

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL HARDWARE  
NUMBER: 03-1-0408-X**

**SUBSYSTEM NAME: MAIN PROPULSION**

**REVISION: 1 5/11/94**

	<b>PART NAME VENDOR NAME</b>	<b>PART NUMBER VENDOR NUMBER</b>
LRU	: DISCONNECT, LO2, 17 INCH	MC284-0389-0551 (ORB HALF)
LRU	: DISCONNECT, LO2, 17 INCH	MC284-0389-0552 (ET HALF)

**PART DATA**

**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**  
DISCONNECT, LO2 FEED, 17 INCH, ORBITER & ET HALF. (PD1)

**QUANTITY OF LIKE ITEMS: 1**  
ONE

**FUNCTION:**

ET/ORBITER FEED LINE DISCONNECT PROVIDES LO2 PROPELLANT TO THE MPS AND A MEANS OF LOADING AND DETANKING THE ET. EACH DISCONNECT HALF CONTAINS A PNEUMATICALLY ACTUATED FLAPPER CLOSURE DEVICE WHICH REMAINS IN ITS LAST ACTUATED POSITION (BISTABLE). THE VALVES ARE CLOSED AFTER MECO TO PREVENT PROPULSIVE VENTING LEADING TO ET/ORBITER RECONTACT, TILE/DOOR DAMAGE DUE TO EXPOSURE TO PROPELLANTS, LOSS OF HELIUM SUPPLY DURING MANIFOLD REPRESSURIZATION (RTLSTAL ABORT CRITICAL), AND SYSTEM CONTAMINATION DURING ENTRY. DURING UMBILICAL SEPARATION, THE VALVE SYSTEM IS DESIGNED TO MECHANICALLY CLOSE BOTH THE ORBITER AND ET DISCONNECT FLAPPERS IF UNABLE TO CLOSE THEM PNEUMATICALLY (POST MECO). REDUNDANT OPEN AND CLOSE (TWO EACH) VALVE POSITION SWITCHES ARE LOCATED ON THE ORBITER HALF OF THE DISCONNECT. THE FLAPPER DRIVE MECHANISM IS DESIGNED TO ALLOW RELIEF OF PROPELLANTS TRAPPED BETWEEN THE FLAPPERS AFTER DISCONNECT CLOSURE.

A PNEUMATICALLY ACTUATED LATCH MECHANISM IS PROVIDED TO PREVENT THE VALVE FLAPPERS FROM CLOSING DURING FLOW CONDITIONS. THE LATCH IS BISTABLE AND IS CONTROLLED BY A SEPARATE PNEUMATIC ACTUATOR ASSEMBLY WITH REDUNDANT LOCK AND UNLOCK (TWO EACH) POSITION SWITCHES. LATCH MECHANISM INCORPORATES A TOGGLE PIVOT WHICH ALLOWS FLAPPER CLOSURE DURING BACK UP MECHANICAL SEPARATION WITH LATCH IN LOCKED POSITION. SEE LATCH FMEA/CIL 0454 FOR ADDITIONAL INFORMATION.

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM : MAIN PROPULSION FMEA NO: 03-1 -0408 -12 REV: 12/17/87

ASSEMBLY :  
P/N RI : MC2B4-0389-KXXX CRIT. FUNC: 1  
ORB HALF 0531 CRIT. HDW: 1  
ET HALF 0532

P/N VENDOR:  
QUANTITY : 1 VEHICLE 102 103 104  
EFFECTIVITY: X X X  
: ONE PHASE(S): PL X LO X OO DO LS  
:

PREPARED BY: DES J E OSUND REL L H FINEBERG QE E M GUTIERREZ  
REDUNDANCY SCREEN: A- B- C-  
APPROVED BY: DES [Signature] APPROVED BY (NAME): SSM [Signature]  
REL [Signature] REL [Signature]  
QE [Signature] QE [Signature]

ITEM:  
DISCONNECT, LO2 FEED (WITH LATCH) 17 INCH, ORBITER & ET HALF. (PD1)

