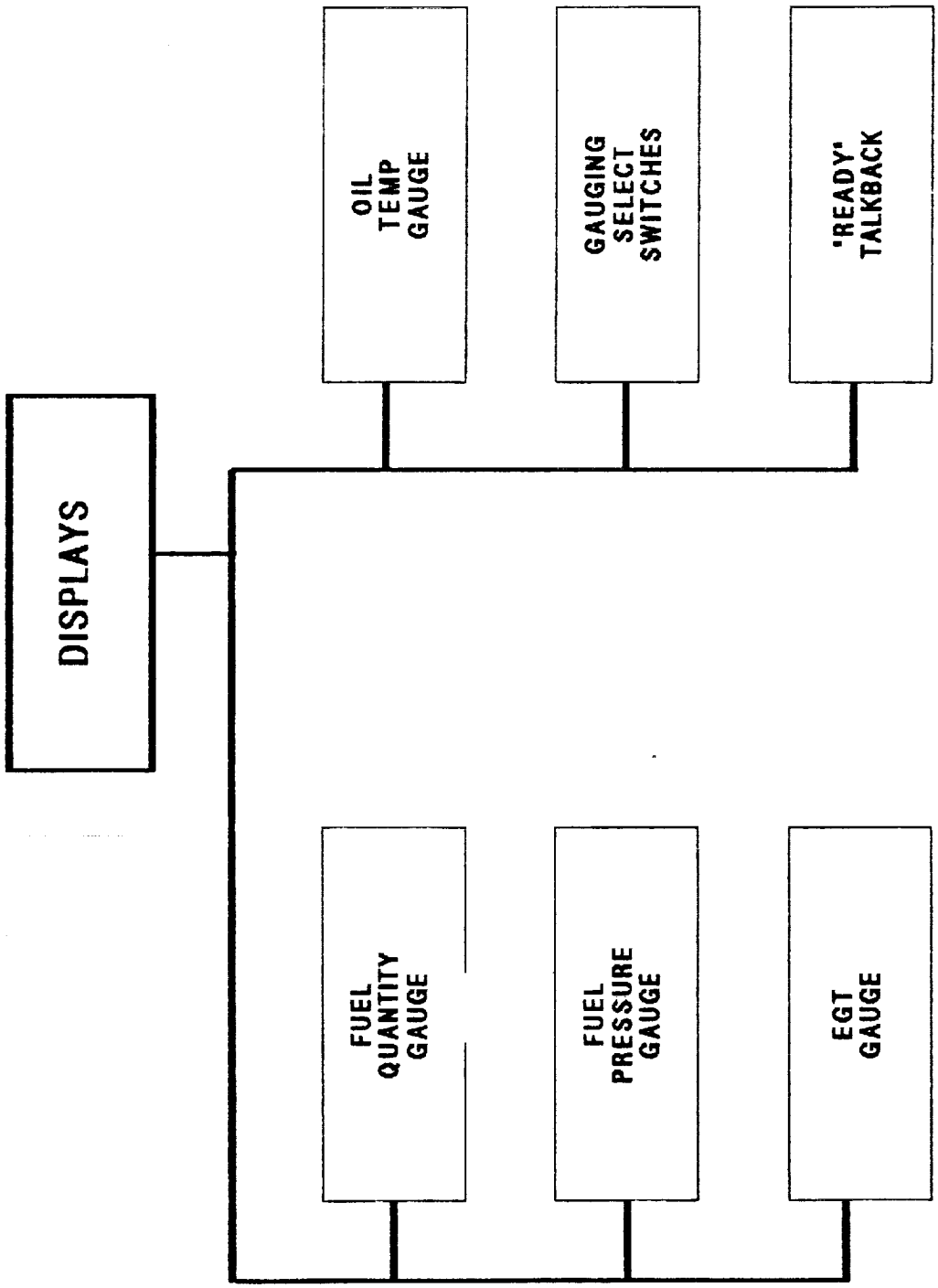

Figure 13 - DISPLAYS HIERARCHY

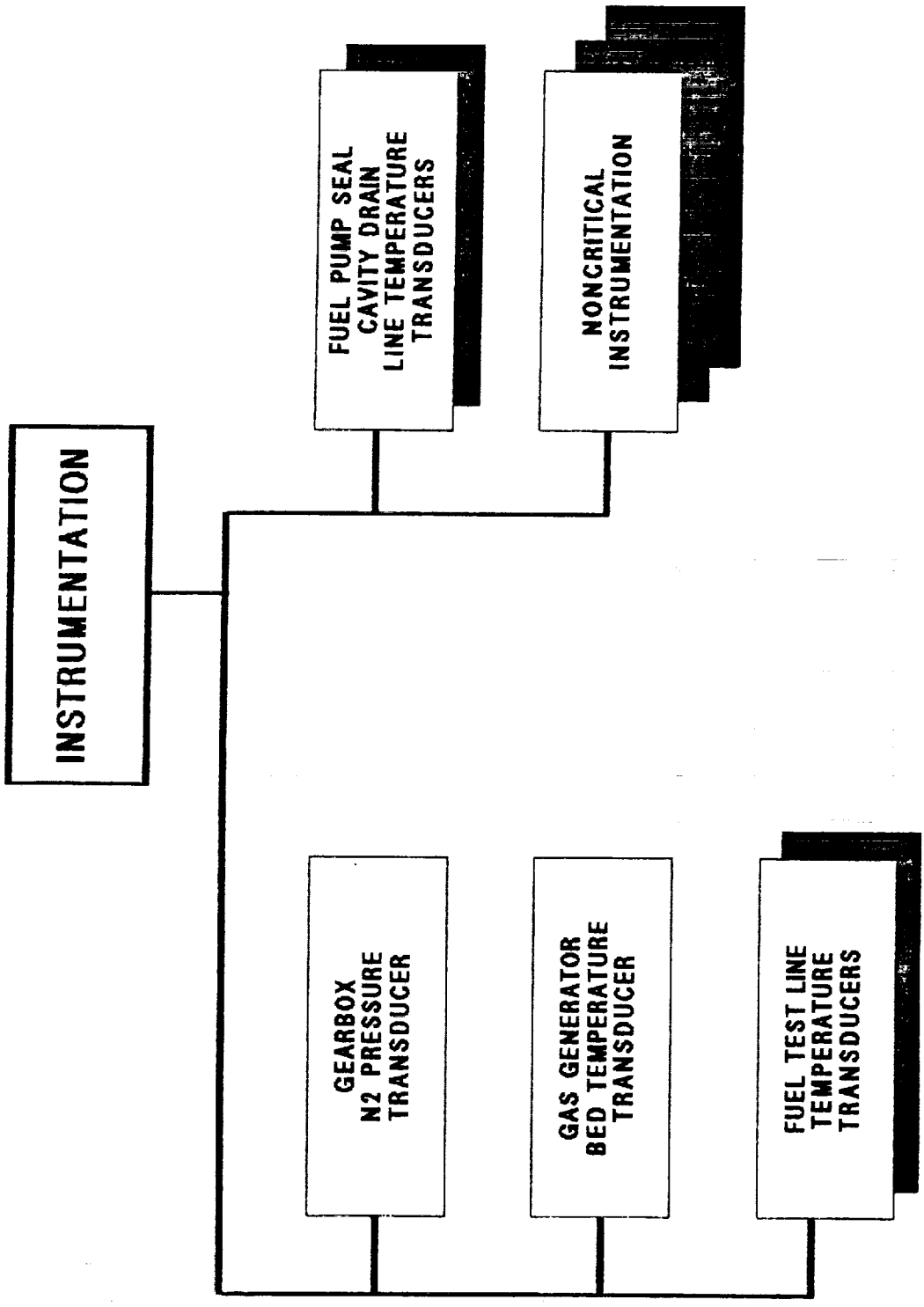

Figure 14 - INSTRUMENTATION HIERARCHY

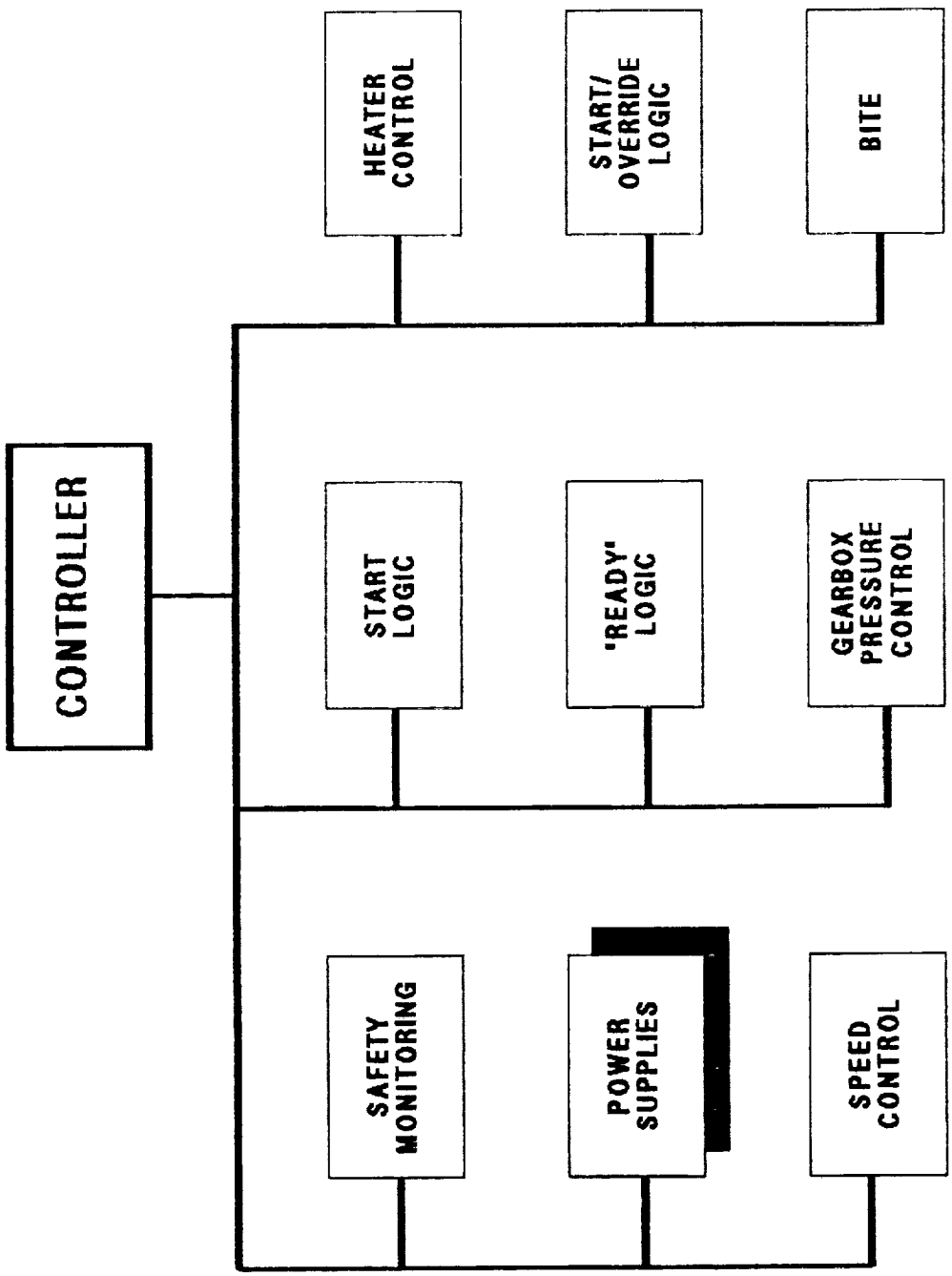

Figure 15 - CONTROLLER HIERARCHY

4.0 ANALYSIS RESULTS

Detailed analysis results for each of the identified failure modes are presented in Appendix C. Table I presents a summary of the failure criticalities. Further discussion of each of these subdivisions and the applicable failure modes is provided in subsequent paragraphs.

TABLE I Summary of IOA Failure Modes and Criticalities

Criticality:	1/1	2/1R	2/2	3/1R	3/2R	3/3	TOTAL
Power System	4	4	-	5	-	2	15
Fuel System	20	22	-	20	1	9	72
Lube Oil System	1	16	-	11	-	9	37
GG Injector Cooling	7	5	-	4	-	6	22
Fuel Pump/ GGVM Cooling	-	13	-	12	-	5	30
Structures	1	3	-	-	-	-	4
Electrical System	3	14	-	30	-	37	84
Displays	-	-	-	-	-	10	10
Instrumen-tation	-	-	-	4	-	1	5
Controller	1	7	-	7	-	7	22
TOTAL	37	84	-	93	1	86	301

Of the 301 failure modes analyzed, 37 were determined to result in loss of crew or vehicle, and 84 created a situation where one additional failure would result in loss of crew or vehicle. A summary of the potential critical items is presented in Table II. Appendix D presents a cross reference between each Potential Critical Item (PCI) and a specific worksheet in Appendix C.

TABLE II Summary of IOA Potential Critical Items

Criticality:	1/1	2/1R	2/2	3/1R	3/2R	TOTAL
Power System	4	4	-	-	-	8
Fuel System	20	22	-	3	1	46
Lube Oil System	1	16	-	3	-	20
GG Injector Cooling	7	5	-	-	-	12
Fuel Pump/ GGVM Cooling	-	13	-	-	-	13
Structures	1	3	-	-	-	4
Electrical System	3	14	-	17	-	34
Displays	-	-	-	-	-	-
Instrumen-tation	-	-	-	2	-	2
Controller	1	7	-	2	-	10
TOTAL	37	84	-	27	1	149

4.1 Analysis Results - Power System

The power system analysis identified 15 failure modes, of which 4 were determined to be of criticality 1/1, and 4 to be of criticality 2/1R. Eight PCIs were identified.

4.2 Analysis Results - Fuel System

The fuel system analysis id ntified 72 failure modes, of which 20 were determined to be of criticality 1/1. This high number of 1/1 failure modes is due mainly to the fact that all APU fuel leaks into the Orbiter aft compartment are considered to be criticality 1/1. Forty-six PCIs were identified.

4.3 Analysis Results - Lube Oil System

The lube oil system analysis identified 37 failure modes, of which the largest number were determined to be criticality 2/1R or 3/1R. Only one failure mode was determined to be criticality 1/1. Twenty PCIs were identified.

4.4 Analysis Results - Gas Generator Injector Cooling System

The gas generator injector cooling system analysis identified 22 failure modes, seven of which were determined to be of criticality 1/1. The high number of 1/1 failure modes stems from the lack of redundancy in this cooling system. Twelve PCIs were identified.

4.5 Analysis Results - Fuel Pump/GGVM Cooling System

The fuel pump/GGVM cooling system analysis identified 30 failure modes, none of which were identified to be of criticality 1/1. Thirteen were determined to be of criticality 2/1R. Thirteen PCIs were identified.

4.6 Analysis Results - Structure

The APU structure analysis identified four failure modes for the APU turbine and gearbox housings. Of these 4, 1 was determined to be criticality 1/1, and the rest 2/1R. Four PCIs were identified.

4.7 Analysis Results - Electrical System

The electrical system analysis identified 84 failure modes. The greatest number were determined to be criticality 3/3 or 3/1R, but three 1/1 failures were identified, and several 2/1R failures were also identified. Thirty-four PCIs were identified.

4.8 Analysis Results - Displays

Ten failure modes were identified for the APU displays. All were determined to be criticality 3/3. No PCIs were identified.

4.9 Analysis Results - Instrumentation

In the instrumentation system, four failure modes were determined to be criticality 3/1R. All other failure modes were determined to be 3/3, and were lumped together into one failure report. Two PCIs were identified.

4.10 Analysis Results - Controller

The APU controller functions were analyzed, and 22 failure modes were identified. One of these was determined to be criticality 1/1, and several were determined to be 2/1R and 3/1R. The 1/1 criticality failure mode is one that eliminates the hot restart capability for all three APUs. Ten PCIs were identified.

5.0 REFERENCES

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

1. JSC-11174, Space Shuttle Systems Handbook Rev. C, DCN-5 9/13/85

2. VS70-946099, Rockwell International Integrated System Schematic Orbiter OV099-APU Rev. A09, 5/10/85

3. JSC-18341, Mechanical Systems Console Handbook Vol. II - Systems Briefs Basic, Rev. A, PCN-3, 2/7/86

4. JSC-08171, Space Shuttle Operations and Maintenance Requirements and Specification Document V46 File III APU 4/15/86

5. JSC-20923, STS Operational Flight Rules Rationale Final, PCN-1, 2/14/86

6. JSC-12770, Shuttle Flight Operations Manual, Vol 9: Auxiliary Power Unit/Hydraulics Basic 3/16/81

7. APU/HYD TM 2101, APU/Hydraulics System Training Manual 11/85

8. V070-465XXX, Rockwell International APU Installation Drawings

9. NSTS-22206, National Space Transportation System Instructions for Preparation of Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL) 10/10/86

APPENDIX A
ACRONYMS

AOA	-	Abort Once Around
APU	-	Auxiliary Power Unit
ATO	-	Abort to Orbit
CIL	-	Critical Items List
CRT	-	Cathode Ray Tube
EGT	-	Exhaust Gas Temperature
F	-	Fahrenheit, Functional
FM	-	Failure Mode
FMEA	-	Failure Mode and Effects Analysis
GFE	-	Government Furnished Equipment
GG	-	Gas Generator
GGVM	-	Gas Generator Valve Module
GN2	-	Gaseous Nitrogen
HW	-	Hardware
IOA	-	Independent Orbiter Assessment
LCA	-	Load Control Assembly
MDAC	-	McDonnell Douglas Astronautics Company
MDM	-	Multiplexer/Demultiplexer
N2	-	Nitrogen
NASA	-	National Aeronautics and Space Administration
NH3	-	Ammonia
NSTS	-	National Space Transportation System
PCI	-	Potential Critical Item
psia	-	Pounds Per Square Inch, Absolute
RTLS	-	Return to Launch Site
STS	-	Space Transportation System
TAL	-	Transatlantic Abort Landing
WSB	-	Water Spray Boiler

APPENDIX B

DEFINITIONS, GROUND RULES, AND ASSUMPTIONS

APPENDIX B
DEFINITIONS, GROUND RULES, AND ASSUMPTIONS

B.1 Definitions

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

INTACT ABORT DEFINITIONS:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

OPS - software operational sequence

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

PHASE DEFINITIONS:

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

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

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

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

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

B.2 IOA Project Level Ground Rules and Assumptions

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

B.3 APU-Specific Ground Rules and Assumptions

The IOA analysis was performed to the component or assembly level of the APU subsystem. The analysis considered the worst case effects of the hardware or functional failure on the subsystem, mission, and crew and vehicle safety.

1. The APU Controller was analyzed only to the functional level.

   RATIONALE: This is in keeping with the NASA and Rockwell analyses, and is due to lack of adequate data, and resource and schedule constraints.

2. Couplings with caps were considered as one unit for analysis purposes.

   RATIONALE: This simplified the analysis, and took into account the worst case failure (external leak).

3. Switches were analyzed as failing totally open or totally closed, regardless of the number of switch contacts. For multiposition switches, the analysis considered the worst-case position for failed-on cases.

   RATIONALE: This simplified the analysis, and took into account the worst case failure (failure of all contacts is worse than failure of any one contact).

4. Fuel line temperature sensor failures were considered criticality 3/3, except in cases where fewer than 3 sensors were available to monitor the status of a particular fuel line heater.

   RATIONALE: This was to avoid classifying all fuel line temperature sensor failures as 3/1R or greater, based on loss of detection of a failed-on heater.

5. The APU Fuel Pump/GGVM Cooling System and Gas Generator Injector Cooling System failures were assigned criticalities based on the effects of the failure during a flight situation where these cooling systems were required to be used.

   RATIONALE: This approach considered the worst case effects of loss of a system - loss of that system under circumstances where use of the system is required.

APPENDIX C
DETAILED ANALYSIS

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

LEGEND FOR IOA ANALYSIS WORKSHEETS

Hardware Criticalities:

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

Functional Criticalities:

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

Redundancy Screen A:

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

Redundancy Screens B and C:

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

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/22/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 100 ABORT: 1/1

ITEM: GAS GENERATOR
FAILURE MODE: NO OUTPUT OR LOW OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) POWER SYSTEM
3) GAS GENERATOR
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION, BED LIFETIME EXCEEDED, CRACKED OR LEAKING HOUSING

EFFECTS/RATIONALE:
IF OUTPUT IS REDUCED SUFFICIENTY, APU WILL SUFFER UNDERSPEED SHUTDOWN. CRITICALITY IS 2/1R DUE TO LOSS OF ONE APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/22/86
SUBSYSTEM: APU
MDAC ID: 101

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 1/1
ABORT: 1/1

ITEM: GAS GENERATOR
FAILURE MODE: LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) POWER SYSTEM
3) GAS GENERATOR
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	1/1	RTLS:	1/1
LIFTOFF:	1/1	TAL:	1/1
ONORBIT:	3/3	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	1/1		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CORROSION, FATIGUE

EFFECTS/RATIONALE:
FUEL LEAK CAN CAUSE FIRE; DETONATION OF FUEL IN FUEL PUMP AND FUEL VALVES. POSSIBLE DAMAGE TO OTHER APU'S FROM SHRAPNEL. CRITICALITY IS 1/1 DUE TO FIRE AND EXPLOSION HAZARD.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 102 ABORT: 1/1

ITEM: TURBINE WHEEL
FAILURE MODE: STRUCTURAL FAILURE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) POWER SYSTEM
3) TURBINE WHEEL
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: OVERSPEED, MANUFACTURING DEFECT, HANDLING DAMAGE, CONTAMINATION DAMAGE AND FATIGUE

EFFECTS/RATIONALE:
LOSS OF APU, SHRAPNEL DAMAGE IN AFT COMPARTMENT-POTENTIAL LOSS OF ANOTHER APU, OR FUEL LEAK. CRITICALITY IS 1/1 DUE TO SHRAPNEL DAMAGE EFFECTS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/18/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 103 ABORT: 1/1

ITEM: TURBINE WHEEL
FAILURE MODE: BINDING

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) POWER SYSTEM
3) TURBINE WHEEL
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE, BEARING FAILURE

EFFECTS/RATIONALE:
TURBINE MAY SEIZE UP; APU MAY EXPERIENCE UNDERSPEED SHUTDOWN.
CRITICALITY IS 2/1R DUE TO LOSS OF APU.
ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE
LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/18/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 104 ABORT: 1/1

ITEM: EXHAUST DUCT
FAILURE MODE: LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) POWER SYSTEM
3) EXHAUST DUCT
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	1/1	RTLS:	1/1
LIFTOFF:	1/1	TAL:	1/1
ONORBIT:	1/1	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	1/1		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC271-0080-094X

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE, FATIGUE FAILURE, CORROSION

EFFECTS/RATIONALE:
RELEASES HOT (~1000F) GASES INTO AFT COMPARTMENT. THIS HOT GAS COULD CAUSE DAMAGE TO OTHER AFT COMPARTMENT EQUIPMENT, INCLUDING FIRE, AND LOSS OF MULTIPLE APU'S. CRITICALITY IS 1/1 DUE TO FIRE HAZARD AND EFFECT ON OTHER EQUIPMENT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 105 ABORT: 1/1

ITEM: EXHAUST DUCT BELLOWS
FAILURE MODE: LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) POWER SYSTEM
3) EXHAUST DUCT
4) BELLOWS
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	1/1	RTLS:	1/1
LIFTOFF:	1/1	TAL:	1/1
ONORBIT:	1/1	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	1/1		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC271-0080-094X

CAUSES: FATIGUE, MANUFACTURING DEFECT, CORROSION

EFFECTS/RATIONALE:
RELEASES HOT (~1000F) GASES INTO AFT COMPARTMENT. THIS HOT GAS COULD CAUSE DAMAGE TO OTHER AFT COMPARTMENT EQUIPMENT, INCLUDING FIRE AND LOSS OF MULTIPLE APU'S. CRITICALITY IS 1/1 DUE TO FIRE HAZARD AND EFFECT ON OTHER EQUIPMENT.

REFERENCES: NO DESIGN DATA WAS OBTAINED FOR THIS ITEM.

