**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE**
**NUMBER: 03-2A-221310 -X**

**SUBSYSTEM NAME:** AFT REACTION CONTROL SYSTEM (RCS)
**REVISION:** 2 12/12/89

**PART DATA**

| | PART NAME<br>VENDOR NAME | PART NUMBER<br>VENDOR NUMBER |
|---|---|---|
| LRU | : THRUSTER, PRIMARY | MC467-0028 |
| SRU | : VALVE, INLET | 234175 |
| SRU | : VALVE, INLET | 234180 |

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
INLET VALVE, ENGINE PILOT OPERATED, SOLENOID DRIVEN (28 VOLTS DC) FLUID ACTIVATED.

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 48
24 EACH POD
12 FUEL AND 12 OX

FUNCTION:
VALVES ARE USED TO INITIATE THRUSTER FIRING BY OPENING UPON GN&C COMMAND. AN OX AND FUEL VALVE ARE PROVIDED FOR EACH THRUSTER.

**FAILURE MODES EFFECTS ANALYSIS FMEA – CIL FAILURE MODE**
**NUMBER: 03-2A-221310- 04**

**REVISION#:** 1 04/03/96

**SUBSYSTEM NAME:** AFT REACTION CONTROL SYSTEM (RCS)
**LRU:** THRUSTER, PRIMARY
**ITEM NAME:** VALVE, INLET

**CRITICALITY OF THIS FAILURE MODE:** 1R3

**FAILURE MODE:**
FAILS TO OPEN, FAILS CLOSED, FAILS TO REMAIN OPEN, RESTRICTED FLOW.

**MISSION PHASE:**
LO LIFT-OFF
OO ON-ORBIT
DO DE-ORBIT

**VEHICLE/PAYLOAD/KIT EFFECTIVITY:**
102 COLUMBIA
103 DISCOVERY
104 ATLANTIS
105 ENDEAVOUR

**CAUSE:**
CONTAMINATION, PIECE PART FAILURE, VIBRATION, SEAL WEAR, MATERIAL DEFECT, ELECTRICAL FAILURE, JAMMING OF POPPET, CORROSION, PILOT POPPET SEAL EXTRUSION.

**CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO**

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**REDUNDANCY SCREEN**
**A)** FAIL
**B)** PASS
**C)** PASS

**PASS/FAIL RATIONALE:**
**A)**
"A" SCREEN FAILS BECAUSE THRUSTERS CANNOT BE FIRED WHILE ON THE VEHICLE DURING GROUND CHECKOUT.

**B)**

**C)**

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**- FAILURE EFFECTS -**

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**(A) SUBSYSTEM:**
LOSS OF ONE THRUSTER IN AFFECTED AXIS.

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(B) INTERFACING SUBSYSTEM(S):
INCREASED GN&C SWITCHING AND USAGE OF ALTERNATE THRUSTERS.

(C) MISSION:
NO EFFECT

(D) CREW, VEHICLE, AND ELEMENT(S):
NO EFFECT

(E) FUNCTIONAL CRITICALITY EFFECTS:
POSSIBLE LOSS OF CREW/VEHICLE DUE TO INABILITY TO PERFORM ET SEP AND OR ENTRY DUE TO INSUFFICIENT THRUST CAPABILITY IN THE REQUIRED AXIS.

-DISPOSITION RATIONALE-

(A) DESIGN:
ALL MATERIALS COMPATIBLE WITH PROPELLANTS, DESIGNED TO OPERATE AT 175-350 PSIA, THE VALVE HAS IMPROVED SEALS, CONTAINS A 75 MICRON FILTER AT THE INLET, THE VALVE OPENS WITH AS LITTLE AS 18V DC AND IS PILOT OPERATED, HAS CYCLE LIFE OF 80000 CYCLES.

(B) TEST:
THE QUALIFICATION TEST PROGRAM INCLUDED ROUGH HANDLING, VIBRATION (34 MIN/AXIS), FORWARD AND REVERSE INTERNAL LEAKAGE, EXTERNAL LEAKAGE, ABNORMAL OPERATION, BUBBLE INGESTION, ELECTROMAGNETIC INTERFERENCE, IGNITION OVERPRESSURE, BURST PRESSURE, SAFETY MARGIN, LIGHTNING, HEATER OUT IGNITION, ZOTS, MISSION DUTY CYCLES, ACCELERATED LIFE DUTY CYCLE, AND PROPELLANT COMPATIBILITY.

THE UNITS ALSO QUALIFIED AS PART OF THE HOT FIRE TEST PROGRAM AT WSTF (24 EQUIVALENT MISSION DUTY CYCLES AND APPROX 7 YEARS OF PROPELLANT EXPOSURE).

