INDEPENDENT ORBITER ASSESSMENT

ANALYSIS
OF THE
AUXILIARY POWER
UNIT

12 DECEMBER 1986
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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.

<table>
<thead>
<tr>
<th>Summary of IOA Failure Modes By Criticality (HW/F)</th>
</tr>
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<tbody>
<tr>
<td>Criticality:</td>
</tr>
<tr>
<td>Number :</td>
</tr>
</tbody>
</table>

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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:

<table>
<thead>
<tr>
<th>Criticality</th>
<th>1/1</th>
<th>2/1R</th>
<th>2/2</th>
<th>3/1R</th>
<th>3/2R</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>37</td>
<td>84</td>
<td>-</td>
<td>27</td>
<td>1</td>
<td>149</td>
</tr>
</tbody>
</table>

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
independent control system.
If the failure causes loss of the gas generator compressor, creating a severe fire hazard, at
reducing the flow of fuel to escape into the atmosphere, a
Corresponding to the independent Analysis results,
which can achieve braking by engaging the brake,
noting the pressure of the hydraulic system during ascent and
This report documents the NASYA-FWA/CLT documentation
accompanied by the NASYA-FWA/CLT documentation
To preserve independence, this analysis was
which can achieve braking by engaging the brake.
and compressor, criticality, and potential criticality
prices. This approach measures a top-down
abstract is the result of the independent analysis assessment.
the auxiliary power unit

**********
System Failures
Spacecraft Components
Component Reliability
Others

Assessments
Aerospace Safety

N5S (N5 System)

Characterize Particular
Spacecraft Reliability
Failure Modes
Space Shuttle Orbits

Required Terms

Number of Records in Range = 23

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

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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

19
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>
<thead>
<tr>
<th>Criticality:</th>
<th>1/1</th>
<th>2/1R</th>
<th>2/2</th>
<th>3/1R</th>
<th>3/2R</th>
<th>3/3</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power System</td>
<td>4</td>
<td>4</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Fuel System</td>
<td>20</td>
<td>22</td>
<td>-</td>
<td>20</td>
<td>1</td>
<td>9</td>
<td>72</td>
</tr>
<tr>
<td>Lube Oil System</td>
<td>1</td>
<td>16</td>
<td>-</td>
<td>11</td>
<td>-</td>
<td>9</td>
<td>37</td>
</tr>
<tr>
<td>GG Injector Cooling</td>
<td>7</td>
<td>5</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>6</td>
<td>22</td>
</tr>
<tr>
<td>Fuel Pump/ GGVM Cooling</td>
<td></td>
<td></td>
<td>-</td>
<td>13</td>
<td>-</td>
<td>12</td>
<td>30</td>
</tr>
<tr>
<td>Structures Electrical System</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>14</td>
<td>30</td>
<td>84</td>
</tr>
<tr>
<td>Displays</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Controller</td>
<td>1</td>
<td>7</td>
<td>-</td>
<td>7</td>
<td>-</td>
<td>7</td>
<td>22</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>37</td>
<td>84</td>
<td>-</td>
<td>93</td>
<td>1</td>
<td>86</td>
<td>301</td>
</tr>
</tbody>
</table>

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.
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 identified 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.

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5.0 REFERENCES

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


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


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


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

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>AOA</td>
<td>Abort Once Around</td>
</tr>
<tr>
<td>APU</td>
<td>Auxiliary Power Unit</td>
</tr>
<tr>
<td>ATO</td>
<td>Abort to Orbit</td>
</tr>
<tr>
<td>CIL</td>
<td>Critical Items List</td>
</tr>
<tr>
<td>CRT</td>
<td>Cathode Ray Tube</td>
</tr>
<tr>
<td>EGT</td>
<td>Exhaust Gas Temperature</td>
</tr>
<tr>
<td>F</td>
<td>Fahrenheit, Functional</td>
</tr>
<tr>
<td>FM</td>
<td>Failure Mode</td>
</tr>
<tr>
<td>FMEA</td>
<td>Failure Mode and Effects Analysis</td>
</tr>
<tr>
<td>GFE</td>
<td>Government Furnished Equipment</td>
</tr>
<tr>
<td>GG</td>
<td>Gas Generator</td>
</tr>
<tr>
<td>GGVM</td>
<td>Gas Generator Valve Module</td>
</tr>
<tr>
<td>GN2</td>
<td>Gaseous Nitrogen</td>
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APPENDIX B

DEFINITIONS, GROUND RULES, AND ASSUMPTIONS

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

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

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

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

LANDING/SAFING PHASE - begins at first main gear touchdown and ends with the completion of post-landing safing operations
APPENDIX B
DEFINITIONS, GROUND RULES, AND ASSUMPTIONS

B.2 IOA Project Level Ground Rules and Assumptions

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

1. The operational flight software is an accurate implementation of the Flight System Software Requirements (FSSRs).
   RATIONALE: Software verification is out-of-scope of this task.

2. After liftoff, any parameter which is monitored by system management (SM) or which drives any part of the Caution and Warning System (C&W) will support passage of Redundancy Screen B for its corresponding hardware item.
   RATIONALE: Analysis of on-board parameter availability and/or the actual monitoring by the crew is beyond the scope of this task.

3. Any data employed with flight software is assumed to be functional for the specific vehicle and specific mission being flown.
   RATIONALE: Mission data verification is out-of-scope of this task.

4. All hardware (including firmware) is manufactured and assembled to the design specifications/drawings.
   RATIONALE: Acceptance and verification testing is designed to detect and identify problems before the item is approved for use.

5. All Flight Data File crew procedures will be assumed performed as written, and will not include human error in their performance.
   RATIONALE: Failures caused by human operational error are out-of-scope of this task.
6. All hardware analyses will, as a minimum, be performed at the level of analysis existent within NASA/Prime Contractor Orbiter FMEA/CILs, and will be permitted to go to greater hardware detail levels but not lesser.

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

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

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

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

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

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

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

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

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

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

RATIONALE: Clarify definition of emergency systems to ensure consistency throughout IOA project.
B.3 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/CGVM 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.
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
MDAC ID: 100

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
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CRITICALITIES

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LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

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

EFFECTS/RATIONALE:
IF OUTPUT IS REDUCED SUFFICIENTLY, 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:

REPORT DATE 12/10/86  C-2
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

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

ITEM: GAS GENERATOR
FAILURE MODE: LEAK

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

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

REPORT DATE 12/10/86 C-3
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/03/86
SUBSYSTEM: APU
MDAC ID: 102

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 1/1
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
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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—POSSIBLE LOSS OF ANOTHER APU, OR FUEL LEAK. CRITICALITY IS 1/1 DUE TO SHRAPNEL DAMAGE EFFECTS.