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/18/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 106 ABORT: 1/1

ITEM: GEARBOX
FAILURE MODE: LOSS OF OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) POWER SYSTEM
3) GEARBOX
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: STRIPPED GEARS, BROKEN SHAFTS, SEIZED BEARINGS, CRACKED AND DISTORTED HOUSING CAUSING RUBBING OR FATIGUE

EFFECTS/RATIONALE:
APU WILL BE LOST DUE TO LOSS OF FUEL PUMP OR LUBE OIL PUMP, OR HYDRAULIC SYSTEM WILL BE LOST DUE TO LOSS OF HYDRAULIC PUMP. CRITICALITY IS 2/1R FOR LOSS OF ONE APU AND/OR HYDRAULIC SYSTEM. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/22/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 107 ABORT: 3/1R

ITEM: GAS GENERATOR BED HEATER
FAILURE MODE: FAIL OFF

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) POWER SYSTEM
3) GAS GENERATOR BED HEATER
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: BROKEN WIRE

EFFECTS/RATIONALE:
LOSS OF REDUNDANCY FOR KEEPING GAS GENERATOR BED WARM WHILE APU IS INACTIVE. CRITICALITY IS 3/1R FOR DEORBIT BECAUSE LOSS OF BOTH HEATERS COULD CAUSE ONE APU TO BE LOST, AND LOSS OF ANOTHER APU WOULD BE A CRITICAL SITUATION.
ABORT: FAILURE HAS NO EFFECT WHILE APU IS RUNNING.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/22/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 108 ABORT: 3/3

ITEM: GAS GENERATOR BED HEATER
FAILURE MODE: GAS LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) POWER SYSTEM
3) GAS GENERATOR BED HEATER
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
CREATES VERY LIMITED LIFETIME FOR BOTH A AND B HEATER. CRITICALITY IS 3/3 BECAUSE SECOND HEATER IS NOT LOST UNTIL A CERTAIN LENGTH OF TIME AFTER IT IS ACTIVATED; IT IS USABLE FOR APU DEORBIT STARTUP.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/22/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 109 ABORT: 3/1R

ITEM: GAS GENERATOR BED HEATER
FAILURE MODE: SHORT CIRCUIT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) POWER SYSTEM
3) GAS GENERATOR BED HEATER
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE

EFFECTS/RATIONALE:
HEATER IS LOST WHEN HEATER POWER FUSE BLOWS. LOSS OF REDUNDANCY. CRITICALITY IS 3/1R FOR DEORBIT BECAUSE LOSS OF BOTH HEATERS COULD CAUSE ONE APU TO BE LOST, AND LOSS OF ANOTHER APU WOULD BE A CRITICAL SITUATION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	10/23/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	APU	FLIGHT:	3/1R
MDAC ID:	110	ABORT:	3/1R

ITEM: GAS GENERATOR BED HEATER THERMOSTAT
FAILURE MODE: FAIL OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) POWER SYSTEM
3) GAS GENERATOR BED HEATER
4) THERMOSTAT
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: ME360-0017-0001

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF BACKUP CONTROL OF GAS GENERATOR BED HEATERS. IF HEATERS ARE LOST FOR ORBIT STAY, APU WILL BE LOST. CRITICALITY IS 3/1R DUE TO HEATER CONTROL REDUNDANCY AND APU REDUNDANCY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/23/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 111 ABORT: 3/3

ITEM: GAS GENERATOR BED HEATER THERMOSTAT
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) POWER SYSTEM
3) GAS GENERATOR BED HEATER
4) THERMOSTAT
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME360-0017-0001

CAUSES: SHORT

EFFECTS/RATIONALE:
GAS GENERATOR BED HEATERS WILL BE STUCK ON WHILE ACTIVATED; AUTOMATIC CONTROL WILL BE LOST. HEATERS CAN BE DEACTIVED, HOWEVER.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/18/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 112 ABORT: 1/1

ITEM: MAGNETIC PICKUP UNIT 1
FAILURE MODE: NO OUTPUT, OR INTERMITTENT OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) POWER SYSTEM
3) MPU 1
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: OPEN CIRCUIT DUE TO MANF. DEFECT, HANDLING DAMAGE, OR MECHANICAL SHOCK. SHORT TO GROUND DUE TO CONTAMINATION OR MOISTURE

EFFECTS/RATIONALE:
GIVES FALSE INDICATION OF UNDERSPEED. WILL PRODUCE UNDERSPEED ALARM AND APU SHUTDOWN (IF AUTOMATIC SHUTDOWN IS ENABLED). APU CAN BE RESTARTED IF AUTOMATIC SHUTDOWN IS INHIBITED.
CRITICALITY IS 2/1R DUE TO LOSS OF APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/18/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 113 ABORT: 2/1R

ITEM: MAGNETIC PICKUP UNIT 2
FAILURE MODE: NO OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) POWER SYSTEM
3) MPU 2
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: OPEN CIRCUIT DUE TO MANF. DEFECT, HANDLING DAMAGE, OR MECHANICAL SHOCK. SHORT TO GROUND DUE TO CONTAMINATION OR MOISTURE.

EFFECTS/RATIONALE:
INDICATES SPEED <113% TO COMPARATOR 2; NO EFFECT WHILE APU IS IN NORMAL SPEED. IF APU IS TAKEN TO HIGH SPEED (113%) COMPARATOR 1 WILL CONTROL AT SECONDARY SPEED (115%).
CRITICALITY IS 3/1R BECAUSE SITUATION IS 2 FAILURES AWAY FROM CRITICAL (COMPARATOR 3+ ANOTHER APU). ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS BECAUSE SITUATION IS 1 FAILURE AWAY FROM CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/18/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 114 ABORT: 2/1R

ITEM: MAGNETIC PICKUP UNIT 3
FAILURE MODE: NO OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) POWER SYSTEM
3) MPU 3
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: OPEN CIRCUIT DUE TO MANF. DEFECT, HANDLING DAMAGE, OR MECHANICAL SHOCK. SHORT TO GROUND DUE TO CONTAMINATION OR MOISTURE.

EFFECTS/RATIONALE:
INDICATES SPEED <103% TO COMPARATOR 3. APU SHIFTS TO HIGH SPEED (113%) AS COMPARATOR 2 TAKES OVER. CRITICALITY IS 3/1R BECAUSE SITUATION IS 2 FAILURES AWAY FROM CRITICAL (COMPARATOR 2 + COMPARATOR 1 FAILURES CAN PRODUCE UNCONTROLLED OVERSPEED, STRUCTURAL FAILURE OF TURBINE, SHRAPNEL DAMAGE IN AFT COMMPARTMENT, FIRE HAZARD). ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS BECAUSE ONE MORE FAILURE (COMPARATOR 2) CAN CAUSE LOSS OF AN APU AND POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 8/18/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 115 ABORT: 1/1

ITEM: FUEL TANK
FAILURE MODE: RUPTURE AT OPERATING PRESSURE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL TANK
4) SHELL
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	1/1	RTLS:	1/1
LIFTOFF:	1/1	TAL:	1/1
ONORBIT:	1/1	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	1/1		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC282-0084-0100

CAUSES: MANUFACTURING DEFECT. HANDLING DAMAGE.

EFFECTS/RATIONALE:
1) LOSS OF FUEL-LOSS OF ONE APU, 2) SHRAPNEL DAMAGE IN AFT COMPARTMENT, 3) FUEL IN AFT COMPARTMENT - FIRE HAZARD, HARDWARE CRITICALITY IS 1 DUE TO SHRAPNEL AND FIRE HAZARD FUNCTIONAL CRITICALITY IS 1 DUE TO FIRE HAZARD. SCREEN C: RUPTURE OF APU 1 FUEL TANK CAN CAUSE SHRAPNEL DAMAGE TO APU 2 FUEL TANK AND VICEVERSA.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 8/18/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 116 ABORT: 1/1

ITEM: FUEL TANK
FAILURE MODE: EXTERNAL LEAK (FUEL)

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL TANK
4) SHELL
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC282-0084-0100

CAUSES: DEFECTIVE WELD MANUFACTURING DEFECT, HANDLING DAMAGE

EFFECTS/RATIONALE:
1) LOSS OF FUEL-LOSS OF ONE APU, 2) FUEL IN AFT COMPARTMENT-FIRE HAZARD. CRITICALITY IS 1/1 DUE TO FIRE HAZARD.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 8/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 117 ABORT: 1/1

ITEM: FUEL TANK
FAILURE MODE: EXTERNAL LEAK (GN2)

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL TANK
4) SHELL
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC282-0084-0100

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE

EFFECTS/RATIONALE:
1) LOSS OF FUEL PRESSURE, 2) LOSS OF APU. CRITICALITY IS 2/1R DUE TO LOSS OF ONE APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 8/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 118 ABORT: 1/1

ITEM: FUEL TANK
FAILURE MODE: INTERNAL LEAK THROUGH DIAPHRAGM

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL TANK
4) DIAPHRAGM
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC282-0084-0100

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE, INSTALLATION ERROR, FATIGUE FAILURE

EFFECTS/RATIONALE:
1) MIGRATION OF FUEL INTO GAS, AND VICEVERSA, 2) DECREASED FUEL TANK PRESSURE; POSSIBLE LOSS OF APU (IF PRESSURE DECREASE IS GREAT ENOUGH). CRITICALITY IS 2/1R DUE TO LOSS OF ONE APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS, DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 8/20/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 119 ABORT: 1/1

ITEM: FUEL TANK GN2 LINE
FAILURE MODE: LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL TANK GN2 LINE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: V070-465203

CAUSES: MANUFACTURING DEFECT, HANDLING, INSTALLATION ERROR

EFFECTS/RATIONALE:
1) LOSS OF FUEL PRESSURE, 2) LOSS OF APU. CRITICALITY IS 2/1R DUE TO LOSS OF ONE APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 8/20/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 120 ABORT: 1/1

ITEM: FUEL TANK GN2 FILL COUPLING
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL TANK GN2 LINE
4) GN2 FILL COUPLING
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: APU SERVICE PANEL
PART NUMBER: ME276-0030-0017

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE, CONTAMINATION

EFFECTS/RATIONALE:
1)LOSS OF FUEL PRESSURE, 2) LOSS OF APU. CRITICALITY IS 2/1R DUE TO LOSS OF ONE APU.
ABORT: CRITICALLY IS 1/1 FOR ENGINE-OUT ABORTS, DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/08/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 121 ABORT: 3/3

ITEM: FUEL TANK GN2 FILL COUPLING
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL TANK GN2 LINE
4) GN2 FILL COUPLING
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		

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

LOCATION: APU SERVICE PANEL
PART NUMBER: ME276-0030-0017

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
CANNOT SERVICE FUEL TANK; POSSIBLE LAUNCH DELAY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/06/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 122 ABORT: 3/1R

ITEM: FUEL TANK ISOLATION VALVE
FAILURE MODE: FAILS TO OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL TANK ISOLATION VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0558-000X

CAUSES: CONTAMINATION, CORROSION, OPEN OR SHORT COIL

EFFECTS/RATIONALE:
REDUNDANT VALVE ALLOWS FUEL TO REACH APU; NO EFFECT. CRITICALITY IS 3/1R DUE TO REDUNDANCY OF APU'S AND OF FUEL TANK ISOLATION VALVES. FAILURE CANNOT OCCUR AFTER APU START.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/06/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/2R
MDAC ID: 123 ABORT: 3/2R

ITEM: FUEL TANK ISOLATION VALVE
FAILURE MODE: FAILS TO CLOSE (STUCK OPEN); INTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL TANK ISOLATION VALVE
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:	3/3	AOA:	3/3
DEORBIT:	3/3	ATO:	3/2R
LANDING/SAFING:	3/2R		

REDUNDANCY SCREENS: A [3] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0558-000X

CAUSES: CONTAMINATION, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
SECONDARY FUEL VALVE PROVIDES REDUNDANT SHUTOFF OF FUEL; NO EFFECT. CRITICALITY IS 3/2R DUE TO REDUNDANCY OF APU'S AND OF FUEL SHUTOFF VALVES. IF FUEL COULD NOT BE SHUT OFF, TURBINE WOULD RUN AWAY AND COME APART.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 124 ABORT: 2/1R

ITEM: FUEL TANK ISOLATION VALVE
FAILURE MODE: FAILS TO REMAIN OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL TANK ISOLATION VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0558-000X

CAUSES: SHORT OR OPEN CIRCUIT IN COIL

EFFECTS/RATIONALE:
REDUNDANT VALVE ALLOWS FUEL TO REACH APU; NO EFFECT. CRITICALITY IS 3/1R DUE TO REDUNDANCY OF APU'S AND OF FUEL TANK ISOLATION VALVES.
ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/06/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 125 ABORT: 1/1

ITEM: FUEL TANK ISOLATION VALVE
FAILURE MODE: BARRIER LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL TANK ISOLATION VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0558-000X

CAUSES: MANUFACTURING DEFECT, FATIGUE FAILURE

EFFECTS/RATIONALE:
POSSIBLE SHORT CIRCUIT IN SOLENOID COIL OR RUPTURE OF VALVE DUE TO HYDRAZINE DECOMPOSITION: EXTERNAL FUEL LEAK. CRITICALITY IS 1/1 FOR FUEL LEAK DUE TO FIRE HAZARD.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/06/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 126 ABORT: 1/1

ITEM: FUEL TANK ISOLATION VALVE
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL TANK ISOLATION VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0558-000X

CAUSES: MANUFACTURING DEFECT, INSTALLATION ERROR

EFFECTS/RATIONALE:
FUEL IN AFT COMPARTMENT: FIRE HAZARD. CRITICALITY IS 1/1 DUE TO FIRE HAZARD.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/25/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 127 ABORT: 2/1R

ITEM: FUEL TANK ISOLATION VALVE
FAILURE MODE: FAILS TO RELIEVE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL TANK ISOLATION VALVE
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:	2/1R	AOA:	3/3
DEORBIT:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0558-000X

CAUSES: CONTAMINATION, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
NO EFFECT UNLESS REDUNDANT VALVE ALSO FAILS TO RELIEVE; IF SO, POSSIBLE LINE RUPTURE AND FUEL LEAK-FIRE HAZARD. CRITICALITY IS 2/1R DUE TO VALVE REDUNDANCY. FAILURE CANNOT OCCUR WHILE APU IS OPERATING.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/10/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 128 ABORT: 1/1

ITEM: FUEL PUMP
FAILURE MODE: INTERNAL LEAK PAST FACE SEAL

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL PUMP
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE, CONTAMINATION

EFFECTS/RATIONALE:
IF FACE SEAL IS WORN OR DAMAGED AND ALLOWS METAL-TO-METAL CONTACT IN ADDITION TO LEAK, HEAT SOURCE CAN CAUSE FUEL DETONATION; APU IS LOST AND FUEL IS RELEASED INTO AFT COMPARTMENT CAUSING FIRE HAZARD.
IF NO METAL-TO-METAL CONTACT IS INVOLVED, LEAK SHOULD BE HANDLED BY SEAL CAVITY DRAIN SYSTEM. IF CATCH BOTTLE FILLS AND RELIEVES OVERBOARD, HYDRAZINE MAY BE INGESTED INTO AFT COMPARTMENT THROUGH VENT DOORS. CRITICALITY IS 1/1 DUE TO FIRE HAZARD.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/10/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 129 ABORT: 1/1

ITEM: FUEL PUMP
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL PUMP
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	1/1	RTLS:	1/1
LIFTOFF:	1/1	TAL:	1/1
ONORBIT:	3/3	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	1/1		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT IN SEAL OR COUPLING

EFFECTS/RATIONALE:
1) LOSS OF FUEL - POSSIBLE LOSS OF ONE APU, 2) FUEL IN AFT COMPARTMENT-FIRE HAZARD. CRITICALITY IS 1/1 DUE TO FIRE HAZARD.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/10/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 130 ABORT: 1/1

ITEM: FUEL PUMP
FAILURE MODE: NO OUTPUT OR LOW OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL PUMP
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: LOSS OF INPUT POWER, INTERNAL LEAKAGE, JAMMING OR BINDING, CHECK VALVE OR RELIEF VALVE FAILS OPEN

EFFECTS/RATIONALE:
IF OUTPUT IS LOW ENOUGH, APU WILL SHUT DOWN. CRITICALITY IS 2/1R DUE TO LOSS OF ONE APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/11/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 131 ABORT: 2/1R

ITEM: FUEL PUMP BYPASS VALVE
FAILURE MODE: FAILS OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL PUMP
4) BYPASS VALVE
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
APU WILL NOT START IF FAILURE OCCURS WHILE APU IS SHUT DOWN. FAILURE IS NOT CREDIBLE WHILE APU IS RUNNING. CRITICALITY IS 2/1R DUE TO LOSS OF ONE APU. PRELAUNCH: WILL LEAD TO LAUNCH SCRUB.
ABORT: FAILURE IS NOT CREDIBLE WHILE APU IS RUNNING.

REFERENCES: NO DESIGN DATA WAS OBTAINED FOR THIS VALVE.

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/11/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 132 ABORT: 2/1R

ITEM: FUEL PUMP BYPASS VALVE
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL PUMP
4) BYPASS VALVE
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
IF APU IS RUNNING, FAILURE WILL HAVE NO EFFECT. IF APU IS SHUT DOWN, IT WILL NOT START. APU WILL BE LOST. CRITICALITY IS 2/1R DUE TO LOSS OF ONE APU.
PRELAUNCH: NO EFFECT UNTIL APU STARTUP; THEN, WILL CAUSE LAUNCH SCRUB. ABORT: NO EFFECT ON OPERATING APU. IF APU IS SHUT DOWN, IT CANNOT BE RESTARTED.

REFERENCES: NO DESIGN DATA WAS OBTAINED FOR THIS VALVE.

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/11/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 133 ABORT: 1/1

ITEM: FUEL PUMP RELIEF VALVE
FAILURE MODE: RELIEVES AT LOW PRESSURE/FAILS OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL PUMP
4) RELIEF VALVE
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION, CORROSION, MECHANICAL FAILURE

EFFECTS/RATIONALE:
COULD DIVERT FUEL PUMP OUTPUT FROM GAS GENERATOR LEADING TO DEGRADED APU PERFORMANCE OR APU SHUTDOWN. CRITICALITY IS 2/1R DUE TO LOSS OF APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 12/01/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 134 ABORT: 2/1R

ITEM: FUEL PUMP RELIEF VALVE
FAILURE MODE: FAILS TO RELIEVE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL PUMP
4) RELIEF VALVE
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
FLOW RESTRICTION DOWNSTREAM OF PUMP CAN CAUSE PRESSURE RISE - WITHOUT RELIEF, PRESSURE COULD FORCE FUEL INTO FUEL PUMP SEAL CAVITY AND POSSIBLY INTO THE GEARBOX. GEARBOX LUBRICATION COULD BE DEGRADED, LEADING TO OVERHEATING AND LOSS OF APU.
CRITICALITY IS 3/1R (ONE FAILURE AWAY FROM LOSS OF ONE APU).
ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/25/86
SUBSYSTEM: APU
MDAC ID: 135

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 1/1
ABORT: 1/1

ITEM: FUEL PUMP RELIEF VALVE
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL PUMP
4) RELIEF VALVE
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, INSTALLATION ERROR

EFFECTS/RATIONALE:
FUEL LEAK INTO AFT COMPARTMENT - FIRE HAZARD. CRITICALITYY IS 1/1 DUE TO FIRE HAZARD.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/01/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 136 ABORT: 1/1

ITEM: FUEL PUMP FILTER
FAILURE MODE: BLOCKAGE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL PUMP
4) FILTER
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
IF BLOCKAGE IS SEVERE, APU WILL BE STARVED OF FUEL AND WILL SHUT DOWN. CRITICALITY IS 2/1R DUE TO LOSS OF AN APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBILITY OF LOSING ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/25/86
SUBSYSTEM: APU
MDAC ID: 137

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/1R
ABORT: 2/1R

ITEM: FUEL PUMP FILTER
FAILURE MODE: FAILS OPEN-NO FILTERING

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL PUMP
4) FILTER
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: HANDLING DAMAGE, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
ANY CONTAMINATION PRESENT WOULD PASS INTO FUEL VALVES AND GAS GENERATOR; COULD CAUSE APU TO SHUT DOWN IF VALVE FAILED CLOSED OR GAS GENERATOR OBSTRUCTED. CRITICALITY IS 3/1R DUE TO POSSIBLE LOSS OF ONE APU IF CONTAMINATION IS PRESENT.
ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 138 ABORT: 1/1

ITEM: FUEL PUMP DRAIN COUPLING
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL PUMP
4) DRAIN COUPLING
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
1) LOSS OF FUEL-POSSIBLE LOSS OF ONE APU. 2) FUEL IN AFT COMPARTMENT-FIRE HAZARD. CRITICALITY IS 1/1 DUE TO FIRE HAZARD. PRELAUNCH: NO FUEL IS PRESENT IN PUMP UNTIL APU FUEL TANK VALVES ARE OPENED FOR STARTUP.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/06/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 139 ABORT: 2/1R

ITEM: PRIMARY FUEL VALVE
FAILURE MODE: FAILS TO CLOSE (STUCK OPEN); FAILS TO REMAIN CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) PRIMARY FUEL VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION, SHORTED OR OPEN SOLENOID COIL, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
APU RUNS AT HIGH SPEED (113%) ON SECONDARY FUEL VALVE (COMPARATOR 2). CRITICALITY IS 3/1R DUE TO REDUNDANCY OF CONTROL VALVES AND APU'S.
ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/06/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 140 ABORT: 1/1

ITEM: PRIMARY FUEL VALVE
FAILURE MODE: FAILS TO OPEN (STUCK CLOSED)

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) PRIMARY FUEL VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
APU WILL SHUT DOWN DUE TO FUEL STARVATION. CRITICALITY IS 2/1R DUE TO LOSS OF AN APU.
ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/06/86
SUBSYSTEM: APU
MDAC ID: 141

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/1R
ABORT: 2/1R

ITEM: PRIMARY FUEL VALVE
FAILURE MODE: INTERNAL LEAK TO OUTLET

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) PRIMARY FUEL VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, FATIGUE FAILURE OF SEAT, CONTAMINATION

EFFECTS/RATIONALE:
ALLOWS FUEL PAST PRIMARY VALVE TO SECONDARY FUEL VALVE AND GAS GENERATOR; AT WORST, SECONDARY VALVE WILL TAKE OVER AND CONTROL APU AT HIGH SPEED (113%). CRITICALITY IS 3/1R DUE TO REDUNDANCY IN CONTROL VALVES AND APU'S.
ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/06/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 142 ABORT: 1/1

ITEM: PRIMARY FUEL VALVE
FAILURE MODE: INTERNAL LEAK TO BYPASS

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) PRIMARY FUEL VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, FATIGUE FAILURE OF SEAT, CONTAMINATION

EFFECTS/RATIONALE:
DIVERTS FUEL FROM GAS GENERATOR BACK TO FUEL PUMP INLET; AT WORST, APU WILL SHUT DOWN DUE TO FUEL STARVATION. CRITICALITY IS 2/1R DUE TO LOSS OF APU.
ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/07/86
SUBSYSTEM: APU
MDAC ID: 143

HIGHEST CRITICALITY	HDW/FUNC
FLIGHT:	1/1
ABORT:	1/1

ITEM: PRIMARY FUEL VALVE
FAILURE MODE: INTERNAL BARRIER LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) PRIMARY FUEL VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	1/1	RTLS:	1/1
LIFTOFF:	1/1	TAL:	1/1
ONORBIT:	3/3	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	1/1		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
SHORT CIRCUIT IN THE COIL; LOSS OF VALVE FUNCTION. VALVE WILL BE FAILED OPEN. APU WILL RUN AT HIGH SPEED (113%) ON SECONDARY FUEL VALVE. FUEL PRESSURE WILL CAUSE FUEL LEAK TO AFT COMPARTMENT-FIRE HAZARD. POSSIBLE FUEL DETONATION.
CRITICALITY IS 1/1 DUE TO FIRE HAZARD.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/07/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 144 ABORT: 1/1

ITEM: PRIMARY FUEL VALVE
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) PRIMARY FUEL VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	1/1	RTLS:	1/1
LIFTOFF:	1/1	TAL:	1/1
ONORBIT:	3/3	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	1/1		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
FUEL IN AFT COMPARTMENT NEAR IGNITION SOURCE (HEAT) - FIRE HAZARD. CRITICALITY IS 1/1 DUE TO FIRE HAZARD.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/07/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 145 ABORT: 1/1

ITEM: SECONDARY FUEL VALVE
FAILURE MODE: FAILS TO OPEN; FAILS TO REMAIN OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) SECONDARY FUEL VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION, SHORTED OR OPEN SOLENOID COIL, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
APU SHUTS DOWN DUE TO FUEL STARVATION. CRITICALITY IS 2/1R DUE TO LOSS OF APU.
ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/07/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 146 ABORT: 2/1R

ITEM: SECONDARY FUEL VALVE
FAILURE MODE: FAILS OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) SECONDARY FUEL VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
NO EFFECT UNLESS APU IS TAKEN TO HIGH SPEED (113%); THEN, PRIMARY VALVE WILL TAKE OVER AT 115% (COMPARATOR 3). CRITICALITY IS 3/1R DUE TO CONTROL VALVE AND APU REDUNDANCY.
ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS WHERE ONE APU LOSS CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/07/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 147 ABORT: 1/1

ITEM: SECONDARY FUEL VALVE
FAILURE MODE: FAILS MID-POSITION

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) SECONDARY FUEL VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	1/1	RTLS:	1/1
LIFTOFF:	1/1	TAL:	1/1
ONORBIT:	3/3	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	1/1		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
FUEL FROM PRIMARY VALVE CAN REACH GAS GENERATOR THROUGH SECONDARY VALVE REGARDLESS OF PRIMARY VALVE POSITION; RESULT IS UNCONTROLLED APU OVERSPEED, AND APU AUTOMATIC SHUTDOWN AT 129% (IF AUTO SHUTDOWN IS ENABLED). TURBINE WILL GO BEYOND 129% USING FUEL REMAINING DOWNSTREAM OF TANK ISOLATION VALVES - MAY COME APART. CRITICALITY IS 1/1 DUE TO SHRAPNEL DAMAGE EFFECTS IN AFT COMPARTMENT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/07/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 148 ABORT: 2/1R

ITEM: SECONDARY FUEL VALVE
FAILURE MODE: INTERNAL LEAK TO OUTLET

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) SECONDARY FUEL VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION, MANUFACTURING DEFECT, FATIGUE FAILURE OF VALVE SEAT

EFFECTS/RATIONALE:
NO EFFECT UNLESS APU TAKEN TO HIGH SPEED (113%); THEN, IN WORST CASE, PRIMARY VALVE WILL TAKE OVER AT 115% (COMPARATOR 3). CRITICALITY IS 3/1R DUE TO CONTROL VALVE AND APU REDUNDANCY. ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS WHERE ONE APU LOSS CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/07/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 149 ABORT: 1/1

ITEM: SECONDARY FUEL VALVE
FAILURE MODE: INTERNAL LEAK TO BYPASS

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) SECONDARY FUEL VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION, MANUFACTURING DEFECT, FATIGUE FAILURE OF VALVE SEAT

EFFECTS/RATIONALE:
FUEL IS DIVERTED FROM GAS GENERATOR TO PUMP INLET. IN WORST CASE, APU MAY SHUT DOWN DUE TO UNDERSPEED. CRITICALITY IS 2/1R DUE TO LOSS OF APU.
ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/08/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 150 ABORT: 1/1