ACCEPTANCE TESTING INCLUDES PROOF PRESSURE (INLET VALVE - 1500 PSIG), INTERNAL LEAKAGE, THRUSTER PERFORMANCE, INSULATION RESISTANCE, PULL-IN VOLTAGE, CONTINUITY/RESISTANCE, EXTERNAL LEAKAGE, FLOW CALIBRATION, CLEANLINESS, RESPONSE OF THE VALVES AND DIELECTRIC STRENGTH.

GROUND TURNAROUND TEST
ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

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(C) INSPECTION:
RECEIVING INSPECTION
INSPECTION VERIFIES MATERIAL AND PHYSICAL PROPERTIES.

CONTAMINATION CONTROL
CLEANLINESS PER MPS 210 IS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
FINAL INSPECTION OF ALL DIMENSIONS IS VERIFIED. INSPECTION VERIFIES THREADS ARE LUBRICATED WITH KRYTOX 143AC PER MPS 1103, APPENDIX I. THE 235595 SEAT ASSEMBLY IS VISUALLY INSPECTED PER STD V234159.

NONDESTRUCTIVE EVALUATION
INSPECTION VERIFIES VALVE CLOSURE WELDS (VALVE/CAP WELD AND VALVE/SEAT WELD) ARE ULTRASONIC INSPECTED PER MPS-907, LEVEL AA, AFTER WELD AND AFTER MTS-1291 PARAGRAPH 4.4 (1500 PSIG PROOF). OTHER STRUCTURAL CLASS A WELDS ARE, UNLESS OTHERWISE CALLED OUT, RADIOGRAPHIC INSPECTED AND EITHER PENETRANT OR MAGNETIC PARTICLE INSPECTED.

CRITICAL PROCESSES
INSPECTION VERIFIES WELDING IS PER SPECIFICATION REQUIREMENTS, INCLUDING VALVE CLOSURE WELDS, PER MPS 1609, APPENDIX VI AND TACK WELDS PER MPS 1601, CLASS B, AND VISUALLY INSPECTS WELDS.

TESTING
VALVE ACCEPTANCE TESTING PER MTS1270 PART II PRIOR TO WELDING AND PER MTS1291 AFTER WELDING IS VERIFIED BY INSPECTION. VALVE IS LEAK TESTED PER THE REQUIREMENTS OF MPS 120 AND IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING
PACKAGING PROCEDURES ARE VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:
CURRENT DATA ON TEST FAILURES, FLIGHT FAILURES, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATA BASE. THE FAILURE HISTORY DATA PROVIDED BELOW IS NO LONGER BEING KEPT UP-TO-DATE.

CAR 17F011:
ONE FLIGHT ANOMALY RESULTED IN A FAILED CLOSE ENGINE VALVE. ANALYSIS SHOWED THE CAUSE TO BE METALLIC CONTAMINATION PREVENTING THE PILOT STAGE FROM OPENING.
CORRECTIVE ACTION IS TO PLACE RIGID CONTROLS ON REMOVAL AND REPLACEMENT OF COMPONENTS TO ELIMINATE METALLIC PARTICULATE CONTAMINATION AND TO ASSURE PROPELLANT IS PER SPECIFICATION REQUIREMENTS.

CAR'S AD0044 AND AD0045:
A STICKY OXIDIZER VALVE ON OV-102 WAS REPORTED DURING THE AA MOD. THIS WAS CAUSED BY IRON NITRATE BUILD UP AROUND THE PILOT STAGE. THE THRUSTER HAD BEEN INACTIVE FOR 18 MONTHS. DURING NORMAL OPERATIONS, THRUSTER VALVES ARE MAINTAINED IN A WET CONDITION AND THIS CONDITION WOULD NOT EXIST.

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CORRECTIVE ACTION HAS PLACED RIGID CONTROLS ON REMOVAL AND REPLACEMENT OF COMPONENTS TO ELIMINATE METALLIC PARTICULATE CONTAMINATION AND TO ASSURE PROPELLANT IS PER SPECIFICATION REQUIREMENTS.

(E) OPERATIONAL USE:
THE AFT RCS SYSTEM CAN HANDLE ANY TWO THRUSTER FAILURES. NO ACTION IS AVAILABLE IF ALL REDUNDANCY IS LOST.

- APPROVALS -

| | | |
|---|---|---|
| PAE MANAGER | : K. L. PRESTON | : K L Preston 4/19/96 |
| PRODUCT ASSURANCE ENGR | : T. K. KIMURA | : T K Kimura 4/19/96 |
| DESIGN ENGINEERING | : D. L. PERRY | : D L Perry 4/19/96 |
| NASA SSMA | : | : [illegible] 6/7/96 |
| NASA SUBSYSTEM MANAGER | : | : [illegible] 6/7/96 |
| NASA MOD | : | : [illegible] 6/13/96 |