REFERENCES:

REPORT DATE 12/10/86
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
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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:

REPORT DATE 12/10/86  C-5
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/18/86
SUBSYSTEM: APU
MDAC ID: 104

ITEM: EXHAUST DUCT
FAILURE MODE: LEAK

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

BREAKDOWN HIERARCHY:
1) APU
2) POWER SYSTEM
3) EXHAUST DUCT
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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:

REPORT DATE 12/10/86 C-6
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/26/86
SUBSYSTEM: APU
MDAC ID: 105

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

CRITICALITIES

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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
SUBSYSTEM: APU
MDAC ID: 106

ITEM: GEARBOX
FAILURE MODE: LOSS OF OUTPUT

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

BREAKDOWN HIERARCHY:
1) APU
2) POWER SYSTEM
3) GEARBOX
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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:

REPORT DATE 12/10/86 C-8
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/22/86

HIGHEST CRITICALITY HDW/FUNC

SUBSYSTEM: APU

MDAC ID: 107

FLIGHT: 3/1R

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
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CRITICALITIES

FLIGHT PHASE HDW/FUNC ABORT HDW/FUNC

PRELAUNCH: 3/3 RTL: 3/3
LIFTOFF: 3/3 TAL: 3/3
ONORBIT: 3/3 AOA: 3/3
DEORBIT: 3/1R ATO: 3/1R
LANDING/SAVING: 3/3


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:

REPORT DATE 12/10/86 C-9
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/22/86
SUBSYSTEM: APU
MDAC ID: 108

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
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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:

REPORT DATE 12/10/86 C-10
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/22/86
SUBSYSTEM: APU
MDAC ID: 109

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/1R
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

CRITICALITIES

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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:

REPORT DATE 12/10/86  C-11
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/23/86
SUBSYSTEM: APU
MDAC ID: 110

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
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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:

REPORT DATE 12/10/86  C-12
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/23/86
SUBSYSTEM: APU
MDAC ID: 111

HIGHEST CRITICALITY
FLIGHT: 3/3
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
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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:

REPORT DATE 12/10/86 C-13
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/18/86       HIGHEST CRITICALITY: 2/1R
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
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REDUNDANCY SCREENS: A [ ] B [ ] C [ ]

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:

REPORT DATE 12/10/86   C-14
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

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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:

REPORT DATE 12/10/86  C-15
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
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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 COMPARTMENT, 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:

REPORT DATE 12/10/86  C-16
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 8/18/86
SUBSYSTEM: APU
MDAC ID: 115

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

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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:

REPORT DATE 12/10/86 C-17
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 8/18/86
SUBSYSTEM: APU
MDAC ID: 116
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

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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:

REPORT DATE 12/10/86 C-18
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 8/19/86
SUBSYSTEM: APU
MDAC ID: 117

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
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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:

REPORT DATE 12/10/86 C-19
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
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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:

REPORT DATE 12/10/86  C-20
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 8/20/86
SUBSYSTEM: APU
MDAC ID: 119

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
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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:

REPORT DATE 12/10/86  C-21
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 8/20/86
SUBSYSTEM: APU
MDAC ID: 120

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

CRITICALITIES

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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:

REPORT DATE 12/10/86 C-22
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/08/86

HIGHEST CRITICALITY

SUBSYSTEM: APU
MDAC ID: 121

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

CRITICALITIES

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

CAUSES: CONTAMINATION

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

REFERENCES:

REPORT DATE 12/10/86 C-23
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
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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:

REPORT DATE 12/10/86  C-24
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
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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:

REPORT DATE 12/10/86  C-25
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/12/86
SUBSYSTEM: APU
MDAC ID: 124

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
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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

SUBSYSTEM: APU

MDAC ID: 125

FAILURE MODE: BARRIER LEAK

ITEM: FUEL TANK ISOLATION VALVE

LEAD ANALYST: J. BARNES

SUBYS LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
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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:

REPORT DATE 12/10/86 C-27
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/06/86
SUBSYSTEM: APU
MDAC ID: 126

ITEM: FUEL TANK ISOLATION VALVE
FAILURE MODE: EXTERNAL LEAK

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

BREAKDOWN HIERARCHY:
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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:

REPORT DATE 12/10/86 C-28
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/25/86

SUBSYSTEM: APU
MDAC ID: 127

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

REPORT DATE 12/10/86 C-29
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/10/86
SUBSYSTEM: APU
MDAC ID: 128

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

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

BREAKDOWN HIERARCHY:
1) APU
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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:

REPORT DATE 12/10/86 C-30
INDEPENDENT ORBITER ASSESSMENT  
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

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**SUBSYSTEM: APU**
**MDAC ID:** 129

**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
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**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:**

**REPORT DATE 12/10/86**  
**C-31**
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
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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:

REPORT DATE 12/10/86  C-32
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
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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.

REPORT DATE 12/10/86 C-33
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/11/86
SUBSYSTEM: APU
MDAC ID: 132

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

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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. ABO RTS: NO EFFECT ON OPERATING APU. IF APU IS SHUT DOWN, IT CANNOT BE RESTARTED.

REFERENCES: NO DESIGN DATA WAS OBTAINED FOR THIS VALVE.

REPORT DATE 12/10/86 C-34
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/11/86
SUBSYSTEM: APU
MDAC ID: 133

HIGHEST CRITICALITY HDW/_FUNC
FLIGHT: 2/1R
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
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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:

REPORT DATE 12/10/86  C-35
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 12/01/86
SUBSYSTEM: APU
MDAC ID: 134

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

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

LEAD ANALYST: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) FUEL PUMP
4) RELIEF VALVE
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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:

REPORT DATE 12/10/86 C-36
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/25/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 1/1
MDAC ID: 135 ABORT: 1/1

ITEM: FUEL PUMP RELIEF VALVE CRITICALITIES
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
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LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, INSTALLATION ERROR

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

REFERENCES:

REPORT DATE 12/10/86 C-37
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/01/86
SUBSYSTEM: APU
MDAC ID: 136

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
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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:

REPORT DATE 12/10/86 C-38
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/25/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU FLIGHT: 3/1R
MDAC ID: 137 ABOERT: 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

CRITICALITIES

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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. ABOERT: CRITICALITY IS 2/1R FOR ENGINE-OUT ABOERTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

REPORT DATE 12/10/86 C-39
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/12/86
SUBSYSTEM: APU
MDAC ID: 138

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

CRITICALITIES

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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:

REPORT DATE 12/10/86  C-40
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/06/86
SUBSYSTEM: APU
MDAC ID: 139

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

REPORT DATE 12/10/86 C-41
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/06/86
SUBSYSTEM: APU
MDAC ID: 140

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
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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:

REPORT DATE 12/10/86 C-42
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

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

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

LEAD ANALYST: J. BARNES
LEAD: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL SYSTEM
3) PRIMARY FUEL VALVE
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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:

REPORT DATE 12/10/86 C-43
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/06/86

HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU
MDAC ID: 142
FLIGHT: 2/1R
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

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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:

REPORT DATE 12/10/86 C-44
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

CRITICALITIES

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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:

REPORT DATE 12/10/86 C-45
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

CRITICALITIES

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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:

REPORT DATE 12/10/86  C-46
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

CRITICALITIES

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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:

REPORT DATE 12/10/86  C-47
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/07/86

SUBSYSTEM: APU
MDAC ID: 146

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
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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:

REPORT DATE 12/10/86 C-48
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/07/86
SUBSYSTEM: APU
MDAC ID: 147

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
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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:

REPORT DATE 12/10/86  C-49
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
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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:

REPORT DATE 12/10/86  C-50
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
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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:

REPORT DATE 12/10/86 C-51
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

CRITICALITIES

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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:

REPORT DATE 12/10/86 C-52
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/25/86
SUBSYSTEM: APU
MDAC ID: 151

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
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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:

REPORT DATE 12/10/86 C-53
**INDEPENDENT ORBITER ASSESSMENT**  
**ORBITER SUBSYSTEM ANALYSIS WORKSHEET**

**DATE:** 8/27/86  
**SUBSYSTEM:** APU  
**MDAC ID:** 152  
**HIGHEST CRITICALITY**  
**FLIGHT:** 1/1  
**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  
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**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:**

**REPORT DATE 12/10/86**  
C-54
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

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**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

**CRITICALITIES**

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**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:**

REPORT DATE 12/10/86  
C-55
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/08/86
SUBSYSTEM: APU
MDAC ID: 154

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
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

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

CAUSES: FILTER BLOCKAGE, CONTAMINATION

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

REFERENCES:

REPORT DATE 12/10/86  C-56
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/30/86

HIGHEST CRITICALITY

HDW/FUNC

FLIGHT: 1/1

ABORT: 1/1

SUBSYSTEM: APU

MDAC ID: 155

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) 
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9) 

CRITICALITIES

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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 S 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:

REPORT DATE 12/10/86 C-57
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/08/86
SUBSYSTEM: APU
MDAC ID: 156

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

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

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
NO EFFECT ON STANDARD TURNAROUND ACTIVITIES.