ITEM: SECONDARY FUEL VALVE
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) SECONDARY FUEL VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	1/1	RTLS:	1/1
LIFTOFF:	1/1	TAL:	1/1
ONORBIT:	3/3	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	1/1		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
FUEL IN AFT COMPARTMENT NEAR IGNITION SOURCE (HEAT) - FIRE HAZARD. CRITICALITY IS 1/1 DUE TO FIRE HAZARD.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/25/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 151 ABORT: 1/1

ITEM: FUEL LINE-UPSTREAM OF TANK ISOL VALVES
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL LINE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: V070-465XXX

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE

EFFECTS/RATIONALE:
1) LOSS OF FUEL-LOSS OF ONE APU. 2) FUEL IN AFT COMPARTMENT-FIRE HAZARD. CRITICALITY IS 1/1 DUE TO FIRE HAZARD.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	8/27/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	APU	FLIGHT:	1/1
MDAC ID:	152	ABORT:	1/1

ITEM: FUEL LINE-DOWNSTREAM OF TANK ISOL VALVES
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL LINE
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	1/1	RTLS:	1/1
LIFTOFF:	1/1	TAL:	1/1
ONORBIT:	3/3	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	1/1		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: V070-465XXX

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE

EFFECTS/RATIONALE:
1) LOSS OF FUEL-LOSS OF ONE APU. 2) FUEL IN AFT COMPARTMENT-FIRE HAZARD. CRITICALITY IS 1/1 DUE TO FIRE HAZARD.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/30/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 153 ABORT: 1/1

ITEM: FUEL TANK HYDRAZINE FILL COUPLING
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL LINES
4) FILL COUPLING
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: APU SERVICE PANEL
PART NUMBER: ME276-0030-0015

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE, CONTAMINATION

EFFECTS/RATIONALE:
FUEL LEAKS OUT, ESCAPES TO OUTSIDE AROUND APU SERVICE PANEL. SOME FUEL COULD BE INGESTED INTO AFT COMPARTMENT THROUGH VENT DOOR 8 DURING ENTRY (FIRE HAZARD). APU IS LOST DUE TO LOSS OF FUEL. CRITICALITY IS 1/1 FOR ENTRY, DUE TO FIRE HAZARD. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/08/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 154 ABORT: 3/3

ITEM: FUEL TANK HYDRAZINE FILL COUPLING
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL LINES
4) FILL COUPLING
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		

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

LOCATION: APU SERVICE PANEL
PART NUMBER: ME276-0030-0015

CAUSES: FILTER BLOCKAGE, CONTAMINATION

EFFECTS/RATIONALE:
CANNOT SERVICE FUEL TANK; POSSIBLE LAUNCH DELAY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/30/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 155 ABORT: 1/1

ITEM: FUEL LINE TEST POINT COUPLING
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL LINES
4) TEST POINT COUPLING
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: APU SERVICE PANEL
PART NUMBER: ME276-0032-0025

CAUSES: MANUFACTURING DEFECT, CONTAMINATION, HANDLING DAMAGE

EFFECTS/RATIONALE:
LOSS OF FUEL; IF APU OPERATING, FUEL COULD BE DEPLETED, APU WOULD BE LOST. NO LEAK IS POSSIBLE BEFORE FUEL TANK VALVES ARE OPENED FOR APU START, EXCEPT FOR RESIDUAL FUEL IN LINE. FUEL ESCAPES AROUND APU SERVICE PANEL, MAY BE INGESTED INTO AFT COMPARTMENT THROUGH VENT DOOR 8 DURING ENTRY (FIRE HAZARD). CRITICALITY IS 1/1 FOR ENTRY DUE TO FIRE HAZARD. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/08/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 156 ABORT: 3/3

ITEM: FUEL LINE TEST POINT COUPLING
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL LINES
4) TEST POINT COUPLING
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		

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

LOCATION: APU SERVICE PANEL
PART NUMBER: ME276-0032-0025

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
NO EFFECT ON STANDARD TURNAROUND ACTIVITIES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/08/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 157 ABORT: 1/1

ITEM: FUEL LINE FLEX HOSE
FAILURE MODE: LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL LINES
4) FLEX HOSE
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	1/1	RTLS:	1/1
LIFTOFF:	1/1	TAL:	1/1
ONORBIT:	3/3	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	1/1		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME271-0079-58XX

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE

EFFECTS/RATIONALE:
1) LOSS OF FUEL TO APU. 2) FUEL IN AFT COMPARTMENT-FIRE HAZARD. CRITICALITY IS 1/1 DUE TO FIRE HAZARD.

REFERENCES:

C-2

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/08/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 158 ABORT: 1/1

ITEM: FUEL LINE HIGH POINT BLEED COUPLING
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL LINES
4) HIGH POINT BLEED COUPLING
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	1/1	RTLS:	1/1
LIFTOFF:	1/1	TAL:	1/1
ONORBIT:	3/3	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	1/1		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME276-0032-0027

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE, INSTALLATION ERROR

EFFECTS/RATIONALE:
1) LOSS OF FUEL-LOSS OF ONE APU. 2) FUEL IN AFT COMPARTMENT-FIRE HAZARD. CRITICALITY IS 1/1 DUE TO FIRE HAZARD.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/08/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 159 ABORT: 3/3

ITEM: FUEL LINE HIGH POINT BLEED COUPLING
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL LINES
4) HIGH POINT BLEED COUPLING
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME276-0032-0027

CAUSES: CONTAMINATION, FILTER BLOCKAGE

EFFECTS/RATIONALE:
CANNOT PERFORM HYDRAZINE SERVICING-POSSIBLE LAUNCH DELAY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/22/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 160 ABORT: 3/1R

ITEM: FUEL TANK HEATER
(11A,11B,12A,12B,21A,21B,22A,22B,31A,31B,32A,32B)
FAILURE MODE: FAIL OFF, OR LOW OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL TANK HEATER
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:	3/1R	AOA:	3/3
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC363-0025-0001

CAUSES: BROKEN WIRE, THERMOSTAT FAIL OPEN, SHORT CIRCUIT, INSTALLATION ERROR

EFFECTS/RATIONALE:
LOSS OF REDUNDANCY FOR HEATING FUEL TANK. IF BOTH HEATERS ARE LOST, FUEL CAN FREEZE AND APU MAY BE LOST. CRITICALITY IS 3/1R FOR DEORBIT: 2 FAILURES AWAY FROM CRITICAL (1 MORE HEATER + 1 MORE APU).

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/23/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 161 ABORT: 3/1R

ITEM: FUEL TANK HEATER THERMOSTAT (S11A, S11B, S21A, S21B, S31A, S31B)
FAILURE MODE: FAIL OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL TANK HEATER
4) THERMOSTAT
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:	3/1R	AOA:	3/3
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: ME360-0017-0005

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF REDUNDANT FUEL TANK HEATERS. CRITICALITY IS 3/1R FOR DEORBIT: 2 FAILURES AWAY FROM CRITICAL (1 MORE HEATER + 1 MORE APU).

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	9/23/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	APU	FLIGHT:	3/3
MDAC ID:	162	ABORT:	3/3

ITEM: FUEL TANK HEATER THERMOSTAT (S11A, S11B, S21A, S21B, S31A, S31B)
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL TANK HEATER
4) THERMOSTAT
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		

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: ME360-0017-0005

CAUSES: SHORT, WELDED CONTACTS

EFFECTS/RATIONALE:
AFFECTED HEATER SET (A OR B) IS FAILED ON WHEN ACTIVE, BUT CAN BE SWITCHED OFF.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/23/86
SUBSYSTEM: APU
MDAC ID: 163

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/1R
ABORT: 3/1R

ITEM: FUEL LINE HEATER
FAILURE MODE: FAIL OFF, OR LOW OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL LINE HEATER
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:	3/1R	AOA:	3/3
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: BROKEN WIRE, THERMOSTAT FAILED OPEN, SHORT CIRCUIT, INSTALLATION ERROR

EFFECTS/RATIONALE:
LOSS OF REDUNDANCY FOR HEATING FUEL LINES. IF BOTH HEATERS LOST, FUEL CAN FREEZE AND APU MAY BE LOST. CRITICALITY IS 3/1R FOR DEORBIT: 2 FAILURES AWAY FROM CRITICAL (1 MORE HEAT + 1 MORE APU).

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/23/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 164 ABORT: 3/1R

ITEM: FUEL LINE HEATER THERMOSTAT
(S16A,S16B,S112A,S112B,S11A,S11B,S26A,S26B,S212A,S212B,S21A,S21B,
S36A,S36B,S312A,S312B,S31A,S31B)
FAILURE MODE: FAIL OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL LINE HEATER
4) THERMOSTAT
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:	3/1R	AOA:	3/3
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: ME360-0017-000X

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF REDUNDANT FUEL LINE HEATERS. CRITICALITY IS 3/1R FOR DEORBIT: 2 FAILURES AWAY FROM CRITICAL (1 MORE HEATER + 1 MORE APU).

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	9/23/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	APU	FLIGHT:	3/3
MDAC ID:	165	ABORT:	3/3

ITEM: FUEL LINE HEATER THERMOSTAT
(S16A,S16B,S112A,S112B,S11A,S11B,S26A,S26B,S212A,S212B,S21A,S21B,
S36A,S36B,S312A,S312B,S31A,S31B)
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL LINE HEATER
4) THERMOSTAT
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME360-0017-000X

CAUSES: SHORT, WELDED CONTACTS

EFFECTS/RATIONALE:
AFFECTED HEATER SET (A OR B) IS FAILED ON WHEN ACTIVE, BUT CAN BE SWITCHED OFF.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/24/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 166 ABORT: 3/1R

ITEM: FUEL LINE HEATER THERMOSTAT (REDUNDANT)
(S19A,S19B,S14A,S14B,S29A,S29B,S24A,S24B,S39A,S39B,S34A,S34B)
FAILURE MODE: FAIL OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL LINE HEATER
4) THERMOSTAT (REDUNDANT)
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:	3/1R	AOA:	3/3
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: ME360-0017-000X

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
NO EFFECT EXCEPT LOSS OF THERMOSTAT REDUNDANCY. CRITICALITY IS 3/1R FOR DEORBIT: IF ALL THERMOSTATS FAIL OPEN, FUEL LINES CAN FREEZE, POSSIBLY LEADING TO FREEZING AND FUEL LEAK.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/24/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 167 ABORT: 3/3

ITEM: FUEL LINE HEATER THERMOSTAT (REDUNDANT)
(S19A,S19B,S14A,S14B,S29A,S29B,S24A,S24B,S39A,S39B,S34A,S34B)
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL LINE HEATER
4) THERMOSTAT (REDUNDANT)
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME360-0017-000X

CAUSES: SHORT, WELDED CONTACTS

EFFECTS/RATIONALE:
AFFECTED HEATER SET (A OR B) IS FAILED ON WHEN ACTIVE, BUT CAN BE SWITCHED OFF.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/24/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 168 ABORT: 3/1R

ITEM: FUEL PUMP SEAL CAVITY DRAIN LINE HEATER
FAILURE MODE: FAIL OFF, OR LOW OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL PUMP SEAL CAVITY DRAIN LINE HEATER
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:	3/1R	AOA:	3/3
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC363-0026-0007

CAUSES: BROKEN WIRE, THERMOSTAT FAILED OPEN, SHORT CIRCUIT, INSTALLATION ERROR

EFFECTS/RATIONALE:
LOSS OF REDUNDANCY FOR HEATING SEAL CAVITY DRAIN LINE. IF FUEL HAS LEAKED INTO DRAIN LINE, AND BOTH HEATERS ARE LOST, FUEL CAN FREEZE AND BLOCK DRAIN. ANY REWARMING COULD RUPTURE LINE AND CAUSE FUEL LEAK.
CRITICALITY IS 3/1R FOR DEORBIT: 2 FAILURES AWAY FROM CRITICAL (1 MORE HEATER + 1 MORE APU).

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/24/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 169 ABORT: 3/1R

ITEM: FUEL PUMP SEAL CAVITY DRAIN LINE HEATER THERMOSTAT (S112A,S112B,S212A,S212B,S312A,S312B)
FAILURE MODE: FAIL OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL PUMP SEAL CAVITY DRAIN LINE HEATER
4) THERMOSTAT
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:	3/1R	AOA:	3/3
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: ME360-0017-0008

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF REDUNDANT HEATER FOR HEATING DRAIN LINE. IF BOTH HEATERS ARE LOST, FUEL CAN FREEZE AND APU MAY BE LOST. CRITICALITY IS 3/1R FOR DEORBIT: 2 FAILURES AWAY FROM CRITICAL (1 MORE HEATER + 1 MORE APU).

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 170 ABORT: 1/1

ITEM: FUEL PUMP SEAL CAVITY DRAIN LINE HEATER THERMOSTAT (S112A,S112B,S212A,S212B,S312A,S312B)
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL PUMP SEAL CAVITY DRAIN LINE HEATER
4) THERMOSTAT
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:	2/1R	AOA:	3/3
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	1/1		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME360-0017-0008

CAUSES: SHORT, WELDED CONTACTS

EFFECTS/RATIONALE:
HEATER STUCK ON; IF FUEL IS PRESENT IN LINE, IT WILL OVERHEAT AND DETONATE BEFORE FDA ALARM. FUEL LEAK - FIRE HAZARD. CRITICALITY IS 1/1 DUE TO FIRE HAZARD.

REFERENCES: ROCKWELL INTERNATIONAL RECOMMENDED CIL CHANGE 6-13-86 (CIL 1219.2). ROCKWELL INTERNATIONAL PRESENTATION "APU DRAIN LINE HEATER SAFETY CONCERN", PRESENTED BY J.L. SCHAEFER, JUNE 1986.

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/24/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 171 ABORT: 3/1R

ITEM: FUEL PUMP/VALVE HEATER
FAILURE MODE: FAIL OFF, OR LOW OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL PUMP HEATER
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:	3/1R	AOA:	3/3
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: BROKEN WIRE, THERMOSTAT FAILED OPEN, SHORT CIRCUIT, INSTALLATION ERROR

EFFECTS/RATIONALE:
LOSS OF REDUNDANCY FOR HEATING FUEL PUMP AND FUEL VALVES. IF BOTH HEATERS ARE LOST, FUEL CAN FREEZE AND APU MAY BE LOST. CRITICALITY IS 3/1R FOR DEORBIT: 2 FAILURES AWAY FROM CRITICAL (1 MORE HEATER + 1 MORE APU).

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/24/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 172 ABORT: 3/1R

ITEM: FUEL PUMP/VALVE HEATER THERMOSTAT
(S17A,S17B,S27A,S27B,S37A,S37B)
FAILURE MODE: FAIL OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL PUMP/VALVE HEATER
4) THERMOSTAT
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: ME360-0017-0001

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF REDUNDANT HEATERS FOR FUEL PUMP AND FUEL VALVES.
CRITICALITY IS 3/1R FOR DEORBIT: 2 FAILURES AWAY FROM CRITICAL (1 MORE HEATER + 1 MORE APU).

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/24/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 173 ABORT: 3/3

ITEM: FUEL PUMP/VALVE HEATER THERMOSTAT
(S17A,S17B,S27A,S27B,S37A,S37B)
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL PUMP/VALVE HEATER
4) THERMOSTAT
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME360-0017-0001

CAUSES: SHORT, WELDED CONTACTS

EFFECTS/RATIONALE:
AFFECTED HEATER SET (A OR B) IS FAILED ON WHEN ACTIVE, BUT CAN BE SWITCHED OFF.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/08/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 174 ABORT: 1/1

ITEM: FUEL IN-LINE FILTER
FAILURE MODE: BLOCKAGE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL IN-LINE FILTER
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC286-0051-0001

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF APU IF BLOCKAGE IS SEVERE ENOUGH. CRITICALITY IS 2/1R DUE TO LOSS OF ONE APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/09/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 175 ABORT: 1/1

ITEM: FUEL IN-LINE FILTER
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL IN-LINE FILTER
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	1/1	RTLS:	1/1
LIFTOFF:	1/1	TAL:	1/1
ONORBIT:	3/3	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	1/1		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC286-0051-0001

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE

EFFECTS/RATIONALE:
1) LOSS OF FUEL-LOSS OF ONE APU. 2) FUEL IN AFT COMPARTMENT-FIRE HAZARD. CRITICALITY IS 1/1 DUE TO FIRE HAZARD.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/25/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 176 ABORT: 2/1R

ITEM: FUEL IN-LINE FILTER
FAILURE MODE: FAILS OPEN-NO FILTERING

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL IN-LINE FILTER
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC286-0051-0001

CAUSES: MANUFACTURING ERROR, FATIGUE FAILURE

EFFECTS/RATIONALE:
POSSIBLE INGESTION OF CONTAMINANTS INTO FUEL ISOLATION VALVES AND FUEL PUMP. THIS CONTAMINATION COULD CAUSE LOSS OF APU. CRITICALITY IS 3/1R DUE TO LOSS OF APU IF CONTAMINATION IS PRESENT. ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/25/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 177 ABORT: 2/1R

ITEM: SEAL CAVITY DRAIN LINE
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) SEAL CAVITY DRAIN LINE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: V070-465XXX

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE

EFFECTS/RATIONALE:
ONE FAILURE AWAY FROM FUEL IN AFT COMPARTMENT (FUEL PUMP SEAL LEAK). FUEL IN AFT COMPARTMENT IS FIRE HAZARD. CRITICALITY IS 2/1R.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/25/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 178 ABORT: 2/1R

ITEM: SEAL CAVITY DRAIN FLEX HOSE
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) SEAL CAVITY DRAIN LINE
4) FLEX HOSE
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME271-0079-560X

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE, FATIGUE WEAR

EFFECTS/RATIONALE:
ONE FAILURE AWAY FROM FUEL IN AFT COMPARTMENT (FUEL PUMP SEAL LEAK). FUEL IN AFT COMPARTMENT: FIRE HAZARD. CRITICALITY IS 2/1R.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/04/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 179 ABORT: 2/1R

ITEM: SEAL CAVITY DRAIN LINE
FAILURE MODE: BLOCKAGE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) SEAL CAVITY DRAIN LINE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: V070-465XXX

CAUSES: WAX FORMED BY MIXING OF LUBE OIL AND HYDRAZINE

EFFECTS/RATIONALE:
IN CASE OF A GROSS FUEL LEAK INTO THE SEAL CAVITY, SEAL CAVITY COULD BE OVERPRESSURIZED AND HYDRAZINE COULD BE FORCED INTO THE GEARBOX. THIS COULD LEAD TO GEARBOX DAMAGE DUE TO INADEQUATE LUBRICATION. CRITICALITY IS 3/1R (1 FAILURE AWAY FROM APU LOSS). ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/30/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 180 ABORT: 2/1R

ITEM: SEAL CAVITY DRAIN RELIEF VALVE
FAILURE MODE: LOW CRACKING PRESSURE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) SEAL CAVITY DRAIN RELIEF VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0544-0002

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LEAKING FUEL WILL RELIEVE OVERBOARD AT LOWER PRESSURE; SOME FUEL COULD BE INGESTED INTO AFT COMPARTMENT THROUGH VENT DOORS DURING ENTRY (FIRE HAZARD). CRITICALITY IS 2/1R FOR ENTRY DUE TO FIRE HAZARD (1 FAILURE AWAY).

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/30/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 181 ABORT: 2/1R

ITEM: SEAL CAVITY DRAIN RELIEF VALVE
FAILURE MODE: FAILS TO RESEAT (FAILS OPEN), LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) SEAL CAVITY DRAIN RELIEF VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0544-0002

CAUSES: CONTAMINATION, VIBRATION, MECHANICAL SHOCK, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
LOSS OF SEAL CAVITY LEAK DETECTION, IF VALVE FAILS OPEN BEFORE LEAK STARTS. SOME FUEL COULD BE INGESTED INTO AFT COMPARTMENT THROUGH VENT DOORS DURING ENTRY (FIRE HAZARD). CRITICALITY IS 2/1R FOR ENTRY DUE TO FIRE HAZARD (1 FAILURE AWAY).

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/25/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 182 ABORT: 2/1R

ITEM: SEAL CAVITY DRAIN RELIEF VALVE
FAILURE MODE: FAILS CLOSED; FAILS TO RELIEVE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) SEAL CAVITY DRAIN RELIEF VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0544-0002

CAUSES: CONTAMINATION, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
IN CASE OF A GROSS FUEL LEAK INTO THE SEAL CAVITY, HYDRAZINE COULD BE FORCED INTO THE LUBE OIL SYSTEM; RESULT COULD BE LOSS OF APU. CRITICALITY IS 3/1R: TWO FAILURES AWAY FROM CRITICAL (FUEL LEAK + ANOTHER APU).
ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/25/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 183 ABORT: 2/1R

ITEM: SEAL CAVITY DRAIN RELIEF VALVE
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) SEAL CAVITY DRAIN LINE RELIEF VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [F] C [F]

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0544-0002

CAUSES: MANUFACTURING DEFECT, INSTALLATION ERROR

EFFECTS/RATIONALE:
IF FUEL LEAKS INTO SEAL CAVITY, RESULT WILL BE FUEL IN AFT COMPARTMENT (FIRE HAZARD). CRITICALITY IS 2/1R: 1 FAILURE AWAY FROM CRITICAL SITUATION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/25/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 184 ABORT: 2/1R

ITEM: SEAL CAVITY DRAIN CATCH BOTTLE
FAILURE MODE: LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) SEAL CAVITY DRAIN CATCH BOTTLE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [F] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: V070-465232

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE

EFFECTS/RATIONALE:
A FUEL PUMP FACE SEAL LEAK WILL RESULT IN FUEL IN THE AFT COMPARTMENT, IF THE CATCH BOTTLE LEAKS. THIS CREATES A FIRE HAZARD. CRITICALITY IS 2/1R: 1 FAILURE AWAY FROM CRITICAL (FUEL PUMP FACE SEAL LEAK).

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 185 ABORT: 3/1R

ITEM: SEAL CAVITY DRAIN CATCH BOTTLE DRAIN VALVE
FAILURE MODE: LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) SEAL CAVITY DRAIN CATCH BOTTLE
4) DRAIN VALVE
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0543-0002

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE, CONTAMINATION

EFFECTS/RATIONALE:
IF FUEL PRESENT IN CATCH BOTTLE, FUEL WILL LEAK PAST VALVE BUT WILL BE STOPPED BY CAP ON DRAIN LINE. CRITICALITY IS 3/1R DUE TO CAP ON LINE. WITHOUT CAP, IT WOULD ALLOW FUEL TO LEAK INTO AFT COMPARTMENT-FIRE HAZARD.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 186 ABORT: 3/3

ITEM: SEAL CAVITY DRAIN CATCH BOTTLE DRAIN VALVE
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) SEAL CAVITY DRAIN CATCH BOTTLE
4) DRAIN VALVE
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0543-0002

CAUSES: CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
CAN'T DO SEAL CAVITY DRAIN SERVICING; POSSIBLE LAUNCH DELAY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/15/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 187 ABORT: 1/1

ITEM: LUBE OIL PUMP
FAILURE MODE: NO OUTPUT OR LOW OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL PUMP
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: LOSS OF INPUT POWER, INTERNAL LEAKAGE, JAMMING OR BINDING, INSUFFICIENT LUBE OIL IN GEARBOX (SERVICING ERROR)

EFFECTS/RATIONALE:
LOSS OF LUBRICATION TO APU GEARBOX; GEARBOX WILL OVERHEAT AND WILL BE DAMAGED; APU WILL BE LOST. CRITICALITY IS 2/1R DUE TO LOSS OF APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 188 ABORT: 2/1R

ITEM: GEARBOX GN2 BOTTLE
FAILURE MODE: LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) GEARBOX GN2 BOTTLE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE

EFFECTS/RATIONALE:
LOSS OF GN2 TO REPRESSURIZE GEARBOX. IF GEARBOX LOSES GN2, APU WILL BE LOST. CRITICALITY IS 3/1R: 2 FAILURES AWAY FROM CRITICALITY 1. ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE IF ONE APU IS LOST.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 189 ABORT: 1/1

ITEM: GEARBOX GN2 BOTTLE
FAILURE MODE: RUPTURE AT OPERATING PRESSURE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) GEARBOX GN2
4)
5)
6)
7)
8)
9)

CRITICALITIES			
FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	1/1	RTLS:	1/1
LIFTOFF:	1/1	TAL:	1/1
ONORBIT:	3/3	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	1/1		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: HANDLING DAMAGE

EFFECTS/RATIONALE:
1) LOSS OF GN2 TO PRESSURIZE GEARBOX. 2) POSSIBLE SHRAPNEL DAMAGE TO APU'S AND OTHER AFT COMPARTMENT EQUIPMENT. POSSIBLE FUEL LEAK AND FIRE HAZARD. CRITICALITY IS 1/1 DUE TO SHRAPNEL DAMAGE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/17/86
SUBSYSTEM: APU
MDAC ID: 190

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/1R
ABORT: 2/1R

ITEM: GEARBOX GN2 BOTTLE FILL COUPLING
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) GN2 BOTTLE
4) FILL COUPLING
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: ME276-0032-0003

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE, CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF GN2 TO REPRESSURIZE GEARBOX. IF GEARBOX LOSES GN2, APU WILL BE LOST. CRITICALITY IS 3/1R: 2 FAILURES AWAY FROM CRITICALITY 1. ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE IF ONE APU IS LOST.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 191 ABORT: 3/3

ITEM: GEARBOX GN2 BOTTLE FILL COUPLING
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) GN2 BOTTLE
4) FILL COUPLING
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME276-0032-0003

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
CANNOT SERVICE GN2 BOTTLE-POSSIBLE LAUNCH DELAY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 192 ABORT: 2/1R

ITEM: GEARBOX PRESSURIZATION VALVE
FAILURE MODE: FAILS TO OPEN, FAILS TO REMAIN OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) GEARBOX PRESSURIZATION VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: LOSS OF INPUT SIGNAL, CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
LOSS OF GN2 TO REPRESSURIZE GEARBOX. IF GEARBOX LOSES GN2, APU WILL BE LOST. CRITICALITY IS 3/1R BECAUSE SITUATION IS 2 FAILURES AWAY FROM CRIT 1 (GEARBOX LEAK & APU LOSS)
ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE IF ONE APU IS LOST.