FUNCTION

ET/ORBITER FEED LINE DISCONNECT PROVIDES LO2 PROPELLANT TO THE MPS AND A MEANS OF LOADING AND DETANKING THE ET. EACH DISCONNECT HALF CONTAINS A PNEUMATICALLY ACTUATED FLAPPER CLOSURE DEVICE WHICH REMAINS IN ITS LAST ACTUATED POSITION (BISTABLE). THE VALVES ARE CLOSED AFTER MECO TO PREVENT PROPULSIVE VENTING LEADING TO ET/ORBITER RECONTACT, TILE/DOOR DAMAGE DUE TO EXPOSURE TO PROPELLANTS, LOSS OF HELIUM SUPPLY DURING MANIPOLD REPRESSURIZATION (RTLS/TAL ABORT CRITICAL), AND SYSTEM CONTAMINATION DURING ENTRY. DURING UMBILICAL SEPARATION, THE VALVE SYSTEM IS DESIGNED TO MECHANICALLY CLOSE BOTH THE ORBITER AND ET DISCONNECT FLAPPERS IF UNABLE TO CLOSE THEM PNEUMATICALLY (POST MECO). REDUNDANT OPEN AND CLOSE (TWO EACH) VALVE POSITION SWITCHES ARE LOCATED ON THE ORBITER HALF OF THE DISCONNECT. THE FLAPPER DRIVE MECHANISM IS DESIGNED TO ALLOW RELIEF OF PROPELLANTS TRAPPED BETWEEN THE FLAPPERS AFTER DISCONNECT CLOSURE.

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FAILURE MODE

RUPTURE/LEAKAGE OF THE ACTUATOR

CAUSE(S)

FATIGUE, MATERIAL DEFECTS, DAMAGED/DEFECTIVE ACTUATOR SEALS

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :MAIN PROPULSION

FMEA NO:03-1 -0408 -12 REV:12/17/87

EFFECT(S): ON

(A)SUBSYSTEM (B)INTERFACES (C)MISSION (D)CREW/VEHICLE:

(A,B) LOSS OF CONTROL OF THE DISCONNECT VALVE. POSSIBLE DEPLETION OF VALVE ACTUATION PRESSURE CAUSING FAILURE TO CLOSE LO2 PREVALVES AT MECO. RESULTS IN THE INABILITY TO MAINTAIN INJECTED HELIUM AND LO2 PRESSURE AT THE SSME PUMP, RESULTING IN POSSIBLE PUMP OVERSPEED AND EXPLOSION. POSSIBLE AFT COMPARTMENT OVERPRESSURIZATION AND FIRE/EXPLOSIVE HAZARD. AT MECO THE ENGINE NUMBER TWO HELIUM SUPPLY IS SWITCHED INTO THE PNEUMATIC VALVE SYSTEM (VIA LV10) AS A BACKUP, BY SOFTWARE COMMAND, WHICH MAY ACTUATE THE LO2 PREVALVES CLOSED. LEAKAGE MAY BE DETECTABLE ON GROUND USING HAZARDOUS GAS DETECTION SYSTEM (HGDS). ALSO RESULTS IN LOSS OF GHE SUPPLY DURING PROPELLANT DUMP CAUSING POSSIBLE LOSS OF AFT COMPARTMENT PURGE (RTLS/TAL ABORT CRITICAL).

(C) ON GROUND, POSSIBLE VIOLATION OF HGDS LCC WILL RESULT IN LAUNCH SCRUB.

(D) POSSIBLE LOSS OF CREW/VEHICLE.

DISPOSITION & RATIONALE:

(A)DESIGN (B)TEST (C)INSPECTION (D)FAILURE HISTORY (E) OPERATIONAL USE:

(A) DESIGN

DESIGN FACTORS OF SAFETY ARE 1.5 PROOF, 2.0 BURST FOR THE DISCONNECT ACTUATOR. THE DISCONNECT ACTUATOR ASSEMBLY IS DESIGNED FOR 2500 CYCLES (OPEN TO CLOSE TO OPEN) AT AMBIENT AND 1000 CYCLES AT CRYOGENIC TEMPERATURE. THE ACTUATOR IS DESIGNED FOR 1700 PSIG BURST AND 1275 PSIG PROOF.

THE ACTUATOR BODY IS 2219-T851 AL ALLOY. THE PISTON IS 6061-T651 AL ALLOY, ANODIZED. THE ROD END CAP IS 2219-T8511 AL ALLOY. THE ROD BUSHING IS OF 6061-T651, ANODIZED.