REFERENCES:

REPORT DATE 12/10/86 C-58
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

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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

CRITICALITIES

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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:

REPORT DATE 12/10/86 C-59
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/08/86
SUBSYSTEM: APU
MDAC ID: 158

HIGHEST CRITICALITY
FLIGHT: 1/1
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) 
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8) 
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CRITICALITIES

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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:

REPORT DATE 12/10/86  C-60
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/08/86
SUBSYSTEM: APU
MDAC ID: 159

HIGHEST CRITICALITY
FLIGHT: 3/3
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
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LOCATION: AFT COMPARTMENT
PART NUMBER: ME276-0032-0027

CAUSES: CONTAMINATION, FILTER BLOCKAGE
EFFECTS/RATIONALE:
CANNOT PERFORM HYDRAZINE SERVICING—POSSIBLE LAUNCH DELAY.

REFERENCES:

REPORT DATE 12/10/86  C-61
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/22/86

SUBSYSTEM: APU
MDAC ID: 160

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

ITEM: FUEL TANK 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 TANK HEATER

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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:

REPORT DATE 12/10/86 C-62
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

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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:

REPORT DATE 12/10/86  C-63
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/23/86
SUBSYSTEM: APU
MDAC ID: 162

HIGHEST CRITICALITY HDW/FUNC

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
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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:

REPORT DATE 12/10/86 C-64
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
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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:

REPORT DATE 12/10/86 C-65
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/23/86
SUBSYSTEM: APU
MDAC ID: 164

ITEM: FUEL LINE HEATER THERMOSTAT
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

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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:

REPORT DATE 12/10/86  C-66
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/23/86

SUBSYSTEM: APU
MDAC ID: 165

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

ITEM: FUEL LINE HEATER THERMOSTAT
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

CRITICALITIES

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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:

REPORT DATE 12/10/86  C-67
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/24/86
SUBSYSTEM: APU
MDAC ID: 166

ITEM: FUEL LINE HEATER THERMOSTAT (REDUNDANT)
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)

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

CAUSES: CONTAMINATION

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

REFERENCES:

REPORT DATE 12/10/86 C-68
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)
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

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

CAUSES: SHORT, WELDED CONTACTS

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

REFERENCES:

REPORT DATE 12/10/86  C-69
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/24/86

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| MDAC ID: | 168 |

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| FAILURE MODE: | FAIL OFF, OR LOW OUTPUT |

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<th>EFFECTS/RATIONALE:</th>
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<td>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).</td>
</tr>
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| REFERENCES: | |
|-------------||

REPORT DATE 12/10/86 C-70
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/24/86
SUBSYSTEM: APU
MDAC ID: 169

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

ITEM: FUEL PUMP SEAL CAVITY DRAIN LINE HEATER THERMOSTAT
(S112A,S112B,S212A,S212B,S312A,S312B)
FAILURER 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 THERMOSTAT
4) THERMOSTAT
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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:

REPORT DATE 12/10/86 C-71
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/26/86
SUBSYSTEM: APU
MDAC ID: 170

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 1/1
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 THERMOSTAT
4) THERMOSTAT
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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.


REPORT DATE 12/10/86
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/24/86

HIGHEST CRITICALITY HDW/FUNC

SUBSYSTEM: APU

MDAC ID: 171

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

CRITICALITIES

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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:

REPORT DATE 12/10/86  C-73
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

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

CRITICALITIES

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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:

REPORT DATE 12/10/86 C-74
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/24/86
SUBSYSTEM: APU
MDAC ID: 173

HIGHEST CRITICALITY
FLIGHT: 3/3
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
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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:

REPORT DATE 12/10/86 C-75
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/08/86
SUBSYSTEM: APU
MDAC ID: 174

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

CRITICALITIES

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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:

REPORT DATE 12/10/86 C-76
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/09/86

HIGHEST CRITICALITY
FLIGHT: 1/1
ABORT: 1/1

SUBSYSTEM: APU
MDAC ID: 175

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
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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:

REPORT DATE 12/10/86 C-77
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/25/86
SUBSYSTEM: APU
MDAC ID: 176

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
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

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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
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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:

REPORT DATE 12/10/86 C-79
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
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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:

REPORT DATE 12/10/86 C-80
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/04/86
SUBSYSTEM: APU
MDAC ID: 179

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
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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:

REPORT DATE 12/10/86  C-81
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
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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:

REPORT DATE 12/10/86  
C-82
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/30/86
SUBSYSTEM: APU
MDAC ID: 181

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

REPORT DATE 12/10/86  C-83
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/25/86
HIGHEST CRITICALITY
SUBSYSTEM: APU
MDAC ID: 182
FLIGHT: 3/1R
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)

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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:

REPORT DATE 12/10/86 C-84
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/25/86
SUBSYSTEM: APU
MDAC ID: 183

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

REPORT DATE 12/10/86 C-85
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/25/86
SUBSYSTEM: APU
MDAC ID: 184

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
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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:

REPORT DATE 12/10/86 C-86
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/17/86
SUBSYSTEM: APU
MDAC ID: 185

HIGHEST CRITICALITY HDW/FUNC

FLIGHT: 3/1R
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

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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:

REPORT DATE 12/10/86 C-87
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
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LOCATION: AFT COMPARTMENT

PART NUMBER: ME284-0543-0002

CAUSES: CONTAMINATION, CORROSION

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

REFERENCES:

REPORT DATE 12/10/86 C-88
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/15/86
SUBSYSTEM: APU
MDAC ID: 187

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

REPORT DATE 12/10/86 C-89
**INDEPENDENT ORBITER ASSESSMENT**
**ORBITER SUBSYSTEM ANALYSIS WORKSHEET**

**DATE:** 9/17/86

**SUBSYSTEM:** APU

**MDAC ID:** 188

**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

**REDUNDANCY SCREENS:**

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**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:**

**REPORT DATE 12/10/86**

C-90
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/17/86

SUBSYSTEM: APU
MDAC ID: 189

HIGHEST CRITICALITY
FLIGHT: 1/1
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
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CRITICALITIES

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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:

REPORT DATE 12/10/86 C-91
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/17/86

SUBSYSTEM: APU
MDAC ID: 190

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
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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:

REPORT DATE 12/10/86 C-92
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/17/86
SUBSYSTEM: APU
MDAC ID: 191

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
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
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LOCATION: AFT COMPARTMENT
PART NUMBER: ME276-0032-0003

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
CANNOT SERVICE GN2 BOTTLE—POSSIBLE LAUNCH DELAY.

REFERENCES:

REPORT DATE 12/10/86 C-93
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
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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.

REPORT DATE 12/10/86  C-94
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
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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.

REPORT DATE 12/10/86 C-95
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
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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.

REPORT DATE 12/10/86  C-96
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/25/86
SUBSYSTEM: APU
MDAC ID: 195

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
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
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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
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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.

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REPORT DATE 12/10/86  C-98
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/15/86  SUBSYSTEM: APU  MDAC ID: 197

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

REPORT DATE 12/10/86  C-99
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

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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:

REPORT DATE 12/10/86  C-100
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/15/86
SUBSYSTEM: APU
MDAC ID: 199

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
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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:

REPORT DATE 12/10/86 C-101
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/16/86
SUBSYSTEM: APU
MDAC ID: 200

HIGHEST CRITICALITY
HDW/FUNC
FLIGHT: 3/3
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)
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CRITICALITIES

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LOCATION: AFT COMPARTMENT
PART NUMBER: MC621-0038-0500

CAUSES: CONTAMINATION, CORROSION, FILTER BLOCKED

EFFECTS/RATIONALE:
CANNOT SERVICE GEARBOX-POSSIBLE LAUNCH DELAY.