REFERENCES: NO DESIGN DATA WAS OBTAINED FOR THIS VALVE.

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 193 ABORT: 2/1R

ITEM: GEARBOX PRESSURIZATION VALVE
FAILURE MODE: FAILS TO CLOSE (REMAINS OPEN)

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) GEARBOX PRESSURIZATION VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
IF VALVE OPENS, IT WILL STAY OPEN AND OVERPRESSURIZE GEARBOX. IF GEARBOX LEAKS OUT ALL GN2, APU WILL BE LOST. CRITICALITY IS 3/1R: 2 FAILURES AWAY FROM CRITICALITY 1 (GEARBOX LEAK AND ANOTHER APU LOST).
ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE IF ONE APU IS LOST.

REFERENCES: NO DESIGN DATA WAS OBTAINED FOR THIS VALVE.

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 194 ABORT: 2/1R

ITEM: GEARBOX PRESSURIZATION VALVE
FAILURE MODE: INTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) GEARBOX PRESSURIZATION VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION, MANUFACTURING DEFECT, HANDLING DAMAGE

EFFECTS/RATIONALE:
GN2 BOTTLE LEAKS INTO GEARBOX; A SUBSEQUENT GEARBOX LEAK, IF IT DEPLETES THE GEARBOX, WILL CAUSE LOSS OF AN APU. CRITICALITY IS 3/1R BECAUSE SITUATION IS 2 FAILURES AWAY FROM CRIT 1 (GEARBOX LEAK AND APU LOSS).
ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE IF ONE APU IS LOST.

REFERENCES: NO DESIGN DATA WAS OBTAINED FOR THIS VALVE.

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/25/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 195 ABORT: 1/1

ITEM: GEARBOX PRESSURIZATION VALVE
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) GEARBOX PRESSURIZATION VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE, INSTALLATION ERROR

EFFECTS/RATIONALE:
POSSIBLE LOSS OF GN2 FROM GEARBOX; IF LEAK DEPLETES GN2 BOTTLE, APU WILL BE LOST. CRITICALITY IS 2/1R DUE TO LOSS OF ONE APU.
ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE FOR APU LOSS.

REFERENCES: NO DESIGN DATA WAS OBTAINED FOR THIS VALVE.

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/25/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 196 ABORT: 3/3

ITEM: GEARBOX PRESSURIZATION VALVE
FAILURE MODE: BARRIER LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) GEARBOX PRESSURIZATION VALVE
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		

REDUNDANCY SCREENS: A [4] B [F] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
NO EFFECT; VALVE COMPONENTS ARE COMPATIBLE WITH GN2.

REFERENCES: NO DESIGN DATA WAS OBTAINED FOR THIS VALVE.

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/15/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 197 ABORT: 1/1

ITEM: LUBE OIL LINES
FAILURE MODE: LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL LINES
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: V070-465XXX

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE, INSTALLATION ERROR

EFFECTS/RATIONALE:
1) LOSS OF LUBE OIL. 2) LOSS OF APU DUE TO GEARBOX FAILURE. CRITICALITY IS 2/1R DUE TO LOSS OF ONE APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUTS ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/15/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 198 ABORT: 1/1

ITEM: LUBE OIL LINE FLEX HOSES
FAILURE MODE: LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL LINES
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: ME271-0079-410X

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE, HEATER BURN-THROUGH

EFFECTS/RATIONALE:
1) LOSS OF LUBE OIL. 2) LOSS OF APU DUE TO GEARBOX FAILURE. CRITICALITY IS 2/1R DUE TO LOSS OF ONE APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/15/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 199 ABORT: 1/1

ITEM: GEARBOX FILL COUPLING
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL LINES
4) GEARBOX FILL COUPLING
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC621-0038-0500

CAUSES: INSTALLATION ERROR, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
1) LOSS OF LUBE OIL. 2) LOSS OF APU DUE TO GEARBOX FAILURE. CRITICALITY IS 2/1R DUE TO LOSS OF APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/16/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 200 ABORT: 3/3

ITEM: GEARBOX FILL COUPLING
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL LINES
4) GEARBOX FILL COUPLING
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC621-0038-0500

CAUSES: CONTAMINATION, CORROSION, FILTER BLOCKED

EFFECTS/RATIONALE:
CANNOT SERVICE GEARBOX-POSSIBLE LAUNCH DELAY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/16/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 201 ABORT: 1/1

ITEM: GEARBOX HIGH POINT VENT COUPLING
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL LINES
4) GEARBOX HIGH POINT VENT COUPLING
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC621-0038-0500

CAUSES: INSTALLATION ERROR, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
1) LOSS OF LUBE OIL. 2) LOSS OF APU DUE TO GEARBOX FAILURE. CRITICALITY IS 2/1R DUE TO LOSS OF APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/16/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 202 ABORT: 3/3

ITEM: GEARBOX HIGH POINT VENT COUPLING
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL LINES
4) GEARBOX HIGH POINT VENT COUPLING
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC621-0038-0500

CAUSES: CONTAMINATION, CORROSION, FILTER BLOCKED

EFFECTS/RATIONALE:
CANNOT PURGE GEARBOX-POSSIBLE LAUNCH DELAY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/30/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 203 ABORT: 1/1

ITEM: GEARBOX CHIP DETECTOR
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) CHIP DETECTOR
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: TBD

CAUSES: MANUFACTURING DEFECT, INSTALLATION ERROR

EFFECTS/RATIONALE:
1) LOSS OF LUBE OIL. 2) LOSS OF APU DUE TO GEARBOX FAILURE. CRITICALITY IS 2/1R DUE TO LOSS OF APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 204 ABORT: 1/1

ITEM: GEARBOX LOW POINT DRAIN COUPLING
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL LINES
4) GEARBOX LOW POINT DRAIN COUPLING
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC621-0038-0500

CAUSES: CONTAMINATION, MANUFACTURING DEFECT, HANDLING DAMAGE

EFFECTS/RATIONALE:
1) LOSS OF LUBE OIL. 2) LOSS OF APU DUE TO GEARBOX FAILURE. CRITICALITY IS 2/1R DUE TO LOSS OF APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 205 ABORT: 3/3

ITEM: GEARBOX LOW POINT DRAIN COUPLING
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL LINES
4) GEARBOX LOW POINT DRAIN COUPLING
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC621-0038-0500

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
CANNOT PERFORM LUBE OIL SERVICING; POSSIBLE LAUNCH DELAY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 206 ABORT: 1/1

ITEM: GEARBOX HIGH POINT DRAIN COUPLING
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL LINES
4) GEARBOX HIGH POINT DRAIN COUPLING
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC621-0038-0300

CAUSES: CONTAMINATION, MANUFACTURING DEFECT, HANDLING DAMAGE

EFFECTS/RATIONALE:
1) LOSS OF LUBE OIL. 2) LOSS OF APU DUE TO GEARBOX FAILURE. CRITICALITY IS 2/1R DUE TO LOSS OF APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 207 ABORT: 3/3

ITEM: GEARBOX HIGH POINT DRAIN COUPLING
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL LINES
4) GEARBOX HIGH POINT DRAIN COUPLING
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC621-0038-0300

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
CANNOT PERFORM LUBE OIL SERVICING; POSSIBLE LAUNCH DELAY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 208 ABORT: 1/1

ITEM: WSB DRAIN COUPLING
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL LINES
4) WSB DRAIN COUPLING
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER:

CAUSES: CONTAMINATION, MANUFACTURING DEFECT, HANDLING DAMAGE

EFFECTS/RATIONALE:
1) LOSS OF LUBE OIL. 2) LOSS OF APU DUE TO GEARBOX FAILURE. CRITICALITY IS 2/1R DUE TO LOSS OF APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	9/26/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	APU	FLIGHT:	3/3
MDAC ID:	209	ABORT:	3/3

ITEM: WSB DRAIN COUPLING
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL LINES
4) WSB DRAIN COUPLING
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER:

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
CANNOT PERFORM LUBE OIL SERVICING; POSSIBLE LAUNCH DELAY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/04/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 210 ABORT: 3/1R

ITEM: LUBE OIL LINE HEATER (18A, 18B, 19A, 19B)
FAILURE MODE: FAIL OFF, OR LOW OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL LINE HEATER
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:	3/1R	AOA:	3/3
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC363-0027-000X

CAUSES: BROKEN WIRE, SHORT CIRCUIT, INSTALLATION ERROR

EFFECTS/RATIONALE:
LOSS OF LUBE OIL LINE HEATER REDUNDANCY. IF BOTH SETS OF HEATERS ARE LOST, LUBE OIL CAN DROP BELOW 0 F; APU CANNOT BE STARTED SAFELY FOR ENTRY. CRITICALITY IS 3/1R, DUE TO HEATER AND APU REDUNDANCY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/04/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 211 ABORT: 3/1R

ITEM: LUBE OIL LINE HEATER THERMOSTAT (S18A,S18B)
FAILURE MODE: FAIL OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL LINE HEATER
4) THERMOSTAT
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:	3/1R	AOA:	3/3
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: ME360-0017-0007

CAUSES: CONTAMINATION, PIECE-PORT STRUCTURAL FAILURE

EFFECTS/RATIONALE:
LOSS OF REDUNDANCY FOR HEATING APU LUBE OIL LINES. IF ALL HEATERS ARE LOST, LUBE OIL CAN DROP BELOW 0 F; APU CANNOT BE STARTED SAFELY FOR ENTRY. CRITICALITY IS 3/1R, DUE TO HEATER AND APU REDUNDANCY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/04/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 212 ABORT: 3/3

ITEM: LUBE OIL LINE HEATER THERMOSTAT
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL LINE HEATER
4) THERMOSTAT
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		

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: ME360-0017-0007

CAUSES: CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
ONE SET OF LUBE OIL HEATERS IS FAILED ON WHILE ACTIVE, BUT CAN BE SWITCHED OFF.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 213 ABORT: 2/1R

ITEM: LUBE OIL FILTER
FAILURE MODE: PLUGGED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL FILTER
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION, FUEL OR NH3 LEAK INTO LUBE OIL

EFFECTS/RATIONALE:
LUBE OIL WILL BYPASS FILTER - LUBE OIL FLOW RATE WILL BE REDUCED; AND GEARBOX WILL HEAT-UP FASTER, BUT APU WILL NOT BE AFFECTED UNLESS CONTAMINATION PRESENT IN LUBE OIL DAMAGES GEARBOX (APU COULD BE LOST).
CRITICALITY IS 3/1R:2 FAILURES AWAY FROM CRITICAL (CONTAMINATION + ANOTHER APU). ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS SINCE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 214 ABORT: 2/1R

ITEM: LUBE OIL FILTER
FAILURE MODE: FAILS OPEN/NO FILTERING

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL FILTER
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [F] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
NO EFFECT UNLESS CONTAMINATION IN LUBE OIL DAMAGES GEARBOX (APU COULD BE LOST). CRITICALITY IS 3/1R: 2 FAILURES AWAY FROM CRITICAL (CONTAMINATION + ANOTHER APU). ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS SINCE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/29/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 215 ABORT: 1/1

ITEM: LUBE OIL FILTER
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL FILTER
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: HANDLING DAMAGE, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
1) LOSS OF LUBE OIL. 2) LOSS OF APU DUE TO GEARBOX FAILURE. CRITICALITY IS 2/1R DUE TO LOSS OF APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/29/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 216 ABORT: 2/1R

ITEM: OIL FILTER BYPASS RELIEF VALVE
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) OIL FILTER BYPASS RELIEF VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
NO EFFECT, UNLESS FILTER IS PLUGGED. IF SO, LOSS OF LUBE OIL CIRCULATION. APU WILL BE LOST. CRITICALITY IS 3/1R: 2 FAILURES AWAY FROM CRITICAL (PLUGGED FILTER + ANOTHER APU LOST)
ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS, SINCE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES: NO DESIGN DATA WAS OBTAINED FOR THIS VALVE.

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/29/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 217 ABORT: 2/1R

ITEM: OIL FILTER BYPASS RELIEF VALVE
FAILURE MODE: FAILS TO CLOSE (STUCK OPEN), OR FAILS OPEN, OR LEAKS

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) OIL FILTER BYPASS RELIEF VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
ALLOWS ANY CONTAMINATION PRESENT IN LUBE OIL TO ENTER GEARBOX. APU CAN BE LOST IF GEARBOX IS DAMAGED. CRITICALITY IS 3/1R: 2 FAILURES AWAY FROM CRITICAL (CONTAMINATION + ANOTHER APU LOST). ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS, SINCE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES: NO DESIGN DATA WAS OBTAINED FOR THIS VALVE.

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/30/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 218 ABORT: 3/3

ITEM: GEARBOX BYPASS RELIEF VALVE
FAILURE MODE: FAILS CLOSED (FAILS TO RELIEVE)

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) GEARBOX BYPASS RELIEF VALVE
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
NO EFFECT, EXCEPT POSSIBLE INCREASE IN LUBE OIL PRESSURE.

REFERENCES: NO DESIGN DATA WAS OBTAINED FOR THIS VALVE.

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/30/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 219 ABORT: 1/1

ITEM: GEARBOX BYPASS RELIEF VALVE
FAILURE MODE: FAILS OPEN, OR FAILS TO CLOSE, OR LEAKS

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) GEARBOX BYPASS RELIEF VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
ALLOWS LUBE OIL TO BYPASS GEARBOX; GEARBOX CAN OVERHEAT DUE TO INSUFFICIENT LUBRICATION - MAY HAVE TO SHUT DOWN APU.
CRITICALITY IS 2/1R DUE TO LOSS OF APU.
ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES: NO DESIGN DATA WAS OBTAINED FOR THIS VALVE.

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/29/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 220 ABORT: 1/1

ITEM: LUBE OIL ACCUMULATOR (ADD-ON)
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) ACCUMULATOR
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
1) LOSS OF LUBE OIL. 2) LOSS OF APU DUE TO GEARBOK FAILURE.
CRITICALITY IS 2/1R DUE TO LOSS OF APU.
ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/29/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 221 ABORT: 1/1

ITEM: LUBE OIL ACCUMULATOR (ADD-ON)
FAILURE MODE: INTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) ACCUMULATOR
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
1) LOSS OF LUBE OIL SYSTEM PRESSURE, AND REDUCED LUBE OIL FLOW RATE. 2) POSSIBLE LOSS OF APU DUE TO OVERHEATED GEARBOX. CRITICALITY IS 2/1R DUE TO LOSS OF APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/30/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 222 ABORT: 1/1

ITEM: LUBE OIL ACCUMULATOR (INTEGRAL)
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) ACCUMULATOR
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
1) LOSS OF LUBE OIL. 2) LOSS OF APU DUE TO GEARBOX FAILURE.
CRITICALITY IS 2/1R DUE TO LOSS OF APU.
ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/30/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 223 ABORT: 1/1

ITEM: LUBE OIL ACCUMULATOR (INTEGRAL)
FAILURE MODE: INTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) ACCUMULATOR
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
1) LOSS OF LUBE OIL PRESSURE, AND REDUCED LUBE OIL FLOW RATE. 2) POSSIBLE LOSS OF APU DUE TO OVERHEATED GEARBOX. CRITICALITY IS 2/1R DUE TO LOSS OF APU.
ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 224 ABORT: 1/1

ITEM: INJECTOR COOLING VALVE
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) VALVE
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:	1/1	ATO:	1/1
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-20552-000X

CAUSES: MANUFACTURING DEFECT, INSTALLATION ERROR

EFFECTS/RATIONALE:
LOSS OF INJECTOR COOLING WATER. CRITICALITY IS 1/1 FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT MAY CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 225 ABORT: 1/1

ITEM: INJECTOR COOLING VALVE
FAILURE MODE: INTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) VALVE
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:	1/1	ATO:	1/1
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0552-000X

CAUSES: CONTAMINATION, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
DEPLETION OF INJECTOR COOLING WATER. CRITICALITY IS 1/1 FOR EMERGENCY DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT MAY CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 226 ABORT: 2/1R

ITEM: INJECTOR COOLING VALVE
FAILURE MODE: FAIL TO OPEN, FAIL TO REMAIN OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) VALVE
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0552-000X

CAUSES: CONTAMINATION, CORROSION, BROKEN WIRE, SHORTED COIL

EFFECTS/RATIONALE:
LOSS OF INJECTOR COOLING FOR ONE APU. CRITICALITY 2/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT COULD CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 227 ABORT: 3/3

ITEM: INJECTOR COOLING VALVE
FAILURE MODE: FAIL TO CLOSE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) VALVE
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0552-000X

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
DEPLETION OF INJECTOR COOLING WATER; NO MORE IS LIKELY TO BE NEEDED IN THIS CASE, SO LOSS OF WATER IS INCONSEQUENTIAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 228 ABORT: 2/1R

ITEM: INJECTOR COOLING VALVE
FAILURE MODE: BARRIER FAILURE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) VALVE
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0552-000X

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
SHORTING OF COIL; LOSS OF VALVE OPEN CAPABILITY. LOSS OF INJECTOR COOLING TO ONE APU. CRITICALITY IS 2/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT COULD CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 229 ABORT: 1/1

ITEM: INJECTOR COOLING WATER TANK
FAILURE MODE: EXTERNAL LEAK (WATER OR N2)

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) WATER TANK
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:	1/1	ATO:	1/1
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME282-0100-0001

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
•LOSS OF INJECTOR COOLING CAPABILITY FOR HOT RESTART OF APU. CRITICALITY IS 1/1 FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT COULD CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 230 ABORT: 3/3

ITEM: INJECTOR COOLING WATER TANK
FAILURE MODE: DIAPHRAGM LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) WATER TANK
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME282-0100-0001

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE

EFFECTS/RATIONALE:
MORE RAPID DEPLETION OF WATER PRESSURE DURING USE, BUT COOLING SHOULD BE SUFFICIENT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 231 ABORT: 1/1

ITEM: INJECTOR COOLING GN2 FILL COUPLING
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) GN2 FILL COUPLING
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:	1/1	ATO:	1/1
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME276-0032-0009

CAUSES: MANUFACTURING DEFECT, INSTALLATION ERROR, HANDLING DAMAGE

EFFECTS/RATIONALE:
LOSS OF TANK PRESSURE: LOSS OF INJECTOR COOLING CAPABILITY FOR HOT RESTART OF APU. CRITICALITY IS 1/1 FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT COULD CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 232 ABORT: 3/3

ITEM: INJECTOR COOLING GN2 FILL COUPLING
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) GN2 FILL COUPLING
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME276-0032-0009

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
CANNOT SERVICE INJECTOR COOLING SYSTEM; POSSIBLE LAUNCH DELAY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 233 ABORT: 1/1

ITEM: INJECTOR COOLING WATER LINES (MANIFOLD)
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) WATER LINES (MANIFOLD)
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:	1/1	ATO:	1/1
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: V070-465521

CAUSES: INSTALLATION ERROR, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
LOSS OF INJECTOR COOLING WATER AND/OR FREEZE-UP OF LINE: LOSS OF COOLING FOR APU HOT RESTART. CRITICALITY 1/1 FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT MAY CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 234 ABORT: 1/1

ITEM: INJECTOR COOLING WATER LINES (MANIFOLD)
FAILURE MODE: BLOCKAGE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) WATER LINES (MANIFOLD)
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:	1/1	ATO:	1/1
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: V070-465521

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF INJECTOR COOLING CAPABILITY FOR ONE APU, OR ALL 3 APU'S. CRITICALITY IS 1/1 FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT COULD CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	11/03/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	APU	FLIGHT:	1/1
MDAC ID:	235	ABORT:	1/1

ITEM: INJECTOR COOLING WATER FILL COUPLING
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) WATER LINES (MANIFOLD)
4) FILL COUPLING
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:	1/1	ATO:	1/1
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC621-0038-0100

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE, CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF INJECTOR COOLING WATER; LOSS OF COOLING FOR APU HOT RESTART. CRITICALITY IS 1/1 FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT COULD CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 236 ABORT: 3/3

ITEM: INJECTOR COOLING WATER FILL COUPLING
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) WATER LINES (MANIFOLD)
4) FILL COUPLING
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC621-0038-0100

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
CANNOT SERVICE INJECTOR COOLING SYSTEM; POSSIBLE LAUNCH DELAY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 237 ABORT: 2/1R

ITEM: INJECTOR COOLING WATER LINE-APU X
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) WATER LINE-APU X
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: V070-465521

CAUSES: INSTALLATION ERROR, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
LOSS OF INJECTOR COOLING AND/OR FREEZE-UP OF LINE; LOSS OF COOLING FOR HOT RESTART OF ONE APU. CRITICALITY IS 2/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT COULD CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 238 ABORT: 2/1R

ITEM: INJECTOR COOLING WATER LINE-APU X
FAILURE MODE: BLOCKAGE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) WATER LINE-APU X
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: V070-465521

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF INJECTOR COOLING CAPABILITY FOR ONE APU. CRITICALITY IS 2/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT COULD CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 239 ABORT: 2/1R

ITEM: INJECTOR COOLING WATER LINE FLEX HOSE
FAILURE MODE: LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) WATER LINE - APU X
4) FLEX HOSE
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME271-0079-6401

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE, INSTALLATION ERROR, FATIGUE

EFFECTS/RATIONALE:
LOSS OF INJECTOR COOLING, FOR ONE APU. CRITICALITY IS 2/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT COULD CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 240 ABORT: 3/1R

ITEM: INJECTOR COOLING WATER TANK HEATER
FAILURE MODE: FAIL-OFF, OR LOW OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) WATER TANK HEATER
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC363-0025-0002

CAUSES: BROKEN WIRE, THERMOSTAT FAIL OPEN, SHORT CIRCUIT, INSTALLATION ERROR

EFFECTS/RATIONALE:
LOSS OF REDUNDANCY FOR HEATING INJECTOR COOLING WATER TANK. IF BOTH HEATERS ARE LOST, WATER WILL FREEZE, AND INJECTOR COOLING WILL BE LOST. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT COULD CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 241 ABORT: 3/1R

ITEM: INJECTOR COOLING WATER TANK HEATER THERMOSTAT
FAILURE MODE: FAIL OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) WATER TANK HEATER
4) THERMOSTAT
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC452-0147-XXXX

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF REDUNDANT HEATER FOR INJECTOR COOLING WATER TANK. IF BOTH HEATERS ARE LOST, WATER CAN FREEZE AND INJECTOR COOLING WILL BE LOST. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
SUBSYSTEM: APU
MDAC ID: 242

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: INJECTOR COOLING WATER TANK HEATER THERMOSTAT
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) WATER TANK HEATER
4) THERMOSTAT
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC452-0147-XXXX

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
AFFECTED HEATER SET (A OR B) IS FAILED ON WHEN ACTIVE, BUT CAN BE SWITCHED OFF.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 243 ABORT: 3/1R

ITEM: INJECTOR COOLING WATER LINE HEATER
FAILURE MODE: FAILS OFF, OR LOW OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) WATER LINE HEATER
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC363-0026-XXXX

CAUSES: BROKEN WIRE, THERMOSTAT FAIL OPEN, SHORT CIRCUIT, INSTALLATION ERROR

EFFECTS/RATIONALE:
LOSS OF REDUNDANCY FOR HEATING INJECTOR COOLING WATER LINES. IF BOTH HEATERS ARE LOST, WATER LINES WILL FREEZE, AND INJECTOR COOLING WILL BE LOST. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT COULD CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 244 ABORT: 3/1R

ITEM: INJECTOR COOLING WATER LINE HEATER THERMOSTAT
FAILURE MODE: FAIL OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) WATER LINE HEATER
4) THERMOSTAT
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC452-0147-XXXX

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF REDUNDANT HEATER FOR INJECTOR COOLING WATER LINES. IF BOTH HEATERS ARE LOST, LINES CAN FREEZE AND INJECTOR COOLING WILL BE LOST. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT COULD CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 245 ABORT: 3/3

ITEM: INJECTOR COOLING WATER LINE HEATER THERMOSTAT
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INJECTOR COOLING SYSTEM
3) WATER LINE HEATER
4) THERMOSTAT
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC452-0147-XXXX

CAUSES: SHORT, WELDED CONTACTS

EFFECTS/RATIONALE:
AFFECTED HEATER SET (A OR B) IS FAILED ON WHEN ACTIVE, BUT CAN BE SWITCHED OFF.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 246 ABORT: 2/1R

ITEM: FUEL PUMP/GGVM COOLING RELIEF VALVE
FAILURE MODE: FAIL CLOSED; RELIEVE OVER SPEC

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) RELIEF VALVE
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC284-0431-0001

CAUSES: CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
THERMAL EXPANSION IN WATER LINE BETWEEN TANK VALVES COULD RUPTURE WATER LINE OR START A LEAK. RESULT COULD BE LOSS OF REDUNDANCY FOR FUEL PUMP/GGVM COOLING. CRITICALITY IS 2/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	11/03/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	APU	FLIGHT:	3/3
MDAC ID:	247	ABORT:	3/3

ITEM: FUEL PUMP/GGVM COOLING RELIEF VALVE
FAILURE MODE: FAILS TO CLOSE (STUCK OPEN); INTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) RELIEF VALVE
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC284-0431-0001

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
NO EFFECT; PULSING VALVE DOWNSTREAM CLOSES OFF WATER FLOW.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 248 ABORT: 2/1R

ITEM: FUEL PUMP/GGVM COOLING RELIEF VALVE
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) RELIEF VALVE
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC284-0431-0001

CAUSES: MANUFACTURING DEFECT, INSTALLATION ERROR

EFFECTS/RATIONALE:
LOSS OF COOLING WATER; LOSS OF REDUNDANCY FOR FUEL PUMP/GGVM COOLING. CRITICALITY IS 2/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 249 ABORT: 2/1R

ITEM: FUEL PUMP/GGVM COOLING GN2 LINE
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) GN2 LINE
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER:

CAUSES: MANUFACTURING DEFECT, INSTALLATION ERROR, FATIGUE

EFFECTS/RATIONALE:
LOSS OF PRESSURE FROM REDUNDANT COOLING SYSTEM. OTHER SYSTEM IS UNAFFECTED. IF BOTH SYSTEMS WERE LOST, NO APU POST-RUN COOLDOWN. APU COULD DETONATE IF STARTED WHILE HOT FOR EMERGENCY DEORBIT. CRITICALITY IS 2/1R FOR DEORBIT BEFORE APU COOLDOWN.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 250 ABORT: 3/1R

ITEM: FUEL PUMP/GGVM COOLING VALVE
FAILURE MODE: FAIL TO OPEN; FAIL TO REMAIN OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) FUEL PUMP/GGVM COOLING VALVE
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0052-000X

CAUSES: CORROSION, CONTAMINATION, SHORTED OR OPEN COIL

EFFECTS/RATIONALE:
LOSS OF REDUNDANT FUEL PUMP/GGVM COOLING FOR ONE APU.
CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 251 ABORT: 2/1R

ITEM: FUEL PUMP/GGVM COOLING VALVE
FAILURE MODE: FAIL OPEN (FAIL TO CLOSE), INTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) FUEL PUMP/GGVM COOLING VALVE
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0552-000X

CAUSES: CONTAMINATION, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
NO EFFECT UNTIL SYSTEM IS ACTIVATED; THEN, DEPLETION OF ONE SYSTEM'S WATER UNTIL THAT SYSTEM IS DEACTIVATED. CRITICALITY IS 2/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 252 ABORT: 3/1R

ITEM: FUEL PUMP/GGVM COOLING VALVE
FAILURE MODE: INTERNAL BARRIER FAILURE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) FUEL PUMP/GGVM COOLING VALVE
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0552-000X

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
SHORT CIRCUIT OF SOLENOID COIL-VALVE WILL BE FAILED CLOSED. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. VALVE FAILED CLOSED MEANS NO COOLING FOR AFFECTED APU. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 253 ABORT: 3/1R

ITEM: FUEL PUMP/GGVM COOLING VALVE
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) FUEL PUMP/GGVM COOLING VALVE
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0552-000X

CAUSES: MANUFACTURING DEFECT, INSTALLATION ERROR

EFFECTS/RATIONALE:
NO EFFECT UNTIL SYSTEM IS ACTIVATED; THEN, DEPLETION OF ONE SYSTEM'S WATER, AND NO COOLING TO ONE APU (UNTIL SWITCHOVER TO REDUNDANT SYSTEM). CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 254 ABORT: 2/1R

ITEM: FUEL PUMP/GGVM COOLING WATER TANK
FAILURE MODE: EXTERNAL LEAK (WATER OR N2)

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER TANK
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC282-0094-0001

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE

EFFECTS/RATIONALE:
LOSS OF REDUNDANCY FOR POST-RUN APU COOLDOWN. CRITICALITY IS 2/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	11/03/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	APU	FLIGHT:	2/1R
MDAC ID:	255	ABORT:	2/1R

ITEM: FUEL PUMP/GGVM COOLING WATER TANK
FAILURE MODE: DIAPHRAGM LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER TANK
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC282-0094-0001

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE, INSTALLATION ERROR

EFFECTS/RATIONALE:
NO EFFECT UNTIL SYSTEM ACTIVATED; THEN, MAY SEE FASTER DEPLETION OF SYSTEM PRESSURE AS N2 IS EXPELLED. WORST CASE IS LOSS OF REDUNDANT SYSTEM. CRITICALITY IS 2/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 256 ABORT: 2/1R

ITEM: FUEL PUMP/GGVM COOLING WATER LINES-BETWEEN TANK AND TANK VALVES
FAILURE MODE: LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER LINES
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: V070-465521

CAUSES: MANUFACTURING DEFECT, INSTALLATION ERROR

EFFECTS/RATIONALE:
LOSS OF COOLING WATER FROM ONE SYSTEM. CRITICALITY IS 2/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 257 ABORT: 2/1R

ITEM: FUEL PUMP/GGVM COOLING WATER LINES-BETWEEN TANK AND TANK VALVES
FAILURE MODE: BLOCKAGE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER LINES
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: V070-465521

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF REDNUNDANCY FOR POST-RUN APU COOLDOWN. CRITICALITY IS 2/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 258 ABORT: 2/1R

ITEM: FUEL PUMP/GGVM COOLING WATER FILL COUPLING
FAILURE MODE: LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER LINES
4) FILL COUPLING
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC621-0038-0100

CAUSES: MANUFACTURING DEFECT, INSTALLATION ERROR, CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF COOLING WATER FOR ONE SYSTEM. CRITICALITY IS 2/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 259 ABORT: 3/3

ITEM: FUEL PUMP/GGVM COOLING WATER FILL COUPLING
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER LINES
4) FILL COUPLING
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC621-0038-0100

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
CANNOT SERVICE ONE FUEL PUMP/GGVM COOLING SYSTEM. POSSIBLE LAUNCH DELAY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 260 ABORT: 2/1R

ITEM: FUEL PUMP/GGVM COOLING WATER LINES-BETWEEN TANK VALVE AND APU
FAILURE MODE: LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER LINES
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: V070-465521

CAUSES: MANUFACTURING DEFECT, INSTALLATION ERROR

EFFECTS/RATIONALE:
NO EFFECT UNTIL SYSTEM IS ACTIVATED; THEN, LOSS OF COOLING WATER FOR ONE SYSTEM. CRITICALITY IS 2/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	11/03/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	APU	FLIGHT:	3/1R
MDAC ID:	261	ABORT:	3/1R

ITEM: FUEL PUMP/GGVM COOLING WATER LINES-BETWEEN TANK VALVE AND APU
FAILURE MODE: BLOCKAGE AT FILTER

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER LINES
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: V070-465521

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF COOLING REDUNDANCY TO ONE APU. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
SUBSYSTEM: APU
MDAC ID: 262

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/1R
ABORT: 3/1R

ITEM: FUEL PUMP/GGVM COOLING WATER LINE FLEX HOSE
FAILURE MODE: LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER LINES
4) FLEX HOSE
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME271-0079-64XX

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
NO EFFECT UNTIL SYSTEM IS ACTIVATED; THEN, LOSS OF COOLING WATER TO ONE APU. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 263 ABORT: 3/1R

ITEM: SPRAY ORIFICE
FAILURE MODE: BLOCKAGE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER LINES
4) SPRAY NOZZLES
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF POST-RUN COOLING TO ONE APU. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 264 ABORT: 2/1R

ITEM: FUEL PUMP/GGVM COOLING WATER TANK VALVE
FAILURE MODE: FAIL TO OPEN; FAIL TO REMAIN OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER TANK VALVE
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0552-000X

CAUSES: CONTAMINATION, CORROSION, SHORTED OR OPEN SOLENOID COIL

EFFECTS/RATIONALE:
LOSS OF REDUNDANCY FOR APU POST-RUN COOLING. CRITICALITY IS 2/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	11/03/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	APU	FLIGHT:	3/1R
MDAC ID:	265	ABORT:	3/1R

ITEM: FUEL PUMP/GGVM COOLING WATER TANK VALVE
FAILURE MODE: FAIL TO CLOSE (STUCK OPEN), INTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER TANK VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0552-000X

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
NO EFFECT: PULSING VALVES PROVIDE REDUNDANT SHUTOFF.
CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN (MUST LOSE ONE MORE VALVE AND REDUNDANT COOLING SYSTEM AND BE FORCED TO DEORBIT WHILE APU'S ARE HOT TO BE AT CRITICALITY 1).
APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 266 ABORT: 2/1R

ITEM: FUEL PUMP/GGVM COOLING WATER TANK VALVE
FAILURE MODE: INTERNAL BARRIER LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER TANK VALVE
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0552-000X

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
WATER IN SOLENOID CAVITY WILL SHORT OUT SOLENOID COIL; VALVE WILL BE FAILED IN CLOSED POSITION. LOSS OF COOLING SYSTEM REDUNDANCY. CRITICALITY IS 2/1R FOR DEORBIT BEFORE APU COOLDOWN.
APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 267 ABORT: 2/1R

ITEM: FUEL PUMP/GGVM COOLING WATER TANK VALVE
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER TANK VALVE
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: ME284-0552-000X

CAUSES: MANUFACTURING DEFECT, INSTALLATION ERROR

EFFECTS/RATIONALE:
LOSS OF COOLING WATER FROM ONE OF TWO COOLING SYSTEMS.
CRITICALITY IS 2/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 268 ABORT: 3/1R

ITEM: FUEL PUMP/GGVM COOLING WATER TANK HEATER
FAILURE MODE: FAIL OFF, OR LOW OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER TANK HEATER
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC363-0025-0003

CAUSES: SHORT CIRCUIT, BROKEN WIRE, INSTALLATION ERROR

EFFECTS/RATIONALE:
LOSS OF HEATER REDUNDANCY FOR ONE SYSTEM WATER TANK. IF THE OTHER HEATER SET IS LOST, THE WATER TANK CAN FREEZE, CAUSING LOSS OF FUEL PUMP/GGVM COOLING REDUNDANCY. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN.
APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	11/03/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	APU	FLIGHT:	3/1R
MDAC ID:	269	ABORT:	3/1R

ITEM: FUEL PUMP/GGVM COOLING WATER TANK HEATER THERMOSTAT
FAILURE MODE: FAIL OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER TANK HEATER
4) THERMOSTAT
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: ME360-0017-0006

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF HEATER REDUNDANCY FOR ONE OF TWO WATER TANKS. IF BOTH HEATERS LOST, WATER COULD FREEZE, AND COOLING SYSTEM REDUNDANCY WOULD BE LOST. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 270 ABORT: 3/3

ITEM: FUEL PUMP/GGVM COOLING WATER TANK HEATER THERMOSTAT
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER TANK HEATER
4) THERMOSTAT
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME360-0017-0006

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
AFFECTED HEATER SET IS FAILED ON WHEN ACTIVE, BUT CAN BE SWITCHED OFF. REDUNDANT HEATER SET IS UNAFFECTED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	11/03/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	APU	FLIGHT:	3/1R
MDAC ID:	271	ABORT:	3/1R

ITEM: FUEL PUMP/GGVM COOLING WATER LINE HEATER
FAILURE MODE: FAIL OFF, OR LOW OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER LINE HEATER
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC363-0026-XXXX

CAUSES: SHORT CIRCUIT, BROKEN WIRE, INSTALLATION ERROR

EFFECTS/RATIONALE:
LOSS OF HEATER REDUNDANCY FOR A PORTION OF THE WATER LINES FOR ONE OF THE TWO COOLING SYSTEM. IF OTHER HEATER WERE LOST, THE AFFECTED PROTION OF THE LINE WOULD FREEZE, CAUSING LOSS OF COOLING SYSTEM REDUNDANCY TO ONE APU, OR ALL THREE APUS. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 272 ABORT: 3/1R

ITEM: FUEL PUMP/GGVM COOLING WATER LINE HEATER THERMOSTAT
FAILURE MODE: FAIL OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER LINE HEATER
4) THERMOSTAT
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC452-0147-XXXX

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF HEATER REDUNDANCY FOR A PROTION OF THE WATER LINE FOR ONE OF THE TWO COOLING SYSTEMS. IF OTHER HEATER WERE LOST, THE AFFECTED PORTION OF THE LINE WOULD FREEZE, COUSING LOSS OF COOLING SYSTEM REDUNDANCY TO ONE APU, OR ALL THREE APUS. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	10/09/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	APU	FLIGHT:	3/3
MDAC ID:	273	ABORT:	3/3

ITEM: FUEL PUMP/GGVM COOLING WATER LINE HEATER THERMOSTAT
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER LINE HEATER
4) THERMOSTAT
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC452-0147-XXXX

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
AFFECTED HEATER SET IS FAILED ON WHEN ACTIVE, BUT CAN BE SWITCHED OFF. REDUNDANT HEATER SET IS UNAFFECTED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 274 ABORT: 3/1R

ITEM: FUEL PUMP/GGVM COOLING CHECK VALVE
FAILURE MODE: FAIL TO OPEN (FAIL CLOSED)

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) CHECK VALVE
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER:

CAUSES: CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
LOSS OF FUEL PUMP/GGVM COOLING TO ONE APU. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	10/10/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	APU	FLIGHT:	3/3
MDAC ID:	275	ABORT:	3/3

ITEM: FUEL PUMP/GGVM COOLING CHECK VALVE
FAILURE MODE: FAIL TO CLOSE (STUCK OPEN)

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) CHECK VALVE
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER:

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
NO EFFECT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 276 ABORT: 1/1

ITEM: EXHAUST PLENUM HOUSING
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) STRUCTURE
3) EXHAUST PLENUM HOUSING
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	1/1	RTLS:	1/1
LIFTOFF:	1/1	TAL:	1/1
ONORBIT:	3/3	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	1/1		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-00001

CAUSES: MANUFACTURING DEFECT, HANDLING DAMAGE, FATIGUE, CONTAMINATION OF SEALING SURFACES

EFFECTS/RATIONALE:
ALLOWS HOT GASES INTO AFT COMPARTMENT. POSSIBLE DAMAGE TO OTHER EQUIPMENT IN COMPARTMENT, FIRE HAZARD. CRITICALITY IS 1/1 DUE TO FIRE HAZARD.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/02/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 277 ABORT: 1/1

ITEM: EXHAUST PLENUM HOUSING
FAILURE MODE: CRACKING

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) STRUCTURE
3) EXHAUST PLENUM HOUSING
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-00001

CAUSES: THERMAL FATIGUE, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
HOUSING COULD COME INTO CONTACT WITH TURBINE WHEEL, CAUSING LOSS OF APU. CRITICALITY IS 2/1R DUE TO LOSS OF APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/02/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 278 ABORT: 1/1

ITEM: EXHAUST PLENUM HOUSING
FAILURE MODE: INTERNAL LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) STRUCTURE
3) EXHAUST PLENUM HOUSING
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-00001

CAUSES: MANUFACTURING DEFECT IN SEALS

EFFECTS/RATIONALE:
ALLOWS TURBINE GASES TO ENTER GEARBOX; MIXING WITH LUBE OIL PRODUCES WAX WHICH COULD PREVENT PROPER LUBRICATION OF GEARBOX; APU COULD BE LOST. CRITICALITY IS 2/1R FOR APU LOSS. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS, DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/02/86
SUBSYSTEM: APU
MDAC ID: 279

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
ABORT: 1/1

ITEM: GEARBOX HOUSING
FAILURE MODE: LEAK

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) STRUCTURE
3) GEARBOX HOUSING
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF LUBE OIL FROM GEARBOX; APU WIEL BE LOST IF LEAKAGE IS GREAT ENOUGH. CRITICALITY IS 2/1R DUE TO LOSS OF APU. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS DUE TO POSSIBLE LOSS OF ANOTHER MAIN ENGINE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 280 ABORT: 2/1R

ITEM: "APU CONTROL" SWITCH
FAILURE MODE: FAIL TO CLOSE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) APU CONTROL CIRCUIT
4) "APU CONTROL" SWITCH
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: PANEL R2
PART NUMBER:

CAUSES: CONTAMINATION, PIECE PART STRUCTURAL FAILURE

EFFECTS/RATIONALE:
WORST-CASE EFFECT IS LOSS OF APU START/RUN CAPABILITY.
CRITICALITY IS 2/1R DUE TO REDUNDANCY OF APU'S.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 281 ABORT: 1/1

ITEM: "APU CONTROL" SWITCH
FAILURE MODE: FAIL TO REMAIN CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) APU CONTROL CIRCUIT
4) "APU CONTROL" SWITCH
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: PANEL R2
PART NUMBER:

CAUSES: VIBRATION, MECHANICAL SHOCK

EFFECTS/RATIONALE:
LOSS OF APU. CRITICALITY IS 2/1R DUE TO APU REDUNDANCY. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 282 ABORT: 2/1R

ITEM: "APU CONTROL" SWITCH
FAILURE MODE: FAIL TO OPEN (STUCK IN "START/RUN")

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) APU CONTROL CIRCUIT
4) "APU CONTROL" SWITCH
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: PANEL R2
PART NUMBER:

CAUSES: PIECE-PART STRUCTURAL FAILURE, CONTAMINATION (SHORT

EFFECTS/RATIONALE:
APU CANNOT BE SHUT DOWN IN NORMAL MANNER; MUST BE SHUT DOWN BY CLOSING FUEL TANK VALVES. NO HOT RESTART CAPABILITY. CRITICALITY IS 2/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT MAY CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	10/14/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	APU	FLIGHT:	3/3
MDAC ID:	283	ABORT:	3/3

ITEM: "APU CONTROL" SWITCH
FAILURE MODE: INADVERTENT OPERATION

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) APU CONTROL CIRCUIT
4) "APU CONTROL" SWITCH
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: PANEL R2
PART NUMBER:

CAUSES: VIBRATION, CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
NO EFFECT - APU FUEL TANK VALVES WILL PREVENT FUEL FROM REACHING GAS GENERATOR.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/30/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 284 ABORT: 3/3

ITEM: APU CONTROL CIRCUIT GROUND CONTROL INPUT DRIVER
FAILURE MODE: FAIL OFF, FAIL TO REMAIN ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) APU CONTROL CIRCUIT
4) GROUND CONTROL INPUT DRIVER
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		

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

LOCATION: AFT LCA 1,2,3
PART NUMBER:

CAUSES: CONTAMINATION, MANUFACTURING DEFECT, VIBRATION

EFFECTS/RATIONALE:
LOSS OF PRELAUNCH GROUND CONTROL OF APU START. NO EFFECT ON FLIGHT; THIS COMMAND IS NOT NEEDED FOR NORMAL PRELAUNCH ACTIVITIES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/30/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 285 ABORT: /NA

ITEM: APU CONTROL CIRCUIT GROUND CONTROL INPUT DRIVER
FAILURE MODE: INADVERTENT OPERATION

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) APU CONTROL CIRCUIT
4) GROUND CONTROL INPUT DRIVER
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT LCA 1,2,3
PART NUMBER:

CAUSES: CONTAMINATION, VIBRATION, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
PRELAUNCH, SENDS START COMMAND TO APU. APU WILL NOT START, BECAUSE FUEL TANK VALVES ARE CLOSED. COMMAND IS NULLIFIED AT LIFTOFF. APU WILL START WHEN FULE TANK VALVES ARE OPENED BEFORE LIFTOFF.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/30/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 286 ABORT: 2/1R

ITEM: APU CONTROL CIRCUIT SWITCH POWER FUSE
FAILURE MODE: FAIL OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) APU CONTROL CIRCUIT
4) SWITCH POWER FUSE
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: PANEL R2
PART NUMBER:

CAUSES: CORROSION, INSTALLATION ERROR, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
LOSS OF REDUNDANCY FOR APU START AND START/OVERRIDE COMMANDS. IF BOTH FUSES ARE LOST, APU WON'T OPERATE. CRITICALITY IS 3/1R DUE TO START COMMAND REDUNDANCY AND APU REDUNDANCY.
ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/30/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 287 ABORT: 3/1R

ITEM: APU CONTROL CIRCUIT START CONTROL INPUT DIODE
FAILURE MODE: FAIL OPEN, SHORT TO GROUND

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) APU CONTROL CIRCUIT
4) START CONTROL INPUT DIODE
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/1R
LIFTOFF:	3/1R	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: AFT LCA 1,2,3
PART NUMBER:

CAUSES: CONTAMINATION, VIBRATION, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
LOSS OF REDUNDANCY FOR APU START COMMAND, START/OVERRIDE IS UNAFFECTED. IF APU START FUNCTION IS LOST, APU WILL NOT START, OR WILL SHUT DOWN. CRITICALITY IS 3/1R DUE TO START COMMAND REDUNDANCY AND APU REDUNDANCY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 288 ABORT: 2/1R

ITEM: "APU CNTLR PWR" SWITCH
FAILURE MODE: FAIL TO CLOSE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) CONTROLLER POWER CIRCUIT
4) "APU CNTLR PWR" SWITCH
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: PANEL R2
PART NUMBER: ME452-0102-7252

CAUSES: CONTAMINATION, PIECE-PART STRUCTURAL FAILURE

EFFECTS/RATIONALE:
LOSS OF POWER TO APU CONTROLLER, LOSS OF APU. CRITICALITY IS 2/1R DUE TO APU REDUNDANCY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 289 ABORT: 1/1

ITEM: "APU CNTLR PWR" SWITCH
FAILURE MODE: FAIL TO REMAIN CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) CONTROLLER POWER CIRCUIT
4) "APU CNTLR PWR" SWITCH
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: PANEL R2
PART NUMBER: ME452-0102-7252

CAUSES: VIBRATION, MECHANICAL SHOCK

EFFECTS/RATIONALE:
LOSS OF APU. CRITICALITY IS 2/1R DUE TO APU REDUNDANCY. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 290 ABORT: 3/3

ITEM: "APU CNTLR PWR" SWITCH
FAILURE MODE: FAIL TO OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) CONTROLLER POWER CIRCUIT
4) "APU CNTLR PWR" SWITCH
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: PANEL R2
PART NUMBER: ME452-0102-7252

CAUSES: PIECE-PART STRUCTURAL FAILURE, CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
APU CONTROLLER CANNOT BE POWERED OFF. NO ADVERSE AFFECTS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 291 ABORT: 3/3

ITEM: "APU CNTLR PWR" SWITCH
FAILURE MODE: INADVERTENT OPERATION

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) CONTROLLER POWER CIRCUIT
4) "APU CNTLR PWR" SWITCH
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: PANEL R2
PART NUMBER: ME452-0102-7252

CAUSES: VIBRATION, CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
APU CONTROLLER IS POWERED UP INADVERTENTLY. NO ADVERSE EFFECTS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86
SUBSYSTEM: APU
MDAC ID: 292

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/1R
ABORT: 2/1R

ITEM: CONTROLLER POWER CIRCUIT RPC
FAILURE MODE: FAIL OPEN (NO OUTPUT)

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) CONTROLLER POWER CIRCUIT
4) REMOTE POWER CONTROLLER
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AV BAY 4,5,6
PART NUMBER: MC450-0017-1075

CAUSES: CONTAMINATION, VIBRATION, MECHANICAL SHOCK

EFFECTS/RATIONALE:
LOSS OF APU CONTROLLER REDUNDANT POWER SUPPLY. CRITICALITY IS 3/1R DUE TO POWER SUPPLY AND APU REDUNDANCY. ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 293 ABORT: 3/3

ITEM: CONTROLLER POWER CIRCUIT RPC
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) CONTROLLER POWER CIRCUIT
4) REMOT POWER CONTROLLER
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		

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

LOCATION: AV BAY 4,5,6
PART NUMBER: MC450-0017-1075

CAUSES: CONTAMINATION (SHORT), MANUFACTURING DEFECT

EFFECTS/RATIONALE:
APU CONTROLLER IS ADVERTENTLY POWERED UP. NO ADVERSE EFFECTS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 294 ABORT: 2/1R

ITEM: CONTROLLER POWER CIRCUIT POWER INPUT DIODE
FAILURE MODE: FAIL OPEN, OR SHORT CIRCUIT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) CONTROLLER POWER CIRCUIT
4) POWER INPUT DIODE
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AV BAY 4,5,6
PART NUMBER: JANTXIN1188R

CAUSES: CONTAMINATION, VIBRATION, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
LOSS OF REDUNDANT POWER TO APU CONTROLLER. CRITICALITY IS 3/1R DUE TO POWER SUPPLY AND APU REDUNDANCY. ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86
SUBSYSTEM: APU
MDAC ID: 295

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/1R
ABORT: 2/1R

ITEM: CONTROLLER POWER SWITCH POWER FUSE
FAILURE MODE: FAIL OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) CONTROLLER POWER CIRCUIT
4) SWITCH POWER FUSE
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: PANEL R2
PART NUMBER: ME451-0018-0100

CAUSES: MANUFACTURING DEFECT, INSTALLATION ERROR

EFFECTS/RATIONALE:
LOSS OF REDUNDANT POWER TO APU CONTROLLER. CRITICALITY IS 3/1R DUE TO POWER SUPPLY AND APU REDUNDANCY. ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 296 ABORT: 2/1R

ITEM: CONTROLLER POWER CIRCUIT CONTROL INPUT DIODE
FAILURE MODE: FAIL OPEN, OR SHORT CIRCUIT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) CONTROLLER POWER INPUT
4) CONTROL DIODE
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AV BAY 4,5,6
PART NUMBER:

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
LOSS OF CONTROLLER POWER SUPPLY A. CRITICALITY IS 3/1R DUE TO POWER SUPPLY AND APU REDUNDANCY. ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	10/30/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	APU	FLIGHT:	3/3
MDAC ID:	297	ABORT:	3/3

ITEM: CONTROLLER POWER CIRCUIT GROUND CONTROL INPUT DIODE
FAILURE MODE: FAIL OPEN, SHORT TO GROUND

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) CONTROLLER POWER CIRCUIT
4) GROUND CONTROL INPUT DIODE
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		

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

LOCATION: AFT PCA 4,5,6
PART NUMBER:

CAUSES: CONTAMINATION, VIBRATION, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
LOSS OF PRELAUNCH APU CONTROLLER ACTIVATION COMMAND. THIS COMMAND IS NOT NEEDED FOR NORMAL PRELAUNCH ACTIVITIES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 298 ABORT: 3/3

ITEM: "APU SPEED SELECT" SWITCH
FAILURE MODE: FAIL TO CLOSE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) SPEED SELECT CIRCUIT
4) SWITCH
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		

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

LOCATION: PANEL R2
PART NUMBER:

CAUSES: CONTAMINATION, PIECE-PART STRUCTURAL FAILURE

EFFECTS/RATIONALE:
HIGH SPEED CANNOT BE SELECTED FOR AFFECTED APU. NO ADVERSE EFFECT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 299 ABORT: 3/3