REFERENCES:

REPORT DATE 12/10/86 C-102
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
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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:

REPORT DATE 12/10/86  C-103
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/16/86

HIGHEST CRITICALITY
FLIGHT: 3/3
ABORT: 3/3

SUBSYSTEM: APU
MDAC ID: 202

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

CRITICALITIES

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LOCATION: AFT COMPARTMENT
PART NUMBER: MC621-0038-0500

CAUSES: CONTAMINATION, CORROSION, FILTER BLOCKED

EFFECTS/RATIONALE:
CANNOT PURGE GEARBOX-POSSIBLE LAUNCH DELAY.

REFERENCES:

REPORT DATE 12/10/86 C-104
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

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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:

REPORT DATE 12/10/86 C-105
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
SUBSYSTEM: APU
MDAC ID: 204

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

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


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:

REPORT DATE 12/10/86 C-106
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
SUBSYSTEM: APU
MDAC ID: 205

HIGHEST CRITICALITY

FLIGHT: 3/3
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
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LOCATION: AFT COMPARTMENT
PART NUMBER: MC621-0038-0500

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
CANNOT PERFORM LUBE OIL SERVICING; POSSIBLE LAUNCH DELAY.

REFERENCES:

REPORT DATE 12/10/86 C-107
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86

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

SUBSYSTEM: APU
MDAC ID: 206

ITEM: GEARBOX HIGH POINT DRAIN COUPLING
FAILURE MODE: EXTERNAL LEAK

LEAD ANALYST: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL LINES
4) GEARBOX HIGH POINT DRAIN COUPLING
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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:

REPORT DATE 12/10/86 C-108
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86

HIGHEST CRITICALITY

SUBSYSTEM: APU
MDAC ID: 207

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
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LOCATION: AFT COMPARTMENT
PART NUMBER: MC621-0038-0300

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
CANNOT PERFORM LUBE OIL SERVICING; POSSIBLE LAUNCH DELAY.

REFERENCES:

REPORT DATE 12/10/86 C-109
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86

SUBSYSTEM: APU
MDAC ID: 208

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

REPORT DATE 12/10/86 C-110
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/26/86
SUBSYSTEM: APU
MDAC ID: 209

HIGHEST CRITICALITY

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BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL LINES
4) WSB DRAIN COUPLING
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LOCATION: AFT COMPARTMENT

PART NUMBER:

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
CANNOT PERFORM LUBE OIL SERVICING; POSSIBLE LAUNCH DELAY.

REFERENCES:

REPORT DATE 12/10/86 C-111
### INDEPENDENT ORBITER ASSESSMENT

**ORBITER SUBSYSTEM ANALYSIS WORKSHEET**

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**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. 
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#### CRITICALITIES

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**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:**

**REPORT DATE 12/10/86**  
**C-112**
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
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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:

REPORT DATE 12/10/86  C-113
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

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

BREAKDOWN HIERARCHY:
1) APU
2) LUBE OIL SYSTEM
3) LUBE OIL LINE HEATER
4) THERMOSTAT
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CRITICALITIES

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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:

REPORT DATE 12/10/86 C-114
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

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

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

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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:

REPORT DATE 12/10/86 C-115
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
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CRITICALITIES

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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:

REPORT DATE 12/10/86  C-116
**INDEPENDENT ORBITER ASSESSMENT**  
**ORBITER SUBSYSTEM ANALYSIS WORKSHEET**

**DATE:** 9/29/86  
**SUBSYSTEM:** APU  
**MDAC ID:** 215  
**HIGHEST CRITICALITY**  
**HDW/FUNC**  
**FLIGHT:** 2/1R  
**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  
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**CRITICALITIES**

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**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:**

**REPORT DATE 12/10/86**  
C-117
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
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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.

REPORT DATE 12/10/86  C-118
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

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


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.

REPORT DATE 12/10/86 C-119
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/30/86
SUBSYSTEM: APU
MDAC ID: 218

HIGHEST CRITICALITY
HDW/FUNC
FLIGHT: 3/3
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
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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


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.

REPORT DATE 12/10/86 C-120
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/30/86
SUBSYSTEM: APU
MDAC ID: 219

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
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

CRITICALITIES

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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.

REPORT DATE 12/10/86 C-121
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/29/86
SUBSYSTEM: APU
MDAC ID: 220

HIGHEST CRITICALITY
FLIGHT: 2/1R
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

CRITICALITIES

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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:

REPORT DATE 12/10/86  C-122
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/29/86
SUBSYSTEM: APU
MDAC ID: 221

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
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

CRITICALITIES

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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:

REPORT DATE 12/10/86 C-123
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/30/86
SUBSYSTEM: APU
MDAC ID: 222

HIGHEST CRITICALITY
FLIGHT: 2/1R
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

CRITICALITIES
FLIGHT PHASE HDW/FUNC ABORT HDW/FUNC
PRLAUNCH: 3/3 RTLS: 1/1
LIFTOFF: 2/1R TAL: 1/1
ON ORBIT: 2/1R AOA: 1/1
DE ORBIT: 2/1R ATO: 1/1
LANDING/SAFING: 2/1R


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:

REPORT DATE 12/10/86 C-124
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/30/86
SUBSYSTEM: APU
MDAC ID: 223

HIGHEST CRITICALITY
FLIGHT: 2/1R
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

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

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:

REPORT DATE 12/10/86 C-125
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
SUBSYSTEM: APU
MDAC ID: 224

HIGHEST CRITICALITY
FLIGHT: 1/1
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
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CRITICALITIES

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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:

REPORT DATE 12/10/86  C-126
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
SUBSYSTEM: APU
MDAC ID: 225

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 1/1
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) 
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CRITICALITIES

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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:

REPORT DATE 12/10/86        C-127
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
SUBSYSTEM: APU
MDAC ID: 226

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
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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:

REPORT DATE 12/10/86  C-128
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
SUBSYSTEM: APU
MDAC ID: 227

HIGHEST CRITICALITY
FLIGHT: 3/3
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

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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:

REPORT DATE 12/10/86   C-129
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU
MDAC ID: 228
FLIGHT: 2/1R
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
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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:

REPORT DATE 12/10/86 C-130
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86

HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU
MDAC ID: 229
FLIGHT: 1/1
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
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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:

REPORT DATE 12/10/86 C-131
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86

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

SUBSYSTEM: APU
MDAC ID: 230

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
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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:

REPORT DATE 12/10/86  C-132
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86

HIGHEST CRITICALITY

SUBSYSTEM: APU
MDAC ID: 231

FLIGHT: 1
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

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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:

REPORT DATE 12/10/86 C-133
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/03/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU
MDAC ID: 232
FLIGHT: 3/3
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

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LOCATION: AFT COMPARTMENT
PART NUMBER: ME276-0032-0009

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
CANNOT SERVICE INJECTOR COOLING SYSTEM; POSSIBLE LAUNCH DELAY.

REFERENCES:

REPORT DATE 12/10/86 C-134
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
SUBSYSTEM: APU
MDAC ID: 233

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 1/1
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)
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LOCATION: AFT COMPARTMENT
PART NUMBER: VO70-465521

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:

REPORT DATE 12/10/86 C-135
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
SUBSYSTEM: APU
MDAC ID: 234

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 1/1
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)
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LOCATION: AFT COMPARTMENT
PART NUMBER: VO70-465521

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:

REPORT DATE 12/10/86 C-136
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86

HIGHEST CRITICALITY

HDW/FUNC

FLIGHT: 1/1

ABORT: 1/1

SUBSYSTEM: APU

MDAC ID: 235

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

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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:

REPORT DATE 12/10/86 C-137
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/03/86
SUBSYSTEM: APU
MDAC ID: 236

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

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LOCATION: AFT COMPARTMENT
PART NUMBER: MC621-0038-0100

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
CANNOT SERVICE INJECTOR COOLING SYSTEM; POSSIBLE LAUNCH DELAY.