ITEM: "APU SPEED SELECT" SWITCH
FAILURE MODE: FAIL TO REMAIN CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) SPEED SELECT CIRCUIT
4) SWITCH
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		

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

LOCATION: PANEL R2
PART NUMBER:

CAUSES: VIBRATION, MECHANICAL SHOCK

EFFECTS/RATIONALE:
APU DROPS FROM HIGH SPEED (113%) TO NORMAL SPEED (103%). NO ADVERSE EFFECT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 300 ABORT: 3/3

ITEM: "APU SPEED SELECT" SWITCH
FAILURE MODE: FAIL TO OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) SPEED SELECT CIRCUIT
4) SWITCH
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		

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

LOCATION: PANEL R2
PART NUMBER:

CAUSES: PIECE-PART STRUCTURAL FAILURE, CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
APU STUCK IN HIGH SPEED. NO ADVERSE EFFECT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86
SUBSYSTEM: APU
MDAC ID: 301

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: "APU SPEED SELECT" SWITCH
FAILURE MODE: INADVERTENT OPERATION

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) SPEED SELECT CIRCUIT
4) SWITCH
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		

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

LOCATION: PANEL R2
PART NUMBER:

CAUSES: VIBRATION, CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
APU SHIFTS TO HIGH SPEED. NO ADVERSE EFFECTS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 302 ABORT: 3/3

ITEM: SPEED SELECT CIRCUIT
FAILURE MODE: OPEN CIRCUIT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) SPEED SELECT CIRCUIT
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		

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

LOCATION: AV BAY 4,5,6
PART NUMBER: VS70-460109

CAUSES: VIBRATION, HANDLING DAMAGE, INSTALLATION ERROR

EFFECTS/RATIONALE:
LOSS OF HIGH SPEED FOR AFFECTED APU. NO ADVERSE EFFECT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 303 ABORT: 3/3

ITEM: SPEED SELECT CIRCUIT
FAILURE MODE: DRIVER FAIL ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) SPEED SELECT CIRCUIT
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		

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

LOCATION: AV BAY 4,5,6
PART NUMBER: VS70-460109

CAUSES: MANUFACTURING DEFECT, PIECE-PART STRUCTURAL FAILURE, CONTAMINATION

EFFECTS/RATIONALE:
NO EFFECT, DUE TO 2 DRIVERS IN SERIES. IF BOTH FAIL ON, APU SHIFTS TO HIGH SPEED. NO ADVERSE EFFECT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/27/86
SUBSYSTEM: APU
MDAC ID: 304

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: OVERSPEED/UNDERSPEED INDICATION CIRCUIT
FAILURE MODE: OPEN CIRCUIT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) OVERSPEED/UNDERSPEED INDICATION CIRCUIT
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		

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

LOCATION: AV BAY 3,4,5,6;AFT BODY;MIDDECK
PART NUMBER: VS70-460109

CAUSES: PIECE-PART STRUCTURAL FAILURE

EFFECTS/RATIONALE:
NO UNDERSPEED (OR OVERSPEED) SIGNAL TO CAUTION & WARNING SYSTEM TO GENERATE WARNING LIGHT AND TONE. CREW STILL RECEIVES SOFTWARE-GENERATED TONE AND CRT MESSAGE. ALSO, NO AUTOMATIC CLOSURE OF FUEL TANK VALVES.
APU IS SHUT DOWN BY SECONDARY FUEL VALVE ONLY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 305 ABORT: 3/3

ITEM: "APU AUTO SHUTDOWN" SWITCH
FAILURE MODE: FAIL TO CLOSE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) AUTO SHUTDOWN CONTROL CIRCUIT
4) SWITCH
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		

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

LOCATION: PANEL R2
PART NUMBER:

CAUSES: CONTAMINATION, PIECE-PART STRUCTURAL FAILURE

EFFECTS/RATIONALE:
CANNOT INHIBIT APU AUTO SHUTDOWN. NO ADVERSE EFFECT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	10/15/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	APU	FLIGHT:	2/1R
MDAC ID:	306	ABORT:	2/1R

ITEM: "APU AUTO SHUTDOWN" SWITCH
FAILURE MODE: FAIL TO REMAIN CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) AUTO SHUTDOWN CONTROL CIRCUIT
4) SWITCH
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	2/1R		

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

LOCATION: PANEL R2
PART NUMBER:

CAUSES: VIBRATION, MECHANICAL SHOCK

EFFECTS/RATIONALE:
APU AUTO SHUTDOWN IS ENABLED; IF APU WAS IN "INHIBIT" MODE TO ALLOW IT TO RUN (DUE TO PREVIOUS FAILURE), THIS WOULD CAUSE LOSS OF APU. CRITICALITY IS 2/1R.
ABORT: CRITICALITY IS 3/3, BECAUSE NO APU WOULD BE RESTARTED IN "INHIBIT" MODE FOR ASCENT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 307 ABORT: 3/3

ITEM: "APU AUTO SHUTDOWN" SWITCH
FAILURE MODE: FAIL TO OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) AUTO SHUTDOWN CONTROL CIRCUIT
4) SWITCH
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		

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

LOCATION: PANEL R2
PART NUMBER:

CAUSES: PIECE-PART STRUCTURAL FAILURE, CONTAMINATION

EFFECTS/RATIONALE:
APU AUTO SHUTDOWN CANNOT BE ENABLED. NO ADVERSE EFFECT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 308 ABORT: 3/3

ITEM: "APU AUTO SHUTDOWN" SWITCH
FAILURE MODE: INADVERTENT OPERATION

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) AUTO SHUTDOWN CONTROL CIRCUIT
4) SWITCH
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		

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

LOCATION: PANEL R2
PART NUMBER:

CAUSES: VIBRATION, CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
APU AUTO SHUTDOWN IS INHIBITED. NO ADVERSE EFFECT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 309 ABORT: 3/3

ITEM: AUTO SHUTDOWN SWITCH POWER FUSE
FAILURE MODE: FAIL OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) AUTO SHUTDOWN CONTROL CIRCUIT
4) SWITCH POWER FUSE
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		

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

LOCATION: PANEL R2
PART NUMBER:

CAUSES: MANUFACTURING DEFECT, INSTALLATION ERROR

EFFECTS/RATIONALE:
LOSS OF REDUNDANT "INHIBIT" SIGNAL TO 2 APU CONTROLLERS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 310 ABORT: 3/3

ITEM: AUTO SHUTDOWN CONTROL CIRCUIT DIODE
FAILURE MODE: OPEN CIRCUIT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) AUTO SHUTDOWN CONTROL CIRCUIT
4) DIODE
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		

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

LOCATION: AV BAY 4,5,6
PART NUMBER:

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF REDUNDANT 'INHIBIT" SIGNAL TO ONE APU CONTROLLER.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 311 ABORT: 3/3

ITEM: AUTO SHUTDOWN CONTROL CIRCUIT DIODE
FAILURE MODE: SHORT TO GROUND

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) AUTO SHUTDOWN CONTROL CIRCUIT
4) DIODE
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		

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

LOCATION: AV BAY 4,5,6
PART NUMBER:

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF REDUNDANT "INHIBIT" SIGNAL TO 2 APU CONTROLLERS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/27/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 312 ABORT: /NA

ITEM: FUEL VALVE GROUND CONTROL CIRCUIT
FAILURE MODE: FAIL OFF, OPEN CIRCUIT, FAIL TO REMAIN ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL VALVE CONTROL CIRCUIT
4) GROUND CONTROL CIRCUIT
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AV BAY 4,5,6
PART NUMBER: VS70-460109

CAUSES: CONTAMINATION, SHORT TO GROUND, PIECE-PART STRUCTURAL FAILURE

EFFECTS/RATIONALE:
CANNOT OPEN VALVE TO DO GROUND PURGE OF FUEL SYSTEM; POSSIBLE LAUNCH DELAY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/27/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 313 ABORT: /NA

ITEM: FUEL VALVE GROUND CONTROL CIRCUIT
FAILURE MODE: INADVERTENT OPERATION, FAIL ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL VALVE CONTROL CIRCUIT
4) GROUND CONTROL CIRCUIT
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AV BAY 4,5,6
PART NUMBER: VS70-460109

CAUSES: SHORT

EFFECTS/RATIONALE:
THIS CIRCUIT IS NOT POWERED AFTER LIFTOFF-POSSIBLE LAUNCH DELAY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 314 ABORT: 2/1R

ITEM: FUEL TANK VALVE SWITCH
FAILURE MODE: FAIL TO CLOSE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL TANK VALVE CONTROL CIRCUIT
4) SWITCH
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: PANEL R2
PART NUMBER: ME452-0102-7352

CAUSES: CONTAMINATION, PIECE-PART STRUCTURAL FAILURE

EFFECTS/RATIONALE:
CANNOT OPEN FUEL TANK VALVES FOR ONE APU; APU IS LOST.
CRITICALITY IS 2/1R DUE TO APU REDUNDANCY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 315 ABORT: 1/1

ITEM: FUEL TANK VALVE SWITCH
FAILURE MODE: FAIL TO REMAIN CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL TANK VALVE CONTROL CIRCUIT
4) SWITCH
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: PANEL R2
PART NUMBER: ME452-0102-7352

CAUSES: VIBRATION, MECHANICAL SHOCK

EFFECTS/RATIONALE:
LOSS OF APU. CRITICALITY IS 2/1R DUE TO APU REDUNDANCY. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86
SUBSYSTEM: APU
MDAC ID: 316

HIGHEST CRITICALITY	HDW/FUNC
FLIGHT:	1/1
ABORT:	1/1

ITEM: FUEL TANK VALVE SWITCH
FAILURE MODE: FAIL TO OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL TANK VALVE CONTROL CIRCUIT
4) SWITCH
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:	2/1R	AOA:	3/3
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	3/3		

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

LOCATION: PANEL R2
PART NUMBER: ME452-0102-7352

CAUSES: PIECE-PART STRUCTURAL FAILURE, CONTAMINATION

EFFECTS/RATIONALE:
CANNOT CLOSE FUEL TANK VALVES. APU WILL SHUT DOWN WHEN SECONDARY FUEL VALVE CLOSES. WITHOUT FUEL FLOW, VALVE WILL OVERHEAT FUEL - CAN LEAD TO FUEL DETONATION AND FUEL LEAK. THIS CAN CAUSE FIRE DURING ENTRY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 317 ABORT: 1/1

ITEM: FUEL TANK VALVE SWITCH
FAILURE MODE: INADVERTENT OPERATION

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL TANK VALVE CONTROL CIRCUIT
4) SWITCH
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:	1/1	ATO:	1/1
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [1] B [P] C [1]

LOCATION: PANEL R2
PART NUMBER: ME452-0102-7352

CAUSES: CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
BOTH FUEL TANK VALVES FOR ONE APU OPEN UP. FUEL IS STOPPED BY SECONDARY FUEL VALVE. WITHOUT FUEL FLOW, VALVE OVERHEATS, AND FUEL CAN DETONATE, CAUSING FUEL LEAK. THIS CAN CAUSE FIRE DURING ENTRY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 318 ABORT: 2/1R

ITEM: FUEL TANK VALVE CIRCUIT DRIVER
FAILURE MODE: FAIL OFF, OR SHORT TO GROUND

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL TANK VALVE CONTROL CIRCUIT
4) CIRCUIT DRIVER
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT LCA 1,2,3
PART NUMBER: MC477-0263-0002

CAUSES: MANUFACTURING DEFECT, VIBRATION, CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF REDUNDANT FUEL TANK VALVE; OTHER VALVE ALLOWS APU TO OPERATE. CRITICALITY IS 3/1R DUE TO VALVE AND APU REDUNDANCY. ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 319 ABORT: 2/1R

ITEM: FUEL TANK VALVE CIRCUIT DRIVER
FAILURE MODE: FAIL ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL TANK VALVE CONTROL CIRCUIT
4) CIRCUIT DRIVER
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT LCA 1,2,3
PART NUMBER: MC477-0263-0002

CAUSES:

EFFECTS/RATIONALE:
NO EFFECT, DUE TO OTHER CIRCUIT DRIVER IN SERIES. IF BOTH DRIVERS FAILED ON, VALVE COULD OVERHEAT AND DETONATE FUEL (FIRE HAZARD DURING ENTRY). CRITICALITY IS 2/1R: 1 FAILURE AWAY FROM CRITICALITY 1.
NOTE: FOR APU 2, VALVE B, CRITICALITY IS 3/1R DUE TO 3 DRIVERS IN SERIES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 320 ABORT: 3/3

ITEM: FUEL TANK VALVE AUTO SHUTDOWN DRIVER
FAILURE MODE: FAIL OFF, OR SHORT TO GROUND

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL TANK VALVE CONTROL CIRCUIT
4) AUTO SHUTDOWN DRIVER
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		

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

LOCATION: AV BAY 4,5,6
PART NUMBER: MC477-0261-0002

CAUSES: CONTAMINATION, VIBRATION, INSTALLATION ERROR

EFFECTS/RATIONALE:
AUTOMATIC SHUTDOWN OF APU WILL NOT CLOSE ONE OF THE TWO FUEL TANK VALVES. APU WILL BE SHUT DOWN BY SECONDARY FUEL VALVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 321 ABORT: 2/1R

ITEM: FUEL TANK VALVE AUTO SHUTDOWN DRIVER
FAILURE MODE: FAIL ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL TANK VALVE CONTROL CIRCUIT
4) AUTO SHUTDOWN DRIVER
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AFT LCA 1,2,3
PART NUMBER: MC477-0261-0002

CAUSES: CONTAMINATION, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
LOSS OF ONE OF THE TWO FUEL TANK VALVES FOR ONE APU. THE OTHER VALVE ALLOWS THE APU TO CONTINUE OPERATING. CRITICALITY IS 3/1R DUE TO REDUNDANCY OF VALVES AND APU'S.
ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86
SUBSYSTEM: APU
MDAC ID: 322

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/1R
ABORT: 2/1R

ITEM: FUEL TANK VALVE SWITCH POWER FUSE
FAILURE MODE: FAIL OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL TANK VALVE CONTROL CIRCUIT
4) SWITCH POWER FUSE
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: PANEL R2
PART NUMBER:

CAUSES:

EFFECTS/RATIONALE:
LOSS OF ONE OF THE REDUNDANT FUEL TANK VALVES FOR ONE APU. CRITICALITY IS 3/1R DUE TO VALVE AND APU REDUNDANCY. ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 323 ABORT: 2/1R

ITEM: FUEL TANK VALVE SWITCH OUTPUT DIODE
FAILURE MODE: FAIL OPEN, OR SHORT TO GROUND

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL TANK VALVE CONTROL CIRCUIT
4) SWITCH OUTPUT DIODE
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT LCA 1,2,3
PART NUMBER:

CAUSES: MANUFACTURING DEFECT, PIECE-PART STRUCTURAL FAILURE

EFFECTS/RATIONALE:
LOSS OF ONE OF THE REDUNDANT FUEL TANK VALVES FOR ONE APU. CRITICALITY IS 3/1R DUE TO VALVE AND APU REDUNDANCY. ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/23/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 324 ABORT: 3/3

ITEM: FUEL TANK VALVE INDICATOR SWITCH
FAILURE MODE: FAIL OPEN, FAIL TO REMAIN CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL TANK VALVE INDICATOR SWITCH
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC284-0558-000X

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

EFFECTS/RATIONALE:
FUEL TANK VALVE POSITION INDICATOR ALWAYS SHOWS "CLOSED" FOR AFFECTED VALVE. CAN'T TELL VALVE FAILURE FROM INDICATOR FAILURE, DUE TO REDUNDANT VALVE IN PARALLEL. ASSUME VALVE FAILURE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/23/86
SUBSYSTEM: APU
MDAC ID: 325

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: FUEL TANK VALVE INDICATOR SWITCH
FAILURE MODE: FAIL TO OPEN, INADVERTENT OPERATION

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL TANK VALVE INDICATOR SWITCH
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC284-0558-000X

CAUSES: SHORT, CONTAMINATION

EFFECTS/RATIONALE:
FUEL TANK VALVE POSITION INDICATION ALWAYS SHOWS "OPEN" FOR AFFECTED VALVE, BUT DOWNSTREAM READING CONFIRMS VALVE CLOSED (GROUND ONLY).

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 326 ABORT: 2/1R

ITEM: "PUMP/VLV COOL" SWITCH
FAILURE MODE: FAIL TO CLOSE, FAIL TO REMAIN CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) "PUMP/VLV COOL" SWITCH
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

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

LOCATION: PANEL R2
PART NUMBER: ME452-0102-7301

CAUSES: CONTAMINATION, PIECE-PART STRUCTURAL FAILURE

EFFECTS/RATIONALE:
LOSS OF ONE OF TWO FUEL PUMP/GGVM COOLING SYSTEMS. CRITICALITY IS 2/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/16/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 327 ABORT: 3/3

ITEM: "PUMP/VLV COOL" SWITCH
FAILURE MODE: FAIL TO OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) "PUMP/VLV COOL" SWITCH
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: PANEL R2
PART NUMBER: ME452-0102-7301

CAUSES: PIECE-PART STRUCTURAL FAILURE, CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
CANNOT DEACTIVATE COOLING SYSTEM; VALVES MAY OVERHEAT AND BE DAMAGED. NO ADVERSE EFFECTS, OTHERWISE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 328 ABORT: 2/1R

ITEM: "PUMP/VLV COOL" SWITCH
FAILURE MODE: INADVERTENT OPERATION

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) "PUMP/VLV COOL" SWITCH
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

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

LOCATION: PANEL R2
PART NUMBER: ME452-0102-7301

CAUSES: VIBRATION, CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
ONE COOLING SYSTEM IS ACTIVATED AND OPERATES UNTIL DEPLETION OF WATER. CRITICALITY IS 2/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 329 ABORT: 3/1R

ITEM: "PUMP/VLV COOL" SWITCH POWER FUSE
FAILURE MODE: FAIL OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) SWITCH POWER FUSE
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: PANEL R2
PART NUMBER: ME451-0018-0100

CAUSES: MANUFACTURING DEFECT, INSTALLATION ERROR

EFFECTS/RATIONALE:
LOSS OF ONE SWITCH CONTACT: LOSS OF REDUNDANT CONTROL CIRCUIT TO 2 APU COOLING VALVES IN ONE OF TWO REDUNDANT COOLING SYSTEMS. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. OTHERWISE, 3/3.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 330 ABORT: 3/1R

ITEM: FUEL PUMP/GGVM COOLING CONTROL CIRCUIT POWER FUSE
FAILURE MODE: FAIL OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) CONTROL CIRCUIT POWER FUSE
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: APU TIMER BOX 1,2,3
PART NUMBER: ME451-0018-0100

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
LOSS OF ONE OF TWO PATHS TO OPEN WATER COOLING VALVE FOR ONE OF TWO REDUNDANT COOLING SYSTEMS. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 331 ABORT: 3/1R

ITEM: FUEL PUMP/GGVM COOLING CONTROL CIRCUIT POWER INPUT DIODE
FAILURE MODE: FAIL OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) POWER INPUT DIODE
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: APU TIMER BOX 1,2,3
PART NUMBER: JANTXV1N4246

CAUSES: MANUFACTURING DEFECT, PIECE-PART STRUCTURAL FAILURE

EFFECTS/RATIONALE:
LOSS OF REDUNDANT POWER TO WATER COOLING VALVE THERMOSTAT. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/16/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 332 ABORT: 3/1R

ITEM: FUEL PUMP/GGVM COOLING CONTROL CIRCUIT POWER INPUT DIODE
FAILURE MODE: SHORT TO GROUND

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) POWER INPUT DIODE
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: APU TIMER BOX 1,2,3
PART NUMBER: JANTXV1N4246

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF POWER TO REDUNDANT VALVE CONTROL CIRCUIT, WHEN FUSE BLOWS. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 333 ABORT: 3/1R

ITEM: FUEL PUMP/GGVM COOLING CONTROL CIRCUIT INPUT RESISTOR
FAILURE MODE: FAIL OPEN, OR HIGH RESISTANCE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) POWER INPUT DIODE
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: APU TIMER BOX 1,2,3
PART NUMBER: RER65F2150M

CAUSES: VIBRATION, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
LOSS OF REDUNDANT POWER TO WATER COOLING VALVE THERMOSTAT. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. IF THERMOSTAT IS LOST, ONE COOLING SYSTEM IS LOST FOR ONE APU. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 334 ABORT: 3/1R

ITEM: FUEL PUMP/GGVM COOLING CONTROL CIRCUIT INPUT RESISTOR
FAILURE MODE: INTERNAL SHORT, LOW RESISTANCE, OR SHORT TO GROUND

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) POWER INPUT RESISTOR
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: APU TIMER BOX 1,2,3
PART NUMBER: RER65F2150M

CAUSES: CONTAMINATION, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
LOSS OF POWER TO REDUNDANT VALVE CONTROL CIRCUIT, WHEN FUSE BLOWS. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. IF VALVE IS LOST, ONE COOLING SYSTEM IS LOST TO ONE APU. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 335 ABORT: 3/1R

ITEM: FUEL PUMP/GGVM COOLING CONTROL CIRCUIT POWER INPUT DRIVER
FAILURE MODE: FAIL OFF

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) POWER INPUT HYBRID CIRCUIT DRIVER
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: APU TIMER BOX 1,2,3
PART NUMBER: MC477-0263-0002

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF REDUNDANT POWER TO ONE APU COOLING VALVE. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. IF VALVE IS LOST, ONE COOLING SYSTEM IS LOST FOR ONE APU. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 336 ABORT: 3/3

ITEM: FUEL PUMP/GGVM COOLING CONTROL CIRCUIT POWER INPUT DRIVER
FAILURE MODE: FAIL ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) POWER INPUT HYBRID CIRCUIT DRIVER
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		

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

LOCATION: APU TIMER BOX 1,2,3
PART NUMBER: MC477-0263-0002

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
NO EFFECT DUE TO REDUNDANT DRIVER IN SERIES. IF BOTH FAILED ON, WITH APU CONTROLLER ON, COOLING VALVE WOULD OPEN, BUT WATER TANK VALVE WOULD PREVENT WATER FLOW. WITH COOLING ACTIVATED, WATER COULD FLOW CONTINUALLY AND BE DEPLETED EARLY (REDUNDANT COOLING SYSTEM WOULD BE UNAFFECTED).