REFERENCES:

REPORT DATE 12/10/86 C-138
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
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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:

REPORT DATE 12/10/86  C-139
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
SUBSYSTEM: APU
MDAC ID: 238

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

REPORT DATE 12/10/86 C-140
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86

HIGHEST CRITICALITY

SUBSYSTEM: APU

MDAC ID: 239

FLIGHT: 2/1R

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
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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:

REPORT DATE 12/10/86 C-141
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

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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:

REPORT DATE 12/10/86  C-142
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
SUBSYSTEM: APU
MDAC ID: 241

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

REPORT DATE 12/10/86  C-143
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
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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:

REPORT DATE 12/10/86 C-144
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
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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:

REPORT DATE 12/10/86  C-145
**INDEPENDENT ORBITER ASSESSMENT**

**ORBITER SUBSYSTEM ANALYSIS WORKSHEET**

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**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

**CRITICALITIES**

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**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:**

**REPORT DATE 12/10/86 C-146**
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86  SUBSYSTEM: APU  MDAC ID: 245
HIGHEST CRITICALITY: FLIGHT: 3/3  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
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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:

REPORT DATE 12/10/86  C-147
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
SUBSYSTEM: APU
MDAC ID: 246

HIGHEST CRITICALITY
FLIGHT: 2/1R
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

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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:

REPORT DATE 12/10/86 C-148
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
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LOCATION: AFT COMPARTMENT
PART NUMBER: MC284-0431-0001

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
NO EFFECT; PULSING VALVE DOWNSTREAM Closes OFF WATER FLOW.

REFERENCES:

REPORT DATE 12/10/86  C-149
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86

SUBSYSTEM: APU

MDAC ID: 248

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/IR
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
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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:

REPORT DATE 12/10/86 C-150
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86

SUBSYSTEM: APU
MDAC ID: 249

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

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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:

REPORT DATE 12/10/86 C-151
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
SUBSYSTEM: APU
MDAC ID: 250

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

REPORT DATE 12/10/86 C-152
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
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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:

REPORT DATE 12/10/86  C-153
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
SUBSYSTEM: APU
MDAC ID: 252

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
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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:

REPORT DATE 12/10/86 C-154
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
SUBSYSTEM: APU
MDAC ID: 253

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
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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:

REPORT DATE 12/10/86 C-155
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
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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:

REPORT DATE 12/10/86  C-156
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
SUBSYSTEM: APU
MDAC ID: 255
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

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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:

REPORT DATE 12/10/86 C-157
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
SUBSYSTEM: APU
MDAC ID: 256

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
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

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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:

REPORT DATE 12/10/86 C-158
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

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LOCATION: AFT COMPARTMENT
PART NUMBER: V070-465521

CAUSES: CONTAMINATION

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:

REPORT DATE 12/10/86  C-159
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86

SUBSYSTEM: APU
MDAC ID: 258

ITEM: FUEL PUMP/GGVM COOLING WATER FILL COUPLING
FAILURE MODE: LEAK
LEAD ANALYST: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER LINES
4) FILL COUPLING

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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:

REPORT DATE 12/10/86
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
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LOCATION:  AFT COMPARTMENT
PART NUMBER: MC621-0038-0100

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
CANNOT SERVICE ONE FUEL PUMP/GGVM COOLING SYSTEM. POSSIBLE LAUNCH DELAY.

REFERENCES:

REPORT DATE 12/10/86  C-161
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: 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
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CRITICALITIES

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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:

REPORT DATE 12/10/86  C-162
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
HIGHEST CRITICALITY HDW/FUNC

SUBSYSTEM: APU
FLIGHT: 3/1R
ABORT: 3/1R

MDAC ID: 261

ITEM: FUEL PUMP/GGVM COOLING WATER LINES-BETWEEN TANK

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

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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:

REPORT DATE 12/10/86  C-163
**INDEPENDENT ORBITER ASSESSMENT**

**ORBITER SUBSYSTEM ANALYSIS WORKSHEET**

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**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

**CRITICALITIES**

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**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:**

**REPORT DATE 12/10/86**  
C-164
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86

SUBSYSTEM: APU
MDAC ID: 263

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
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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:

REPORT DATE 12/10/86 C-165
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
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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:

REPORT DATE 12/10/86  C-166
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86

SUBSYSTEM: APU

MDAC ID: 265

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/1R
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

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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:

REPORT DATE 12/10/86 C-167
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
SUBSYSTEM: APU
MDAC ID: 266

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

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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:

REPORT DATE 12/10/86 C-168
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
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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:

REPORT DATE 12/10/86  C-169
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
SUBSYSTEM: APU
MDAC ID: 268
HIGHEST CRITICALITY: 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

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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.
AFU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

REPORT DATE 12/10/86 C-170
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
SUBSYSTEM: APU
MDAC ID: 269

ITEM: 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

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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. CRITICALLY IS 3/1R FOR DEORBIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

REPORT DATE 12/10/86 C-171
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86

SUBSYSTEM: APU
MDAC ID: 270

ITEM: FUEL PUMP/GGVM COOLING WATER TANK HEATER

FAILURE MODE: FAIL CLOSED

LEAD ANALYST: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) FUEL PUMP/GGVM COOLING SYSTEM
3) WATER TANK HEATER
4) THERMOSTAT

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LOCATION: AFT COMPARTMENT
PART NUMBER: ME360-0017-0006

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
AFFE_D HEATER SET IS FAILED ON WHEN ACTIVE, BUT CAN BE SWITCHED OFF. REDUNDANT HEATER SET IS UNAFFECTED.

REFERENCES:

REPORT DATE 12/10/86  C-172
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
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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:

REPORT DATE 12/10/86  C-173
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
SUBSYSTEM: APU
MDAC ID: 272

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/IR
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
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CRITICALITIES

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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, 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:

REPORT DATE 12/10/86 C-174
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/09/86
SUBSYSTEM: APU
MDAC ID: 273

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

ITEM: FUEL PUMP/GGVM COOLING WATER LINE HEATER
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

CRITICALITIES

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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:

REPORT DATE 12/10/86 C-175
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

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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:

REPORT DATE 12/10/86  C-176
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/10/86
SUBSYSTEM: APU
MDAC ID: 275
HIGHEST CRITICALITY: FLIGHT: 3/3
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
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LOCATION: AFT COMPARTMENT

PART NUMBER:

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
NO EFFECT.

REFERENCES:

REPORT DATE 12/10/86 C-177
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/03/86
SUBSYSTEM: APU
MDAC ID: 276

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
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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:

REPORT DATE 12/10/86  C-178
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/02/86
SUBSYSTEM: APU
MDAC ID: 277

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

REPORT DATE 12/10/86 C-179
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
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LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-00001

CAUSES: MANUFACTURING DEFECT IN SEALS

EFFECTS/RATIONALE:
ALLOW 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:

REPORT DATE 12/10/86  C-180
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/02/86
SUBSYSTEM: APU
MDAC ID: 279

ITEM: GEARBOX HOUSING
FAILURE MODE: LEAK

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

BREAKDOWN HIERARCHY:
1) APU
2) STRUCTURE
3) GEARBOX HOUSING
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LOCATION: AFT COMPARTMENT
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF LUBE OIL FROM GEARBOX; APU WILL 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:

REPORT DATE 12/10/86 C-181
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
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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:

REPORT DATE 12/10/86  C-182
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
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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:

REPORT DATE 12/10/86  C-183
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86
SUBSYSTEM: APU
MDAC ID: 282

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

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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:

REPORT DATE 12/10/86 C-184
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86
SUBSYSTEM: APU
MDAC ID: 283

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

CRITICALITIES

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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:

REPORT DATE 12/10/86    C-185
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/30/86

SUBSYSTEM: APU
MDAC ID: 284

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
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

FINAL BREAKDOWN:

1) APU
2) ELECTRICAL SYSTEM
3) APU CONTROL CIRCUIT
4) GROUND CONTROL INPUT DRIVER

CRITICALITIES

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LOCATION: AFT LCA 1,2,3

PART NUMBER: APU

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:

REPORT DATE 12/10/86 C-186
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/30/86
SUBSYSTEM: APU
MDAC ID: 285
HIGHEST CRITICALITY HDW/FUNC FLIGHT: 3/3
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

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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 FUEL TANK VALVES ARE OPENED BEFORE LIFTOFF.

REFERENCES:

REPORT DATE 12/10/86 C-187
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/30/86
SUBSYSTEM: APU
MDAC ID: 286

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/1R
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

CRITICALITIES

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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:

REPORT DATE 12/10/86 C-188
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/30/86
SUBSYSTEM: APU
MDAC ID: 287

HIGHEST CRITICALITY
FLIGHT: 3/1R
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

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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:

REPORT DATE 12/10/86 C-189
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86

SUBSYSTEM: APU
MDAC ID: 288

ITEM: "APU CNTLR PWR" SWITCH
FAILURE MODE: FAIL TO CLOSE

LEAD ANALYST: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) CONTROLLER POWER CIRCUIT
4) "APU CNTLR PWR" SWITCH
5) 
6) 
7) 
8) 
9) 

CRITICALITIES

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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:

REPORT DATE 12/10/86 C-190
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

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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. ABO RT: CRITICALITY IS 1/1 FOR ENGINE-OUT ABORTS, WHERE LOSS OF ONE APU CAN BE CRITICAL.

REFERENCES:

REPORT DATE 12/10/86  C-191
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86
SUBSYSTEM: APU
MDAC ID: 290

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

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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:

REPORT DATE 12/10/86 C-192
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86
SUBSYSTEM: APU
MDAC ID: 291

HIGHEST CRITICALITY
FLIGHT: 3/3
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

CRITICALITIES

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LOCATION: PANEL R2
PART NUMBER: ME452-0102-7252

CAUSES: VIBRATION, CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
APU CONTROLLER IS POWERED UP INADVERTENTLY. NO ADVERSE EFFECTS.

REFERENCES:

REPORT DATE 12/10/86 C-193
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86
HIGHEST CRITICALITY
HDW/FUNC

SUBSYSTEM: APU
MDAC ID: 292

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
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6) 
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8) 
9) 

CRITICALITIES

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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:

REPORT DATE 12/10/86 C-194
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86
SUBSYSTEM: APU
MDAC ID: 293

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

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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:

REPORT DATE 12/10/86  C-195
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:  10/14/86
SUBSYSTEM:  APU
MDAC ID:  294

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

ITEM:  CONTROLLER POWER CIRCUIT
FAILURE MODE:  POWER INPUT DIODE
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

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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:

REPORT DATE 12/10/86  C-196
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

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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:

REPORT DATE 12/10/86 C-197
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86

SUBSYSTEM: APU
MDAC ID: 296

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

ITEM: CONTROLLER POWER CIRCUIT
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

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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:

REPORT DATE 12/10/86 C-198
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/30/86
SUBSYSTEM: APU
MDAC ID: 297
HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
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

CRITICALITIES

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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:

REPORT DATE 12/10/86 C-199
**INDEPENDENT ORBITER ASSESSMENT**

**ORBITER SUBSYSTEM ANALYSIS WORKSHEET**

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**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

**CRITICALITIES**

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**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:**

**REPORT DATE 12/10/86 C-200**
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86

HIGHEST CRITICALITY HDW/FUNC

SUBSYSTEM: APU
MDAC ID: 299
FLIGHT: 3/3
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
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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:

REPORT DATE 12/10/86 C-201
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86

SUBSYSTEM: APU

MDAC ID: 300

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
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

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LOCATION: PANEL R2

PART NUMBER:

CAUSES: PIECE-PART STRUCTURAL FAILURE, CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
APU STUCK IN HIGH SPEED. NO ADVERSE EFFECT.

REFERENCES:

REPORT DATE 12/10/86 C-202
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86
SUBSYSTEM: APU
MDAC ID: 301

HIGHEST CRITICALITY

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

CRITICALITIES

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LOCATION: PANEL R2
PART NUMBER:

CAUSES: VIBRATION, CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
APU SHIFTS TO HIGH SPEED. NO ADVERSE EFFECTS.

REFERENCES:

REPORT DATE 12/10/86 C-203
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/14/86
SUBSYSTEM: APU
MDAC ID: 302

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
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

CRITICALITIES

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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:

REPORT DATE 12/10/86  C-204
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
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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:

REPORT DATE 12/10/86  C-205
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/27/86
SUBSYSTEM: APU
MDAC ID: 304

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

CRITICALITIES

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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:

REPORT DATE 12/10/86 C-206
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

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**BREAKDOWN HIERARCHY:**
1) APU
2) ELECTRICAL SYSTEM
3) AUTO SHUTDOWN CONTROL CIRCUIT
4) SWITCH

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**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:**

REPORT DATE 12/10/86 C-207
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
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CRITICALITIES

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LOCATION: PANEL R2
PART NUMBER: C-208

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:

REPORT DATE 12/10/86
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86
SUBSYSTEM: APU
MDAC ID: 307

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

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LOCATION: PANEL R2
PART NUMBER:

CAUSES: PIECE-PART STRUCTURAL FAILURE, CONTAMINATION

EFFECTS/RATIONALE:
APU AUTO SHUTDOWN CANNOT BE ENABLED. NO ADVERSE EFFECT.

REFERENCES:

REPORT DATE 12/10/86 C-209
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86
SUBSYSTEM: APU
MDAC ID: 308

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)
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LOCATION: PANEL R2
PART NUMBER:

CAUSES: VIBRATION, CONTAMINATION (SHORT)

EFFECTS/RATIONALE:
APU AUTO SHUTDOWN IS INHIBITED. NO ADVERSE EFFECT.

REFERENCES:

REPORT DATE 12/10/86 C-210
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)  
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7)  
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CRITICALITIES

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LOCATION: PANEL R2
PART NUMBER:

CAUSES: MANUFACTURING DEFECT, INSTALLATION ERROR

EFFECTS/RATIONALE:
LOSS OF REDUNDANT "INHIBIT" SIGNAL TO 2 APU CONTROLLERS.

REFERENCES:

REPORT DATE 12/10/86  C-211
**INDEPENDENT ORBITER ASSESSMENT**

**ORBITER SUBSYSTEM ANALYSIS WORKSHEET**

**DATE:** 10/15/86  
**SUBSYSTEM:** APU  
**MDAC ID:** 310

**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  
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**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:**

**REPORT DATE 12/10/86 C-212**
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86
SUBSYSTEM: APU
MDAC ID: 311

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

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LOCATION: AV BAY 4,5,6

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
LOSS OF REDUNDANT "INHIBIT" SIGNAL TO 2 APU CONTROLLERS.