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 337 ABORT: 3/1R

ITEM: FUEL PUMP/GGVM COOLING CONTROL CIRCUIT POWER INPUT DRIVER
FAILURE MODE: SHORT TO GROUND

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) POWER INPUT HYBRID CIRCUIT DRIVER
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: APU TIMER BOX 1,2,3
PART NUMBER: MC477-0263-0002

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
WORST CASE EFFECT IS LOSS OF REDUNDANT POWER TO ONE APU COOLING VALVE. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 338 ABORT: 3/3

ITEM: FUEL PUMP/GGVM COOLING CONTROL CIRCUIT TIMING DRIVER
FAILURE MODE: FAIL OFF, FAIL ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) TIMING DRIVER
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		

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

LOCATION: APU TIMER BOX 1,2,3
PART NUMBER: MC477-026200002

CAUSES: CONTAMINATION, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
WORST CASE IS ONE COOLING VALVE STUCK OPEN FOR ONE APU, WHILE THAT COOLING SYSTEM IS ACTIVE. THIS SYSTEM CAN BE TURNED OFF, AND OTHER SYSTEM IS UNAFFECTED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 339 ABORT: 3/1R

ITEM: FUEL PUMP/GGVM COOLING VALVE POWER DIODE
FAILURE MODE: FAIL OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) VALVE POWER DIODE
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: APU TIMER BOX 1,2,3
PART NUMBER: JANTXVIN5551

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
LOSS OF REDUNDANT POWER TO ONE APU COOLING VALVE. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 340 ABORT: 3/1R

ITEM: FUEL PUMP/GGVM COOLING VALVE POWER DIODE
FAILURE MODE: SHORT TO GROUND

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) VALVE POWER DIODE
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: APU TIMER BOX 1,2,3
PART NUMBER: JANTXVIN5551

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF REDUNDANT POWER TO APU COOLING VALVE, AFTER FUSE BLOWS IN CIRCUIT DRIVER. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/20/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 341 ABORT: 3/3

ITEM: FUEL PUMP/GGVM COOLING VALVE INDICATION RESISTOR
FAILURE MODE: FAIL OPEN, OR HIGH RESISTANCE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) VALVE INDICATION RESISTOR
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		

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

LOCATION: APU TIMER BOX 1,2,3
PART NUMBER: RLRO705101GR

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
LOSS OF STATUS INDICATION FOR ONE APU COOLING VALVE. NONCRITICAL MEASUREMENT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/20/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 342 ABORT: 3/3

ITEM: FUEL PUMP/GGVM COOLING VALVE INDICATION RESISTOR
FAILURE MODE: INTERNAL SHORT, OR LOW RESISTANCE

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) VALVE INDICATION RESISTOR
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		

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

LOCATION: APU TIMER BOX 1,2,3
PART NUMBER: RLRO705101GR

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF STATUS INDICATION FOR ONE APU COOLING VALVE. NONCRITICAL MEASUREMENT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 343 ABORT: 3/1R

ITEM: FUEL PUMP/GGVM COOLING TANK VALVE POWER FUSE
FAILURE MODE: FAIL OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) TANK VALVE POWER FUSE
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: APU TIMER BOX 1,2,3
PART NUMBER: ME452-0018-0100

CAUSES: MANUFACTURING DEFECT, INSTALLATION ERROR

EFFECTS/RATIONALE:
LOSS OF ONE OF 3 REDUNDANT POWER SOURCES FOR ONE OF 2 COOLING SYSTEM WATER TANK VALVES. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 344 ABORT: 3/1R

ITEM: FUEL PUMP/GGVM COOLING TANK VALVE DRIVER
FAILURE MODE: FAIL OFF, OPEN CIRCUIT, SHORT TO GROUND

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) WATER TANK VALVE DRIVER
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: APU TIMER BOX 1,2,3
PART NUMBER: MC477-0263-0002

CAUSES: MANUFACTURING DEFECT, CONTAMINATION, VIBRATION

EFFECTS/RATIONALE:
LOSS OF ONE OF 3 REDUNDANT DRIVERS FOR ONE OF 2 COOLING SYSTEM WATER TANK VALVES. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/20/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 345 ABORT: 3/3

ITEM: FUEL PUMP/GGVM COOLING TANK VALVE DRIVER
FAILURE MODE: FAIL ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) WATER TANK VALVE DRIVER
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		

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

LOCATION: APU TIMER BOX 1,2,3
PART NUMBER: MC477-0263-0002

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
WATER TANK VALVE OPENS AS SOON AS APU CONTROLLER IS POWERED UP. WATER CONTROL VALVE DOWNSTREAM PREVENTS WATER DEPLETION. VALVE MAY OVERHEAT. NO OTHER EFFECTS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 346 ABORT: 2/1R

ITEM: FUEL PUMP/GGVM COOLING THERMOSTAT
FAILURE MODE: FAIL OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) THERMOSTAT
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER:

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF ONE OF TWO COOLING SYSTEMS FOR ONE APU. CRITICALITY IS 2/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/20/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 347 ABORT: 3/3

ITEM: FUEL PUMP/GGVM COOLING THERMOSTAT
FAILURE MODE: FAIL CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL PUMP/GGVM COOLING CONTROL CIRCUIT
4) THERMOSTAT
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER:

CAUSES: CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
COOLING VALVE PULSES CONTINUOUSLY, REGARDLESS OF APU TEMPERATURE, BUT CAN BE TURNED OFF BY SWITCH. POSSIBLE DEPLETION OF COOLING WATER FROM ONE SYSTEM.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/20/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 348 ABORT: 3/1R

ITEM: "APU HEATER-TANK/FUEL LINE/H20 SYS" SWITCH
FAILURE MODE: FAIL TO CLOSE, FAIL TO REMAIN CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL/H20 HEATER CONTROL CIRCUIT
4) SWITCH
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: PANEL A12
PART NUMBER:

CAUSES: CONTAMINATION, PIECE-PART STRUCTURAL FAILURE

EFFECTS/RATIONALE:
LOSS OF ONE SET OF HEATERS FOR ONE APU'S FUEL TANK, FUEL LINES, AND WATER LINES, PLUS REDUNDANT HEATERS FOR ONE WATER TANK AND COMMON WATER LINES. LOSS OF BOTH SETS OF HEATERS WOULD ALLOW LINES TO FREEZE, RESULTING IN LOSS OF ONE APU.
CRITICALITY IS 3/1R DUE TO HEATER AND APU REDUNDANCY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/20/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 349 ABORT: 3/3

ITEM: APU HEATER, TANK/FUEL LINE/H20 SYS SWITCH
FAILURE MODE: FAIL TO OPEN, INADVERTENT OPERATION

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL/H20 HEATER CONTROL CIRCUIT
4) SWITCH
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		

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

LOCATION: PANEL A12
PART NUMBER:

CAUSES: PIECE-PART STRUCTURAL FAILURE, CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
CANNOT DEACTIVATE ONE SET OF HEATERS FOR ONE APU'S FUEL TANK, FUEL LINES, AND WATER LINES, PLUS REDUNDANT HEATERS FOR ONE WATER TANK AND COMMON WATER LINES. NO ADVERSE EFFECTS. OTHER SET OF HEATERS UNAFFECTED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/20/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 350 ABORT: 3/1R

ITEM: FUEL/H20 HEATER CONTROL CIRCUIT
FAILURE MODE: OPEN CIRCUIT, SHORT TO GROUND

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL/H20 LINE HEATER CONTROL CIRCUIT
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: AV BAY 4,5,6
PART NUMBER: VS70-460109

CAUSES: INSTALLATION ERROR, HANDLING DAMAGE, CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF ONE SET OF REDUNDANT HEATERS FOR ONE APU'S FUEL TANK, FUEL LINES, OR WATER LINES, OR ONE WATER TANK. LOSS OF BOTH SETS OF HEATERS WOULD ALLOW LINES TO FREEZE, RESULTING IN, AS A WORST CASE, LOSS OF ONE APU. CRITICALITY IS 3/1R DUE TO HEATER AND APU REDUNDANCY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 351 ABORT: 3/1R

ITEM: FUEL/H20 HEATER CONTROL CIRCUIT
FAILURE MODE: CIRCUIT DRIVER FAIL ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL/H20 LINE HEATER CONTROL CIRCUIT
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/1R		

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

LOCATION: AV BAY 4,5,6 (AFT LCA 1,2,3)
PART NUMBER: VS70-460109

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
NO EFFECT, DUE TO MULTIPLE DRIVERS IN SERIES. IF ALL DRIVERS FAILED ON, HEATERS WOULD BE FAILED ON, LEADING TO OVERHEATING AND FUEL DETONATION. CRITICALITY IS 3/1R, DUE TO ENTRY FIRE HAZARD BEING TWO FAILURES AWAY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/26/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 352 ABORT: 1/1

ITEM: FUEL/H2O HEATER CONTROL CIRCUIT
FAILURE MODE: FUEL PUMP DRAIN LINE HEATER THERMOSTAT INPUT DRIVER FAIL ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) FUEL/H2O LINE HEATER CONTROL CIRCUIT
4) FUEL PUMP DRAIN LINE HEATER THERMOSTAT INPUT DRIVER
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:	2/1R	AOA:	3/3
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	1/1		

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

LOCATION: AV BAY 4,5,6 (AFT LCA 1,2,3)
PART NUMBER: VS70-460109

CAUSES: MANUFACTURING DEFECT, SHORT

EFFECTS/RATIONALE:
HEATER IS STUCK ON IF HEATER SWITCH IS IN "AUTO" POSITION - IF FUEL IS PRESENT IN LINE, IT WILL OVERHEAT AND DETONATE BEFORE FDA ALARM. FUEL LEAK - FIRE HAZARD. CRITICALITY IS 1/1 DUE TO FIRE HAZARD.

REFERENCES: ROCKWELL INTERNATIONAL RECOMMENDED CIL CHANGE 6-13-86 (CIL 1219.2). ROCKWELL INTERNATIONAL PRESENTATION "APU DRAIN LINE HEATER SAFETY CONCERN", PRESENTED BY J.L. SCHAEFER, JUNE 1986.

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 353 ABORT: 3/1R

ITEM: "APU HEATER-GAS GEN/FUEL PUMP" SWITCH
FAILURE MODE: FAIL TO CLOSE, FAIL TO REMAIN CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) GG/FUEL PUMP HEATER CONTROL CIRCUIT
4) SWITCH
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: PANEL A12
PART NUMBER:

CAUSES: CONTAMINATION, PIECE-PART STRUCTURAL FAILURE

EFFECTS/RATIONALE:
LOSS OF ONE SET OF GAS GENERATOR BED HEATERS AND FUEL PUMP/GGVM HEATERS, FOR ONE APU. IF BOTH SETS OF HEATERS ARE LOST, FUEL CAN FREEZE AND APU WILL BE LOST. CRITICALITY IS 3/1R DUE TO HEATER AND APU REDUNDANCY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 354 ABORT: 3/1R

ITEM: "APU HEATER-GAS GEN/FUEL PUMP" SWITCH
FAILURE MODE: FAIL TO OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) GG/FUEL PUMP HEATER CONTROL CIRCUIT
4) SWITCH
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: PANEL A12
PART NUMBER:

CAUSES: PIECE-PART STRUCTURAL FAILURE, CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
CANNOT DEACTIVATE ONE SET OF HEATERS OR ACTIVATE REDUNDANT SET (FOR ONE APU). STARTING APU WILL AUTOMATICALLY INHIBIT THESE HEATERS. CRITICALITY IS 3/1R DUE TO HEATER AND APU REDUNDANCY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 355 ABORT: 3/1R

ITEM: GAS GEN/FUEL PUMP HEATER CONTROL CIRCUIT
FAILURE MODE: OPEN CIRCUIT, SHORT TO GROUND

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) GG/FUEL PUMP HEATER CONTROL CIRCUIT
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT LCA 1,2,3
PART NUMBER: VS70-460109

CAUSES: INSTALLATION ERROR, HANDLING DAMAGE

EFFECTS/RATIONALE:
LOSS OF ONE OF TWO REDUNDANT HEATERS FOR ONE APU'S GAS GENERATOR BED OR GGVM/FUEL PUMP. LOSS OF BOTH HEATERS WOULD ALLOW FUEL TO FREEZE, CAUSING LOSS OF APU. CRITICALITY IS 3/1R DUE TO HEATER AND APU REDUNDANCY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 356 ABORT: 2/1R

ITEM: GAS GEN/FUEL PUMP HEATER CONTROL CIRCUIT
FAILURE MODE: CIRCUIT DRIVER FAIL ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) GG/FUEL PUMP HEATER CONTROL CIRCUIT
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [F]

LOCATION: AFT LCA 1,2,3
PART NUMBER: VS70-460109

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
NO EFFECT, DUE TO TWO DRIVERS IN SERIES. IF BOTH DRIVERS FAILED ON, ONE APU'S GAS GENERATOR BED HEATER OR FUEL PUMP/GGVM HEATER WOULD BE FAILED ON, RESULTING IN FUEL OVERHEATING AND DETONATION. CRITICALITY IS 2/1R (ONE FAILURE AWAY FROM CRITICALITY 1/1).

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 357 ABORT: 2/1R

ITEM: "APU HEATER, LUBE OIL LINE" SWITCH
FAILURE MODE: FAIL TO CLOSE, FAIL TO REMAIN CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) LUBE OIL LINE HEATER CONTROL CIRCUIT
4) SWITCH
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:	2/1R	ATO:	2/1R
LANDING/SAFING:	2/1R		

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

LOCATION: PANEL A12
PART NUMBER:

CAUSES: CONTAMINATION, PIECE-PART STRUCTURAL FAILURE

EFFECTS/RATIONALE:
WORST CASE IS LOSS OF ALL LUBE OIL LINE HEATERS FOR ONE APU; LUBE OIL TEMP WILL DROP BELOW 0DEG. F. AND APU WILL BE LOST.
CRITICALITY IS 2/1R DUE TO APU REDUNDANCY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 358 ABORT: 3/1R

ITEM: "APU HEATER, LUBE OIL LINE" SWITCH
FAILURE MODE: FAIL TO OPEN

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) LUBE OIL LINE HEATER CONTROL CIRCUIT
4) SWITCH
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: PANEL A12
PART NUMBER:

CAUSES: CONTAMINATION (SHORT), PIECE-PART STRUCTURAL FAILURE

EFFECTS/RATIONALE:
ONE SET OF LUBE OIL LINE HEATERS IS FAILED ON, AND OTHER SET CAN'T BE ACTIVATED (WORST CASE). CRITICALITY IS 3/1R, SINCE HEATER REDUNDANCY IS LOST FOR ONE APU.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 359 ABORT: 3/3

ITEM: "APU HEATER, LUBE OIL LINE" SWITCH
FAILURE MODE: INADVERTENT OPERATION

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) LUBE OIL LINE HEATER CONTROL CIRCUIT
4) SWITCH
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		

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

LOCATION: PANEL A12
PART NUMBER:

CAUSES: CONTAMINATION(SHORT), VIBRATION

EFFECTS/RATIONALE:
ONE SET OF LUBE OIL LINE HEATERS IS FAILED ON; OTHER SET IS UNAFFECTED. NO ADVERSE EFFECTS ON APU.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 360 ABORT: 3/1R

ITEM: LUBE OIL LINE HEATER CONTROL CIRCUIT
FAILURE MODE: OPEN CIRCUIT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) LUBE OIL LINE HEATER CONTROL CIRCUIT
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: AV BAY 4,5,6
PART NUMBER: VS70-460109

CAUSES: HANDLING DAMAGE, INSTALLATION ERROR

EFFECTS/RATIONALE:
WORST CASE IS LOSS OF ONE OF TWO SETS OF LUBE OIL LINE HEATERS FOR ONE APU. IF ALL HEATERS ARE LOST, LUBE OIL TEMP WILL DROP BELOW 0 DEG. F. AND APU WILL BE LOST. CRITICALITY IS 3/1R DUE TO HEATER AND APU REDUNDANCY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 361 ABORT: 3/3

ITEM: LUBE OIL LINE HEATER CONTROL CIRCUIT
FAILURE MODE: DRIVER FAIL ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) LUBE OIL LINE HEATER CONTROL CIRCUIT
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		

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

LOCATION: AV BAY 4,5,6
PART NUMBER: VS70-460109

CAUSES: MANUFACTURING DEFECT

EFFECTS/RATIONALE:
NO EFFECT, DUE TO 3 DRIVERS IN SERIES. IF ALL DRIVERS FAILED ON, HEATER WOULD BE FAILED ON. NO ADVERSE EFFECTS ON APU.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/23/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 362 ABORT: 3/3

ITEM: BITE INITIATE DRIVER
FAILURE MODE: FAIL OFF, FAIL TO REMAIN ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) BITE CIRCUIT
4) DRIVER
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		

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

LOCATION: AFT LCA 1,2,3
PART NUMBER: MC477-0261-0002

CAUSES: CONTAMINATION, PIECE-PART STRUCTURAL FAILURE

EFFECTS/RATIONALE:
NO BITE FUNCTION FOR APU CONTROLLER-POSSIBLE LAUNCH DELAY. BITE IS NOT USED DURING FLIGHT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/23/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 363 ABORT: /NA

ITEM: BITE INITIATE DRIVER
FAILURE MODE: FAIL ON, INADVERTENT OPERATION

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) BITE CIRCUIT
4) DRIVER
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT LCA 1,2,3
PART NUMBER: MC477-0261-0002

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
FAILURE IS ONLY POSSIBLE PRE-LAUNCH, AND WILL INHIBIT APU START - LAUNCH DELAY. THIS DRIVER RECEIVES NO POWER AFTER LIFTOFF.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 364 ABORT: 3/3

ITEM: "APU FUEL/H2O QTY" GAUGE
FAILURE MODE: NO OUTPUT, OR ERRONEOUS OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) DISPLAYS
3) FUEL QUANTITY GAUGE
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		

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

LOCATION: PANEL F8
PART NUMBER:

CAUSES: MANUFACTURING DEFECT, PIECE-PART STRUCTURAL FAILURE, VIBRATION, MECHANICAL SHOCK, CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF FUEL QUANTITY READING FOR ONE APU. FUEL TANK PRESSURE STILL AVAILABLE TO CREW ON CRT (2 READINGS), AND TELEMETERED TO GROUND. APU STILL USABLE WITH ALL THESE MEASUREMENTS LOST.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 365 ABORT: 3/3

ITEM: "APU FUEL/H20 QTY" SWITCH
FAILURE MODE: FAIL TO CLOSE, FAIL TO REMAIN CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) DISPLAYS
3) FUEL QUANTITY GAUGE
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		

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

LOCATION: PANEL F8
PART NUMBER:

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

EFFECTS/RATIONALE:
LOSS OF FUEL QUANTITY MEASUREMENT FOR ALL 3 APU'S. FUEL TANK PRESSURE STILL AVAILABLE TO CREW ON CRT AND TELEMETERED TO GROUND. APU STILL USABLE WITH ALL THESE MEASUREMENTS LOST.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86
SUBSYSTEM: APU
MDAC ID: 366

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: "APU FUEL/H20 QTY" SWITCH
FAILURE MODE: FAIL TO OPEN, INADVERTANT OPERATION

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) DISPLAYS
3) FUEL QUANTITY GAUGE
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		

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

LOCATION: PANEL F8
PART NUMBER:

CAUSES: CONTAMINATION (SHORT), PIECE-PART STRUCTURAL FAILURE, VIBRATION

EFFECTS/RATIONALE:
GAUGE ONLY READS FUEL QUANTITY, NO WATER SPRAY BOILER WATER QUANTITY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 367 ABORT: 3/3

ITEM: "APU FUEL PRESS" GAUGE
FAILURE MODE: NO OUTPUT, OR ERRONEOUS OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) DISPLAYS
3) FUEL PRESSURE GAUGE
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		

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

LOCATION: PANEL F8
PART NUMBER:

CAUSES: MANUFACTURING DEFECT, PIECE-PART STRUCTURAL FAILURE, VIBRATION, MECHANICAL SHOCK, CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF FUEL PRESSURE READING FOR ALL 3 APU'S; FUEL PRESSURE IS STILL AVAILABLE ON CRT (2 READINGS) AND TELEMETERED TO GROUND. FUEL QUANTITY AVAILABLE IN GAUGE AND TELEMETERED TO GROUND. APU'S STILL USABLE WITH ALL MEASUREMENTS LOST.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 368 ABORT: 3/3

ITEM: "APU EGT" GAUGE
FAILURE MODE: NO OUTPUT, OR ERRONEOUS OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) DISPLAYS
3) EXHAUST GAS TEMPERATURE GAUGE
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		

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

LOCATION: PANEL F8
PART NUMBER:

CAUSES: MANUFACTURING DEFECT, PIECE-PART STRUCTURAL FAILURE, VIBRATION, MECHANICAL SHOCK, CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF EGT READING FOR ALL 3 APU'S; EGT IS STILL AVAILABLE ON CRT (2 READINGS) AND TELEMETERED TO THE GROUND. APU'S ARE STILL USABLE WITH ALL EGT MEASUREMENTS LOST.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 369 ABORT: 3/3

ITEM: "APU OIL TEMP" GAUGE
FAILURE MODE: NO OUTPUT, OR ERRONEOUS OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) DISPLAYS
3) LUBE OIL TEMPERATURE GAUGE
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		

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

LOCATION: PANEL F8
PART NUMBER:

CAUSES: MANUFACTURING DEFECT, PICE-PART STRUCTURAL FAILURE, VIBRATION, MECHANICAL SHOCK, CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF OIL TEMP READING FOR ALL 3 APU'S. OIL TEMP IS STILL AVAILABLE TO CREW ON CRT (2 READINGS + 2 GEARBOX TEMP READINGS), AND TELEMETERED TO GROUND. APU IS STILL USABLE WITH ALL OIL TEMP MEASUREMENTS LOST.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86
SUBSYSTEM: APU
MDAC ID: 370

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: GAUGING APU SELECT SWITCH
FAILURE MODE: FAIL TO CLOSE, FAIL TO REMAIN CLOSED

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) DISPLAYS
3) GAUGING APU SELECT SWITCH
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		

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

LOCATION: PANEL F8
PART NUMBER:

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

EFFECTS/RATIONALE:
WORST CASE EFFECT IS LOSS OF EGT, FUEL PRESSURE, AND OIL TEMP READINGS FOR ALL 3 APU'S. ALL ARE BACKED UP BY CRT READINGS AND TELEMETRY. APU IS USABLE WITH ALL THESE MEASUREMENTS LOST.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 371 ABORT: 3/3

ITEM: GAUGING APU SELECT SWITCH
FAILURE MODE: FAIL TO OPEN, INADVERTENT OPERATION

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) DISPLAYS
3) GAUGING APU SELECT SWITCH
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		

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

LOCATION: PANEL F8
PART NUMBER:

CAUSES: PIECE-PART STRUCTURAL FAILURE, CONTAMINATION (SHORT), VIBRATION

EFFECTS/RATIONALE:
WORST CASE EFFECT, GAUGE READS EGT, FUEL PRESSURE, AND OIL TEMP FOR ONE APU ONLY. OTHER APU READINGS ARE BACKED UP BY CRT READINGS AND TELEMETRY. APU'S ARE USABLE WITH ALL THESE MEASUREMENTS LOST.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86
SUBSYSTEM: APU
MDAC ID: 372

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: "APU/HYD READY TO START" TALKBACK
FAILURE MODE: FAIL OFF

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) DISPLAYS
3) READY-TO-START 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		

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

LOCATION: PANEL R2
PART NUMBER:

CAUSES: LOGIC FAILURE, CONTAMINATION, OPEN CIRCUIT, PIECE-PART STRUCTURAL FAILURE

EFFECTS/RATIONALE:
APU NEVER SHOWS "READY TO START" CONDITION. CONDITIONS CAN BE VERIFIED BY CRT OR TELEMETRY; APU IS OKAY TO START.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 373 ABORT: 3/3

ITEM: "APU/HYD READY TO START" TALKBACK
FAILURE MODE: FAIL ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) DISPLAYS
3) READY-TO-START 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		

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

LOCATION: PANEL R2
PART NUMBER:

CAUSES: LOGIC FAILURE, CONTAMINATION

EFFECTS/RATIONALE:
APU ALWAYS SHOWS "READY TO START" CONDITION. CONDITION CAN BE VERIFIED BY CRT OR TELEMETRY. APU IS OKAY TO START.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 374 ABORT: 2/1R

ITEM: GEARBOX N2 PRESSURE SENSOR V46P0151A(251,351)
FAILURE MODE: NO OUTPUT, OR ERRONEOUS OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INSTRUMENTATION
3) GEARBOX N2 PRESSURE SENSOR
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, PIECE-PART STRUCTURAL FAILURE, VIBRATION, MECHANICAL SHOCK, CONTAMINATION, HANDLING DAMAGE

EFFECTS/RATIONALE:
IF OUTPUT IS BELOW 5.5 PSIA, APU WILL NOT START EXCEPT IN OVERRIDE. GEARBOX PRESSURIZATION VALVE STAYS OPEN AFTER APU STARTUP, DUMPS GN2 BOTTLE INTO GEARBOX. A GEARBOX LEAK OR GN2 LEAK CAN CAUSE LOSS OF APU.
CRITICALITY IS 3/1R (GN2 LEAK + ANOTHER APU LOST = CRITICALITY 1). ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS, WHERE LOSS OF 1 APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/22/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 375 ABORT: 3/1R

ITEM: GAS GENERATOR BED TEMPERATURE SENSOR
V46T0122A(222,322)
FAILURE MODE: NO OUTPUT, OR ERRONEOUS OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INSTRUMENTATION
3) GAS GENERATOR BED TEMP. SENSOR
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, PIECE-PART STRUCTURAL FAILURE, VIBRATION, MECHANICAL SHOCK, CONTAMINATION, HANDLING DAMAGE

EFFECTS/RATIONALE:
LOSS OF SENSOR, OR READING <190 F, MEANS LOSS OF NORMAL APU START; APU MUST BE STARTED IN OVERRIDE MODE. ALSO, GAS GENERATOR BED HEATERS ARE ON CONTINUOUSLY IN AUTO MODE IF SENSOR OUTPUT IS SHIFTED LOW, OR MUST REVERT TO BACKUP THERMOSTAT CONTROL IF SENSOR OUTPUT IS SHIFTED HIGH. NO EFFECT WHILE APU IS RUNNING. CRITICALITY IS 3/1R DUE TO LOSS OF 1 OF 2 METHODS FOR STARTING AN APU, AND APU REDUNDANCY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/25/86
SUBSYSTEM: APU
MDAC ID: 376

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/1R
ABORT: 3/1R

ITEM: FUEL TEST LINE TEMPERATURE SENSOR V46T0183A (283,383) V46T0184A (284,384)
FAILURE MODE: NO OUTPUT, OR ERRONEOUS OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INSTRUMENTATION
3) FUEL TEST LINE TEMPERATURE SENSORS
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:	3/1R	AOA:	3/3
DEORBIT:	3/1R	ATO:	3/3
LANDING/SAFING:	3/1R		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME449-0160-0003

CAUSES: MANUFACTURING DEFECT, PIECE-PART STRUCTURAL FAILURE, VIBRATION, MECHANICAL SHOCK, CONTAMINATION, HANDLING DAMAGE

EFFECTS/RATIONALE:
BOTH SENSORS ARE MOUNTED ON FUEL LINE CLAMP - A LOOSE CLAMP CAN RENDER BOTH SENSORS USELESS. WITH NO TEMPERATURE SENSING, A FAILED-ON HEATER CAN CAUSE FUEL DETONATION AND FIRE HAZARD. CRITICALITY IS 3/1R (HEATER FAILED ON + 2 SENSORS FAILED = CRITICAL).

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	11/25/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	APU	FLIGHT:	3/1R
MDAC ID:	377	ABORT:	3/1R

ITEM: FUEL PUMP SEAL CAVITY DRAIN LINE TEMPERATURE
SENSOR V46T0186A (286,386) V46T0170A (270,370)
FAILURE MODE: NO OUTPUT, OR ERRONEOUS OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INSTRUMENTATION
3) FUEL PUMP SEAL CAVITY DRAIN
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:	3/1R	AOA:	3/3
DEORBIT:	3/1R	ATO:	3/3
LANDING/SAFING:	3/1R		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: ME449-0160-0003

CAUSES: MANUFACTURING DEFECT, PIECE-PART STRUCTURAL FAILURE, VIBRATION, MECHANICAL SHOCK, CONTAMINATION, HANDLING DAMAGE

EFFECTS/RATIONALE:
BOTH SENSORS ARE MOUNTED ON DRAIN LINE CLAMP - A LOOSE CLAMP CAN RENDER BOTH SENSORS USELESS. WITH NO TEMPERATURE SENSING, AND FUEL IN THE LINE FROM A FUEL PUMP SEAL LEAK, A FAILED-ON HEATER CAN CAUSE FUEL DETONATION AND FIRE HAZARD.
CRITICALITY IS 3/1R (FUEL PUMP SEAL LEAK + HEATER FAILED ON + 2 SENSORS FAILED = CRITICAL).

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86
SUBSYSTEM: APU
MDAC ID: 378

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: NONCRITICAL INSTRUMENTATION
FAILURE MODE: NO OUTPUT, OR ERRONEOUS OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) INSTRUMENTATION
3) NONCRITICAL INSTRUMENTATION
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		

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

LOCATION: AFT COMPARTMENT
PART NUMBER: NA

CAUSES: CONTAMINATION, SHORT CIRCUIT, MANUFACTURING DEFECT, HANDLING DAMAGE

EFFECTS/RATIONALE:
LOSS OF MEASUREMENT - APU IS STILL USABLE WITH LOSS OF ALL BACKUP MEASUREMENTS. NOTE: THIS CATEGORY INCLUDES ALL TRANSDUCERS NOT LISTED INDIVIDUALLY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/05/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 379 ABORT: 2/1R

ITEM: CONTROLLER SAFETY MONITORING
FAILURE MODE: NO SHUTDOWN SIGNAL

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) SAFETY MONITORING
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [F] C [F]

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
NO AUTOMATIC SHUTDOWN FOR APU OVERSPEED OR UNDERSPEED; POSSIBLE APU TURBINE OVERSPEED AND STRUCTURAL FAILURE. CRITICALITY IS 2/1R: 1 FAILURE AWAY FROM CRITICALITY 1/1.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/05/86
SUBSYSTEM: APU
MDAC ID: 380

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
ABORT: 1/1

ITEM: CONTROLLER SAFETY MONITORING
FAILURE MODE: SPURIOUS SHUTDOWN SIGNAL

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) SAFETY MONITORING
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
ONE APU WILL SHUT DOWN. CAN BE RESTARTED IN "INHIBIT" MODE.
CRITICALITY IS 2/1R DUE TO APU REDUNDANCY.
ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS, WHERE LOSS OF 1 APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/05/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 381 ABORT: 2/1R

ITEM: CONTROLLER POWER SUPPLY
FAILURE MODE: OPEN CIRCUIT, OR SHORT CIRCUIT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) POWER SUPPLY
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: CONTAMINATION, BROKEN WIRE

EFFECTS/RATIONALE:
LOSS OF REDUNDANT POWER TO APU CONTROLLER; IF BOTH POWER SUPPLIES ARE LOST, ONE APU IS LOST. CRITICALITY IS 3/1R, DUE TO POWER SUPPLY AND APU REDUNDANCY.
ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/05/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 382 ABORT: 2/1R

ITEM: CONTROLLER PRIMARY SPEED CONTROL
FAILURE MODE: LOSS OF OUTPUT, INTERMITTENT OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) SPEED CONTROL
4) PRIMARY SPEED CONTROL
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF OUTPUT TO PRIMARY FUEL VALVE; APU SHIFTS TO HIGH SPEED (113%) AS SECONDARY VALVE TAKES OVER. CRITICALITY IS 3/1R DUE TO REDUNDANCY OF SPEED CONTROL CIRCUITS AND APU'S.
ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/05/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 383 ABORT: 1/1

ITEM: CONTROLLER PRIMARY SPEED CONTROL
FAILURE MODE: OUTPUT FAILED ON, SPURIOUS OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) SPEED CONTROL
4) PRIMARY SPEED CONTROL
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
PRIMARY FUEL VALVE CLOSES, SHUTTING DOWN APU. CRITICALITY IS 2/1R DUE TO APU REDUNDANCY.
ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86
SUBSYSTEM: APU
MDAC ID: 384

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
ABORT: 1/1

ITEM: CONTROLLER SECONDARY SPEED CONTROL
FAILURE MODE: LOSS OF OUTPUT, INTERMITTENT OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) SPEED CONTROL
4) SECONDARY SPEED CONTROL
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
SECONDARY FUEL VALVE CLOSES, SHUTTING DOWN APU. CRITICALITY IS 2/1R DUE TO APU REDUNDANCY.
ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 385 ABORT: 2/1R

ITEM: CONTROLLER SECONDARY SPEED CONTROL
FAILURE MODE: OUTPUT FAILED ON, SPURIOUS OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) SPEED CONTROL
4) SECONDARY SPEED CONTROL
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [F]

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
SECONDARY FUEL VALVE IS HELD OPEN. NO EFFECT UNLESS APU IS TAKEN TO HIGH SPEED - THEN, TURBINE WILL OVERSPEED AND COME APART. CRITICALITY IS 2/1R: 1 FAILURE AWAY FROM CRITICALITY 1. AUTO SHUTDOWN SHUTS FUEL TANK VALVES, BUT TURBINE CAN STILL OVERSPEED TO DESTRUCTION ON RESIDUAL FUEL LEFT IN LINES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86
SUBSYSTEM: APU
MDAC ID: 386

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
ABORT: 1/1

ITEM: CONTROLLER APU START LOGIC
FAILURE MODE: LOSS OF OUTPUT, INTERMITTENT OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) APU START LOGIC
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
APU WILL NOT OPERATE. CRITICALITY IS 2/1R DUE TO APU REDUNDANCY. ABORT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 387 ABORT: 3/3

ITEM: CONTROLLER APU START LOGIC
FAILURE MODE: OUTPUT FAILED ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) APU START LOGIC
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		

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

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: SHORT, MANUFACTURING DEFECT

EFFECTS/RATIONALE:
CONTROLLER ACTIVATION PRODUCES IMMEDIATE "START" SIGNAL. APU WILL START AS SOON AS FUEL TANK VALVES ARE OPENED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86
SUBSYSTEM: APU
MDAC ID: 388

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: CONTROLLER "READY" LOGIC
FAILURE MODE: LOSS OF OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) "READY" LOGIC
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		

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

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
NO "APU READY TO START" SIGNAL TO TALKBACK LOGIC. TALKBACK WILL NOT SHOW "READY". APU WILL BE STARTED ANYWAY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 389 ABORT: 3/3

ITEM: CONTROLLER "READY" LOGIC
FAILURE MODE: OUTPUT FAILED ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) "READY" LOGIC
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		

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

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
CONTROLLER WILL PRODUCE "APU READY TO START" SIGNAL AS SOON AS IT IS ACTIVATED. TALKBACK MAY NOT REFLECT APU'S TRUE STATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 390 ABORT: 2/1R

ITEM: CONTROLLER GEARBOX PRESSURE CONTROL
FAILURE MODE: LOSS OF OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) GEARBOX PRESSURE CONTROL
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [F] C [P]

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
CONTROLLER WILL NOT PRODUCE COMMAND TO OPEN GEARBOX PRESSURIZATION VALVE. IF GEARBOX LOSES PRESSURE (BELOW 5.5 PSIA), APU WILL ONLY START IN OVERRIDE; OIL PUMP MAY CAVITATE. CRITICALITY IS 3/1R: LOSS OF ONE APU IS ONE FAILURE AWAY (GEARBOX LEAK). ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 391 ABORT: 2/1R

ITEM: CONTROLLER GEARBOX PRESSURE CONTROL
FAILURE MODE: OUTPUT FAILED ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) GEARBOX PRESSURE CONTROL
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
GEARBOX PRESSURIZATION VALVE IS HELD OPEN; GN2 BOTTLE DUMPS INTO GEARBOX. IF GEARBOX LEAKS, APU CAN BE LOST. CRITICALITY IS 3/1R: 1 FAILURE AWAY FROM LOSS OF ONE APU.
ABORT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 2/1R
MDAC ID: 392 ABORT: 2/1R

ITEM: CONTROLLER GG BED HEATER CONTROL
FAILURE MODE: LOSS OF HEATER "ON" SIGNAL

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) HEATER CONTROL
4) GG BED HEATER CONTROL
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:	2/1R	AOA:	3/3
DEORBIT:	2/1R	ATO:	2/1R
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF GAS GENERATOR BED HEATERS. APU CANNOT BE STARTED SAFELY DUE TO POSSIBLE FUEL DETONATION. CRITICALITY IS 2/1R DUE TO APU REDUNDANCY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 393 ABORT: 3/3

ITEM: CONTROLLER GG BED HEATER CONTROL
FAILURE MODE: HEATER "ON" SIGNAL FAILED ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) HEATER CONTROL
4) GG BED HEATER CONTROL
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		

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

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
ONE OF TWO GAS GENERATOR BED HEATERS IS FAILED ON WHILE ACTIVE, BUT CAN BE DEACTIVATED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 394 ABORT: 3/1R

ITEM: CONTROLLER GG/FUEL PUMP HEATER INHIBIT
FAILURE MODE: LOSS OF HEATER "INHIBIT" SIGNAL

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) HEATER CONTROL
4) GG/FUEL PUMP HEATER INHIBIT
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
HEATER WILL ACTIVATE WHILE APU IS RUNNING, IF HEATER SWITCH IS ON, BUT THERMOSTATIC CONTROL WILL PREVENT HEATING WHILE GAS GENERATOR BED IS ABOVE 425 F. APU WILL NOT START IN NORMAL MODE IF HEATER SWITCH IS TURNED ON-MUST BE STARTED IN OVERRIDE MODE. CRITICALITY IS 3/1R DUE TO LOSS OF ONE APU START MODE AND APU REDUNDANCY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 395 ABORT: 3/3

ITEM: CONTROLLER GG/FUEL PUMP HEATER INHIBIT
FAILURE MODE: HEATER "INHIBIT" SIGNAL FAILED ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) HEATER CONTROL
4) GG/FUEL PUMP HEATER INHIBIT
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		

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

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
FAILED-ON SIGNAL WILL BE LOST ON ORBIT WHEN CONTROLLER IS POWERED OFF. ONE HEATER WILL BE INHIBITED WHEN CONTROLLER IS ACTIVATED FOR DEORBIT, BUT APU IS ACTIVATED SOON AFTER. NO EFFECT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 396 ABORT: 3/1R

ITEM: CONTROLLER START/OVERRIDE LOGIC
FAILURE MODE: LOSS OF START/OVERRIDE COMMAND

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) START/OVERRIDE LOGIC
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [NA] C [P]

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
APU WILL NOT START IN OVERRIDE MODE. NO EFFECT UNLESS ANOTHER FAILURE FORCES OVERRIDE START ATTEMPT. CRITICALITY IS 3/1R: 1 FAILURE AWAY FROM LOSS OF ONE APU.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 397 ABORT: 3/3

ITEM: CONTROLLER START/OVERRIDE LOGIC
FAILURE MODE: START/OVERRIDE COMMAND FAILED ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) START/OVERRIDE LOGIC
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		

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

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
APU WILL START AS SOON AS FUEL TANK VALVES ARE OPENED (IF CONTROLLER IS ON). NO EFFECT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 398 ABORT: 3/1R

ITEM: CONTROLLER START/OVERRIDE LOGIC
FAILURE MODE: LOSS OF INJECTOR COOLING VALVE COMMAND

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) START/OVERRIDE LOGIC
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:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [F] C [P]

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF REDUNDANT COMMAND TO OPEN INJECTOR COOLING VALVE FOR ONE APU. CRITICALITY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 399 ABORT: 1/1

ITEM: CONTROLLER START/OVERRIDE LOGIC
FAILURE MODE: INJECTOR COOLING VALVE COMMAND FAILED ON

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) START/OVERRIDE LOGIC
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:	1/1	ATO:	1/1
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [1] B [P] C [F]

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
WHEN CONTROLLER IS ACTIVATED, INJECTOR COOLING WATER WILL BE SPRAYED ON AFFECTED APU TO DEPLETION OR UNTIL CONTROLLER DEACTIVATION. NO EFFECT, EXCEPT LOSS OF HOT RESTART CAPABILITY. CRITICALITY IS 1/1 FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/3
MDAC ID: 400 ABORT: 3/3

ITEM: CONTROLLER BITE LOGIC
FAILURE MODE: LOSS OF OUTPUT, ERRONEOUS OUTPUT

LEAD ANALYST: J. BARNES SUBSYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) CONTROLLER
3) BITE LOGIC
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		

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

LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
CANNOT VERIFY CONTROLLER PRELAUNCH-POSSIBLE LAUNCH DELAY. BITE IS NOT USED AFTER LIFTOFF.

REFERENCES:

APPENDIX D
POTENTIAL CRITICAL ITEMS

MDAC-ID	ITEM	FAILURE MODE
100	GAS GENERATOR	NO OUTPUT OR LOW OUTPUT
101	GAS GENERATOR	LEAK
102	TURBINE WHEEL	STRUCTURAL FAILURE
103	TURBINE WHEEL	BINDING
104	EXHAUST DUCT	LEAK
105	EXHAUST DUCT BELLOWS	LEAK
106	GEARBOX	LOSS OF OUTPUT
112	MAGNETIC PICKUP UNIT 1	NO OUTPUT, OR INTERMITTENT OUTPUT
115	FUEL TANK	RUPTURE AT OPERATING PRESSURE
116	FUEL TANK	EXTERNAL LEAK (FUEL)
117	FUEL TANK	EXTERNAL LEAK (GN2)
118	FUEL TANK	INTERNAL LEAK THROUGH DIAPHRAGM
119	FUEL TANK GN2 LINE	LEAK
120	FUEL TANK GN2 FILL COUPLING	EXTERNAL LEAK
123	FUEL TANK ISOLATION VALVE	FAILS TO CLOSE (STUCK OPEN); INTERNAL LEAK
125	FUEL TANK ISOLATION VALVE	BARRIER LEAK
126	FUEL TANK ISOLATION VALVE	EXTERNAL LEAK
127	FUEL TANK ISOLATION VALVE	FAILS TO RELIEVE
128	FUEL PUMP	INTERNAL LEAK PAST FACE SEAL
129	FUEL PUMP	EXTERNAL LEAK
130	FUEL PUMP	NO OUTPUT OR LOW OUTPUT
131	FUEL PUMP BYPASS VALVE	FAILS OPEN
132	FUEL PUMP BYPASS VALVE	FAILS CLOSED
133	FUEL PUMP RELIEF VALVE	RELIEVES AT LOW PRESSURE/FAILS OPEN
134	FUEL PUMP RELIEF VALVE	FAILS TO RELIEVE
135	FUEL PUMP RELIEF VALVE	EXTERNAL LEAK
136	FUEL PUMP FILTER	BLOCKAGE
137	FUEL PUMP FILTER	FAILS OPEN-NO FILTERING
138	FUEL PUMP DRAIN COUPLING	EXTERNAL LEAK
140	PRIMARY FUEL VALVE	FAILS TO OPEN (STUCK CLOSED)
142	PRIMARY FUEL VALVE	INTERNAL LEAK TO BYPASS
143	PRIMARY FUEL VALVE	INTERNAL BARRIER LEAK
144	PRIMARY FUEL VALVE	EXTERNAL LEAK

MDAC-ID	ITEM	FAILURE MODE
145	SECONDARY FUEL VALVE	FAILS TO OPEN; FAILS TO REMAIN OPEN
147	SECONDARY FUEL VALVE	FAILS MID-POSITION
149	SECONDARY FUEL VALVE	INTERNAL LEAK TO BYPASS
150	SECONDARY FUEL VALVE	EXTERNAL LEAK
151	FUEL LINE-UPSTREAM OF TANK ISOL	EXTERNAL LEAK
152	FUEL LINE-DOWNSTREAM OF TANK ISOL	EXTERNAL LEAK
153	FUEL TANK HYDRAZINE FILL COUPLING	EXTERNAL LEAK
155	FUEL LINE TEST POINT COUPLING	EXTERNAL LEAK
156	FUEL LINE TEST POINT COUPLING	FAILS CLOSED
157	FUEL LINE FLEX HOSE	LEAK
158	FUEL LINE HIGH POINT BLEED COUPLING	EXTERNAL LEAK
170	FUEL PUMP SEAL CAVITY DRAIN LINE	FAIL CLOSED
174	FUEL IN-LINE FILTER	BLOCKAGE
175	FUEL IN-LINE FILTER	EXTERNAL LEAK
176	FUEL IN-LINE FILTER	FAILS OPEN-NO FILTERING
177	SEAL CAVITY DRAIN LINE	EXTERNAL LEAK
178	SEAL CAVITY DRAIN FLEX HOSE	EXTERNAL LEAK
180	SEAL CAVITY DRAIN RELIEF VALVE	LOW CRACKING PRESSURE
181	SEAL CAVITY DRAIN RELIEF VALVE	FAILS TO RESEAT (FAILS OPEN), LEAK
183	SEAL CAVITY DRAIN RELIEF VALVE	EXTERNAL LEAK
184	SEAL CAVITY DRAIN CATCH BOTTLE	LEAK
185	SEAL CAVITY DRAIN CATCH BOTTLE DRAIN VALVE	LEAK
187	LUBE OIL PUMP	NO OUTPUT OR LOW OUTPUT
189	GEARBOX GN2 BOTTLE	RUPTURE AT OPERATING PRESSURE
195	GEARBOX PRESSURIZATION VALVE	EXTERNAL LEAK
197	LUBE OIL LINES	LEAK
198	LUBE OIL LINE FLEX HOSES	LEAK
199	GEARBOX FILL COUPLING	EXTERNAL LEAK
201	GEARBOX HIGH POINT VENT COUPLING	EXTERNAL LEAK
203	GEARBOX CHIP DETECTOR	EXTERNAL LEAK
204	GEARBOX LOW POINT DRAIN COUPLING	EXTERNAL LEAK
206	GEARBOX HIGH POINT DRAIN COUPLING	EXTERNAL LEAK
208	WSB DRAIN COUPLING	EXTERNAL LEAK

MDAC-ID	ITEM	FAILURE MODE
214	LUBE OIL FILTER	FAILS OPEN/NO FILTERING
215	LUBE OIL FILTER	EXTERNAL LEAK
216	OIL FILTER BYPASS RELIEF VALVE	FAILS CLOSED
217	OIL FILTER BYPASS RELIEF VALVE	FAILS TO CLOSE (STUCK OPEN), OR FAILS OPEN, OR LEAKS
219	GEARBOX BYPASS RELIEF VALVE	FAILS OPEN, OR FAILS TO CLOSE, OR LEAKS
220	LUBE OIL ACCUMULATOR (ADD-ON)	EXTERNAL LEAK
221	LUBE OIL ACCUMULATOR (ADD-ON)	INTERNAL LEAK
222	LUBE OIL ACCUMULATOR (INTEGRAL)	EXTERNAL LEAK
223	LUBE OIL ACCUMULATOR (INTEGRAL)	INTERNAL LEAK
224	INJECTOR COOLING VALVE	EXTERNAL LEAK
225	INJECTOR COOLING VALVE	INTERNAL LEAK
226	INJECTOR COOLING VALVE	FAIL TO OPEN, FAIL TO REMAIN OPEN
228	INJECTOR COOLING VALVE	BARRIER FAILURE
229	INJECTOR COOLING WATER TANK	EXTERNAL LEAK (WATER OR N2)
231	INJECTOR COOLING GN2 FILL COUPLING	EXTERNAL LEAK
233	INJECTOR COOLING WATER LINES (MANIFOLD)	EXTERNAL LEAK
234	INJECTOR COOLING WATER LINES (MANIFOLD)	BLOCKAGE
235	INJECTOR COOLING WATER FILL COUPLING	EXTERNAL LEAK
237	INJECTOR COOLING WATER LINE-APU X	EXTERNAL LEAK
238	INJECTOR COOLING WATER LINE-APU X	BLOCKAGE
239	INJECTOR COOLING WATER LINE FLEX HOSE	LEAK
246	FUEL PUMP/GGVM COOLING RELIEF VALVE	FAIL CLOSED; RELIEVE OVER SPEC
248	FUEL PUMP/GGVM COOLING RELIEF VALVE	EXTERNAL LEAK
249	FUEL PUMP/GGVM COOLING GN2 LINE	EXTERNAL LEAK
251	FUEL PUMP/GGVM COOLING VALVE	FAIL OPEN (FAIL TO CLOSE), INTERNAL LEAK
254	FUEL PUMP/GGVM COOLING WATER TANK	EXTERNAL LEAK (WATER OR N2)
255	FUEL PUMP/GGVM COOLING WATER TANK	DIAPHRAGM LEAK
256	FUEL PUMP/GGVM COOLING WATER LINES - BETWEEN TANK AND TANK VALVES	LEAK

MDAC-ID	ITEM	FAILURE MODE
257	FUEL PUMP/GGVM COOLING WATER LINES - BETWEEN TANK AND TANK VALVES	BLOCKAGE
258	FUEL PUMP/GGVM COOLING WATER FILL COUPLING	LEAK
260	FUEL PUMP/GGVM COOLING WATER LINES - BETWEEN TANK VALVE AND APU	LEAK
264	FUEL PUMP/GGVM COOLING WATER TANK VALVE	FAIL TO OPEN; FAIL TO REMAIN OPEN
266	FUEL PUMP/GGVM COOLING WATER TANK VALVE	INTERNAL BARRIER LEAK
267	FUEL PUMP/GGVM COOLING WATER TANK VALVE	EXTERNAL LEAK
276	EXHAUST PLENUM HOUSING	EXTERNAL LEAK
277	EXHAUST PLENUM HOUSING	CRACKING
278	EXHAUST PLENUM HOUSING	INTERNAL LEAK
279	GEARBOX HOUSING	LEAK
280	"APU CONTROL" SWITCH	FAIL TO CLOSE
281	"APU CONTROL" SWITCH	FAIL TO REMAIN CLOSED
282	"APU CONTROL" SWITCH	FAIL TO OPEN (STUCK IN "START/RUN")
286	APU CONTROL CIRCUIT SWITCH POWER FUSE	FAIL OPEN
287	APU CONTROL CIRCUIT START CONTROL INPUT DIODE	FAIL OPEN, SHORT TO GROUND
288	"APU CNTLR PWR" SWITCH	FAIL TO CLOSE
289	"APU CNTLR PWR" SWITCH	FAIL TO REMAIN CLOSED
306	"APU AUTO SHUTDOWN" SWITCH	FAIL TO REMAIN CLOSED
314	FUEL TANK VALVE SWITCH	FAIL TO CLOSE
315	FUEL TANK VALVE SWITCH	FAIL TO REMAIN CLOSED
316	FUEL TANK VALVE SWITCH	FAIL TO OPEN
317	FUEL TANK VALVE SWITCH	INADVERTENT OPERATION
319	FUEL TANK VALVE CIRCUIT DRIVER	FAIL ON
322	FUEL TANK VALVE SWITCH POWER FUSE	FAIL OPEN
323	FUEL TANK VALVE SWITCH OUTPUT DIODE	FAIL OPEN, OR SHORT TO GROUND
326	"PUMP/VLV COOL" SWITCH	FAIL TO CLOSE, FAIL TO REMAIN CLOSED
328	"PUMP/VLV COOL" SWITCH	INADVERTENT OPERATION
329	"PUMP/VLV COOL" SWITCH POWER CIRCUIT POWER FUSE	FAIL OPEN
330	FUEL PUMP/GGVM COOLING CONTROL CIRCUIT POWER FUSE	FAIL OPEN
331	FUEL PUMP/GGVM COOLING CONTROL CIRCUIT POWER INPUT DIODE	FAIL OPEN

MDAC-ID	ITEM	FAILURE MODE
332	FUEL PUMP/GGVM COOLING CONTROL CIRCUIT POWER INPUT DIODE	SHORT TO GROUND
333	FUEL PUMP/GGVM COOLING CONTROL CIRCUIT INPUT RESISTOR	FAIL OPEN, OR HIGH RESISTANCE
334	FUEL PUMP/GGVM COOLING CONTROL CIRCUIT INPUT RESISTOR	INTERNAL SHORT, LOW RESISTANCE, OR SHORT TO GROUND
335	FUEL PUMP/GGVM COOLING CONTROL CIRCUIT POWER INPUT DRIVER	FAIL OFF
337	FUEL PUMP/GGVM COOLING CONTROL CIRCUIT POWER INPUT DRIVER	SHORT TO GROUND
339	FUEL PUMP/GGVM COOLING VALVE POWER DIODE	FAIL OPEN
340	FUEL PUMP/GGVM COOLING VALVE POWER DIODE	SHORT TO GROUND
343	FUEL PUMP/GGVM COOLING TANK VALVE POWER FUSE	FAIL OPEN
344	FUEL PUMP/GGVM COOLING TANK VALVE DRIVER	FAIL OFF, OPEN CIRCUIT, SHORT TO GROUND
346	FUEL PUMP/GGVM COOLING THERMOSTAT	FAIL OPEN
351	FUEL/H20 HEATER CONTROL CIRCUIT	CIRCUIT DRIVER FAIL ON
352	FUEL/H2O HEATER CONTROL CIRCUIT	FUEL PUMP DRAIN LINE HEATER THERMOSTAT INPUT DRIVER FAIL ON
356	GAS GEN/FUEL PUMP HEATER CONTROL CIRCUIT	CIRCUIT DRIVER FAIL ON
357	"APU HEATER, LUBE OIL LINE" SWITCH	FAIL TO CLOSE, FAIL TO REMAIN CLOSED
376	FUEL TEST LINE TEMPERATURE SENSOR	NO OUTPUT, OR ERRONEOUS OUTPUT
377	FUEL PUMP SEAL CAVITY DRAIN LINE TEMPERATURE SENSOR	NO OUTPUT, OR ERRONEOUS OUTPUT
379	CONTROLLER SAFETY MONITORING	NO SHUTDOWN SIGNAL
380	CONTROLLER SAFETY MONITORING	SPURIOUS SHUTDOWN SIGNAL
383	CONTROLLER PRIMARY SPEED CONTROL	OUTPUT FAILED ON, SPURIOUS OUTPUT
384	CONTROLLER SECONDARY SPEED CONTROL	LOSS OF OUTPUT, INTERMITTENT OUTPUT
385	CONTROLLER SECONDARY SPEED CONTROL	OUTPUT FAILED ON, SPURIOUS OUTPUT
386	CONTROLLER APU START LOGIC	LOSS OF OUTPUT, INTERMITTENT OUTPUT

MDAC-ID	ITEM	FAILURE MODE
390	CONTROLLER GEARBOX PRESSURE CONTROL	LOSS OF OUTPUT
392	CONTROLLER GG BED HEATER CONTROL	LOSS OF HEATER "ON" SIGNAL
398	CONTROLLER START/OVER-RIDE LOGIC	LOSS OF INJECTOR COOLING VALVE COMMAND
399	CONTROLLER START/OVER-RIDE LOGIC	LOGIC INJECTOR COOLING VALVE COMMAND FAILED ON