REFERENCES:

REPORT DATE 12/10/86 C-213
# INDEPENDENT ORBITER ASSESSMENT
## ORBITER SUBSYSTEM ANALYSIS WORKSHEET

**DATE:** 10/27/86  
**SUBSYSTEM:** APU  
**MDAC ID:** 312  
**HIGHEST CRITICALITY**  
**FLIGHT:** 3/3  
**ABORT:** /NA

**ITEM:** FUEL VALVE GROUND CONTROL CIRCUIT  
**FAILURE MODE:** FAIL OFF, OPEN CIRCUIT, FAIL TO REMAIN ON

**LEAD ANALYST:** J. BARNES  
**S_SYS LEAD:** J. BARNES

### BREAKDOWN HIERARCHY:

1. APU
2. ELECTRICAL SYSTEM
3. FUEL VALVE CONTROL CIRCUIT
4. GROUND CONTROL CIRCUIT
5. 
6. 
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### CRITICALITIES

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### 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:**

**REPORT DATE 12/10/86**  
**C-214**
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/27/86

SUBSYSTEM: APU
MDAC ID: 313

HIGHEST CRITICALITY
HDW/FUNC

FLIGHT: 3/3
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

CRITICALITIES

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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:

REPORT DATE 12/10/86 C-215
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86

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

SUBSYSTEM: APU
MDAC ID: 314

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

CRITICALITIES

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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:

REPORT DATE 12/10/86 C-216
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86
SUBSYSTEM: APU
MDAC ID: 315

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
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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:

REPORT DATE 12/10/86 C-217
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86

SUBSYSTEM: APU
MDAC ID: 316

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

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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:

REPORT DATE 12/10/86 C-218
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

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


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:

REPORT DATE 12/10/86 C-219
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86
SUBSYSTEM: APU
MDAC ID: 318

HIGHEST CRITICALITY
FLIGHT: 3/1R
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
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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:

REPORT DATE 12/10/86  C-220
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86
SUBSYSTEM: APU
MDAC ID: 319

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
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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:

REPORT DATE 12/10/86  C-221
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86
SUBSYSTEM: APU
MDAC ID: 320

HIGHEST CRITICALITY
FLIGHT: 3/3
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

CRITICALITIES

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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:

REPORT DATE 12/10/86 C-222
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
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9)  

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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:

REPORT DATE 12/10/86  C-223
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86

HIGHEST CRITICALITY HDW/FUNC

SUBSYSTEM: APU

FLIGHT: 3/1R

MDAC ID: 322

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
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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:

REPORT DATE 12/10/86 C-224
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/15/86
SUBSYSTEM: APU
MDAC ID: 323

HIGHEST CRITICALITY
FLIGHT: 3/1R
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

CRITICALITIES

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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:

REPORT DATE 12/10/86 C-225
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
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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:

REPORT DATE 12/10/86  C-226
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

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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:

REPORT DATE 12/10/86 C-227
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86
SUBSYSTEM: APU
MDAC ID: 326

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
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
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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 DEORBIRIT BEFORE APU COOLDOWN. APU STARTED HOT CAN CAUSE FUEL TO DETONATE.

REFERENCES:

REPORT DATE 12/10/86 C-228
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/16/86
SUBSYSTEM: APU
MDAC ID: 327

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
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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:

REPORT DATE 12/10/86 C-229
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86
SUBSYSTEM: APU
MDAC ID: 328

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
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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:

REPORT DATE 12/10/86 C-230
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86
HIGHEST CRITICALITY
SUBSYSTEM: APU
HDW/.func
MDAC ID: 329
FLIGHT: 3/1R
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

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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:

REPORT DATE 12/10/86 C-231
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
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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:

REPORT DATE 12/10/86  C-232
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
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LOCATION: APU TIMER BOX 1,2,3
PART NUMBER: JANTXV14246

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
SUBSYSTEM: APU
MDAC ID: 332

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
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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:

REPORT DATE 12/10/86  C-234
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86
SUBSYSTEM: APU
MDAC ID: 333

ITEM: 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

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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:

REPORT DATE 12/10/86 C-235
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86

SUBSYSTEM: APU
MDAC ID: 334

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
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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
SUBSYSTEM: APU
MDAC ID: 335

HIGHEST CRITICALITY
HDW/FUNC FLIGHT: 3/1R
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

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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:
REPORT DATE 12/10/86  C-237
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
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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:

REPORT DATE 12/10/86 C-238
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86
SUBSYSTEM: APU
MDAC ID: 337

HIGHEST CRITICALITY
FLIGHT: 3/1R
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

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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:

REPORT DATE 12/10/86  C-239
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86
SUBSYSTEM: APU
MDAC ID: 338

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
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

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:

REPORT DATE 12/10/86 C-240
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86

SUBSYSTEM: APU
MDAC ID: 339

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

REPORT DATE 12/10/86 C-241
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86
SUBSYSTEM: APU
MDAC ID: 340

ITEM: FUEL PUMP/GGM 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/GGM COOLING CONTROL CIRCUIT
4) VALVE POWER DIODE
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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:

REPORT DATE 12/10/86 C-242
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/20/86
SUBSYSTEM: APU
MDAC ID: 341

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
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

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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:

REPORT DATE 12/10/86    C-243
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/20/86
SUBSYSTEM: APU
MDAC ID: 342

HIGHEST CRITICALITY
HDW/FUNC
FLIGHT: 3/3
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
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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:

REPORT DATE 12/10/86 C-244
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86
HIGHEST CRITICALITY: HDW/FUNC
SUBSYSTEM: APU
MDAC ID: 343
FLIGHT: 3/1R
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

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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:

REPORT DATE 12/10/86

C-245
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
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CRITICALITIES

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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:

REPORT DATE 12/10/86  C-246
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/20/86

SUBSYSTEM: APU
MDAC ID: 345

HIGHEST CRITICALITY HDW/FUNC

FLIGHT: 3/3
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

CRITICALITIES

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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:

REPORT DATE 12/10/86 C-247
**INDEPENDENT ORBITER ASSESSMENT**

**ORBITER SUBSYSTEM ANALYSIS WORKSHEET**

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**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

**REDUNDANCY SCREENS:** A [ 2 ]  
**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:**

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**CRITICALITIES**

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INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/20/86
SUBSYSTEM: APU
MDAC ID: 347

HIGHEST CRITICALITY
FLIGHT: 3/3
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
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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:

REPORT DATE 12/10/86  C-249
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/20/86
HIGHEST CRITICALITY
HDW/FUNC
HDW/FUNC
MADAC ID: 348
FLIGHT: 3/1R
ABORT: 3/1R

ITEM: "APU HEATER-TANK/FUEL LINE/H2O 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/H2O HEATER CONTROL CIRCUIT
4) SWITCH
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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:

REPORT DATE 12/10/86 C-250
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/H2O 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/H2O HEATER CONTROL CIRCUIT
4) SWITCH
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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:

REPORT DATE 12/10/86  C-251
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/20/86
HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: APU
MDAC ID: 350

ITEM: FUEL/H2O 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/H2O LINE HEATER CONTROL CIRCUIT
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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:

REPORT DATE 12/10/86 C-252
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/H2O 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/H2O LINE HEATER CONTROL CIRCUIT

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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:

REPORT DATE 12/10/86  C-253  C - 4
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
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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.


REPORT DATE 12/10/86  C-254
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
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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:

REPORT DATE 12/10/86  C-255
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86
SUBSYSTEM: APU
MDAC ID: 354

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
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

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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:

REPORT DATE 12/10/86  C-256
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
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CRITICALITIES

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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:

 REPORT DATE 12/10/86 C-257
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86
SUBSYSTEM: APU
MDAC ID: 356

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
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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:

REPORT DATE 12/10/86   C-258
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86
SUBSYSTEM: APU
MDAC ID: 357

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

REPORT DATE 12/10/86 C-259
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86
SUBSYSTEM: APU
MDAC ID: 358

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

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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:

REPORT DATE 12/10/86 C-260
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86

SUBSYSTEM: APU
MDAC ID: 359

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
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
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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:

REPORT DATE 12/10/86 C-261
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/12/86
SUBSYSTEM: APU
MDAC ID: 360

ITEM: LUBE OIL LINE HEATER CONTROL CIRCUIT
FAILURE MODE: OPEN CIRCUIT

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

BREAKDOWN HIERARCHY:
1) APU
2) ELECTRICAL SYSTEM
3) LUBE OIL LINE HEATER CONTROL CIRCUIT

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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:

REPORT DATE 12/10/86 C-262
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86
SUBSYSTEM: APU
MDAC ID: 361

HIGHEST CRITICALITY
FLIGHT: 3/3
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

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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:

REPORT DATE 12/10/86 C-263
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/23/85
SUBSYSTEM: APU
MDAC ID: 362

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

CRITICALITIES

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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:

REPORT DATE: 12/10/86
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/23/86

HIGHEST CRITICALITY
HDW/FUNC

SUBSYSTEM: APU
MDAC ID: 363

FLIGHT: 3/3
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
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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:

REPORT DATE 12/10/86 C-265
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86
SUBSYSTEM: APU
MDAC ID: 364

ITEM: "APU FUEL/H2O QTY" GAUGE
FAILURE MODE: NO OUTPUT, OR ERRONEOUS OUTPUT

LEAD ANALYST: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
2) DISPLAYS
3) FUEL QUANTITY GAUGE
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LOCATION: PANEL F8

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:

REPORT DATE 12/10/86  C-266
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

| DATE:       | 10/21/86  |
| SUBSYSTEM:  | APU       |
| MDAC ID:    | 365       |
| HIGHEST CRITICALITY |
| FLIGHT:     | 3/3       |
| ABORT:      | 3/3       |

ITEM: "APU FUEL/H2O 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
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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:

REPORT DATE 12/10/86 C-267
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/H2O 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
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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:

REPORT DATE 12/10/86 C-268
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86
SUBSYSTEM: APU
MDAC ID: 367

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

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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:

REPORT DATE 12/10/86 C-269
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86
SUBSYSTEM: APU
MDAC ID: 368

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
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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:

REPORT DATE 12/10/86  C-270
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
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LOCATION: PANEL F8
PART NUMBER:

CAUSES: MANUFACTURING DEFECT, PIECE-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:

REPORT DATE 12/10/86  C-271
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86
SUBSYSTEM: APU
MDAC ID: 370

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
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LOCATION: PANEL F8

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:

REPORT DATE 12/10/86 C-272
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86
SUBSYSTEM: APU
MDAC ID: 371

HIGHEST CRITICALITY HDW/Func
FLIGHT: 3/3
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
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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:

REPORT DATE 12/10/86 C-273
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86  HIGHEST CRITICALITY  HDW/FUNC
SUBSYSTEM: APU  FLIGHT: 3/3
MDAC ID: 372  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
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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:

REPORT DATE: 12/10/86  C-274
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86
SUBSYSTEM: APU
MDAC ID: 373

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
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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:

REPORT DATE 12/10/86 C-275
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

CRITICALITIES

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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:

REPORT DATE 12/10/86  C-276
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
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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:

REPORT DATE 12/10/86  C-277
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/25/86
SUBSYSTEM: APU
MDAC ID: 376

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
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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:

REPORT DATE 12/10/86 C-278
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/25/86
SUBSYSTEM: APU
MDAC ID: 377

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/1R
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

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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:

REPORT DATE 12/10/86 C-279
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/21/86

SUBSYSTEM: APU
MDAC ID: 378

ITEM: NONCRITICAL INSTRUMENTATION
FAILURE MODE: NO OUTPUT, OR ERRONEOUS OUTPUT

LEAD ANALYST: J. BARNES
SUBSYSTEM: APU
MDAC ID: 378

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

BREAKDOWN HIERARCHY:
1) APU
2) INSTRUMENTATION
3) NONCRITICAL INSTRUMENTATION
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CRITICALITIES

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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:

REPORT DATE 12/10/86 C-280
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/05/86
SUBSYSTEM: APU
MDAC ID: 379

HIGHEST CRITICALITY
FLIGHT: 2/1R
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

CRITICALITIES

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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:

REPORT DATE 12/10/86 C-281
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/05/86
SUBSYSTEM: APU
MDAC ID: 380

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
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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


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:

REPORT DATE 12/10/86   C-282
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

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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:

REPORT DATE 12/10/86  C-283
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
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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:

REPORT DATE 12/10/86    C-284
DATE: 11/05/86

SUBSYSTEM: APU

MDAC ID: 383

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

REPORT DATE 12/10/86 C-285
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
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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:

REPORT DATE 12/10/86 C-286
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86
SUBSYSTEM: APU
MDAC ID: 385

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
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
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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

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:

REPORT DATE 12/10/86 C-287
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86
SUBSYSTEM: APU
MDAC ID: 386

ITEM: CONTROLLER APU START LOGIC
FAILURE MODE: LOSS OF OUTPUT, INTERMITTENT OUTPUT

LEAD ANALYST: J. BARNES

BREAKDOWN HIERARCHY:
1) APU
  2) CONTROLLER
  3) APU START LOGIC
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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:

REPORT DATE 12/10/86 C-288
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86
SUBSYSTEM: APU
MDAC ID: 387

HIGHEST CRITICALITY
FLIGHT: 3/3
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
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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:

REPORT DATE 12/10/86  C-289
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86  HIGHEST CRITICALITY  HDW/FUNC
SUBSYSTEM: APU  FLIGHT: 3/3
MDAC ID: 388  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
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LOCATION:  AV BAY 4,5,6
PART NUMBER:  MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

EFFECTS/RATIONALES:
NO "APU READY TO START" SIGNAL TO TALKBACK LOGIC. TALKBACK WILL
NOT SHOW "READY". APU WILL BE STARTED ANYWAY.

REFERENCES:

REPORT DATE 12/10/86  C-290
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

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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:

REPORT DATE 12/10/86  C-291
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86
SUBSYSTEM: APU
MDAC ID: 390

HIGHEST CRITICALITY: MDAC ID: 390
FLIGHT: 3/1R
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
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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:

REPORT DATE 12/10/86  C-292
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86
SUBSYSTEM: APU
MDAC ID: 391

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

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LOCATION: AV BAY 4,5,6
PART NUMBER: MC201-0001

CAUSES: MANUFACTURING DEFECT, CONTAMINATION

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:

REPORT DATE 12/10/86 C-293
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86
SUBSYSTEM: APU
MDAC ID: 392

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
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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:

REPORT DATE 12/10/86 C-294
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86
HIGHEST CRITICALITY
SUBSYSTEM: APU
MDAC ID: 393
HIGHEST CRITICALITY
FLIGHT: 3/3
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
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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:

REPORT DATE 12/10/86 C-295
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86
SUBSYSTEM: APU
MDAC ID: 394

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

REPORT DATE 12/10/86  C-296
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86
SUBSYSTEM: APU
MDAC ID: 395
HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
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
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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:

REPORT DATE 12/10/86 C-297
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86  HIGHEST CRITICALITY  HDW/FUNC
SUBSYSTEM: APU   FLIGHT:  3/1R
MDAC ID: 396   ABDORT:  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
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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:

REPORT DATE 12/10/86  C-298
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

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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
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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:

REPORT DATE 12/10/86       C-299
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86
SUBSYSTEM: APU
MDAC ID: 398

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
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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:

REPORT DATE 12/10/86  C-300
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86

SUBSYSTEM: APU
MDAC ID: 399

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 1/1
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

CRITICALITIES

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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:

REPORT DATE 12/10/86 C-301
INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 11/06/86

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

SUBSYSTEM: APU
MDAC ID: 400

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
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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:

REPORT DATE 12/10/86  C-302
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<td>EXHAUST DUCT</td>
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<td>105</td>
<td>EXHAUST DUCT BELLOWS</td>
<td>LEAK</td>
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<td>106</td>
<td>GEARBOX</td>
<td>LOSS OF OUTPUT</td>
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<td>MAGNETIC PICKUP UNIT 1</td>
<td>NO OUTPUT, OR INTERMITTENT OUTPUT</td>
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<td>Rupture at operating pressure</td>
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<td>FUEL TANK</td>
<td>EXTERNAL LEAK (FUEL)</td>
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<td>FUEL TANK</td>
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<td>FUEL TANK GN2 LINE</td>
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<td>FUEL PUMP/GGVM COOLING WATER LINES - BETWEEN TANK AND TANK VALVES</td>
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