POTENTIAL ACTUATOR LEAK PATHS:

PORT BLOCK/ACTUATOR BODY (OPEN/CLOSE) INTERFACE  
ACTUATOR BODY/ROD END CAP ASSEMBLY INTERFACE  
BUMPER SEALS  
PISTON ROD SEALS

THE INTERFACE SEALS AND BUMPER SEALS ARE TEFLON (TFE) JACKETED WITH A 301 CRES SPRING. THE PISTON ROD SEALS ARE REDUNDANT AND ARE RULON-A JACKETED WITH 302 CRES SPRINGS. THE SEAL SPRING PROVIDES THE PRELOAD NECESSARY FOR A POSITIVE SEAL.

(B) TEST

ATP (ACTUATOR)

PROOF: AMBIENT, 1275 PSIG

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :MAIN PROPULSION FMEA NO:03-1 -0408 -12 REV:12/17/87

OPERATIONAL (TWO CYCLES): AMBIENT: 400, 740, 780 PSIG

RESPONSE TIME (OPENING/CLOSING): ROOM AMBIENT/-300 DEG F  
RESPONSE TIME AT 400, 700 AND 780 PSIG

LEAKAGE: EXTERNAL AND INTERNAL, AMBIENT AND CRYO

ATP - ET/ORBITER MATED DISCONNECT ASSEMBLY

FLAPPER ANGLE: ET 4.5 +/- 0.25 DEG, ORB 3.0 +/- 0.25 DEG

TIP LOAD: ET 55 LB MINIMUM, ORB 40 LB MINIMUM

POSITION SWITCH VERIFICATION: LATCH IN LOCKED POSITION. ROTATION FROM  
FLAPPER POSITION OF REST ON DOWNSTRIKE SURFACE TO FLAPPER POSITION  
WHERE OPEN INDICATOR LIGHT TURNS ON MUST BE 4 DEG, MINIMUM.

PROOF: AMBIENT, 1275 PSIG, ACTUATOR  
285 PSIG FOR ORBITER CLOSURE DEVICE  
58 PSIG FOR ET CLOSURE DEVICE

OPERATIONAL CYCLE: CRYO, -300 DEG F, ACTUATOR PRESSURE 740 PSIG FOR 8  
CYCLES AND 450 PSIG FOR 5 CYCLES  
AMBIENT, He AT 400 PSIG (1 CYCLE) AND 740 PSIG (5  
CYCLES)

CLEANLINESS VERIFICATION: MOISTURE FREE AND CLEANED TO LEVEL 400A OF  
MA 0110-301

LEAKAGE: EXTERNAL

VALVE: LN2/AMBIENT TEMPS: 50 SCIMS OF GHE AT 10 PSIG, 50  
SCIMS OF GHE AT 50 PSIG; LATCH SHAFT SEAL, 80 SCIMS OF  
GHE; 150 SCIMS OF GN2 AT 185 PSIG; LATCH SHAFT SEAL,  
80 SCIMS OF GN2

VALVE ACTUATOR:

CRYO (BODY TEMP AT -300 DEG F, ACTUATOR AT -200 TO  
0 DEG F)/AMBIENT TEMPS: 100 SCIMS OF GHE AT 740 PSIG

INTERNAL

VALVE: AMBIENT TEMPS: 1000 TO 2000 SCIMS OF GHE AT 1 TO  
15 PSIG; 2500 SCIMS OF GN2 AT 200 PSIG  
LN2 TEMPS: 2500 SCIMS OF GHE AT 60 PSIG; 2500  
SCIMS OF GN2 AT 200 PSIG

VALVE ACTUATOR:

CRYO (BODY TEMP AT -300 DEG F, ACTUATOR AT -200 TO  
0 DEG F)/AMBIENT TEMPS: 100 SCIMS OF GHE AT 740 PSIG

RELIEF OPERATION: -300 DEG F, CRACKING/RESEAT PRESSURE, 0.1-5 PSID (ET  
ONLY)

ELECTRICAL CHARACTERISTICS (INSULATION RESISTANCE AND VOLTAGE DROP), AND  
DIELECTRIC STRENGTH

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :MAIN PROPULSION

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FLOW LINER - ROUNDNESS VERIFICATION (FREE END EIGHT POINTS MEASUREMENT)  
CERTIFICATION

COMPONENT QUALIFICATION (INCLUDES TESTING FROM PREVIOUS CONFIGURATION  
----- WITHOUT LATCH)

SALT FOG

VIBRATION - THREE AXES:

SINUSOIDAL: 5 TO 35 HZ AT 0.25 G, ZERO TO PEAK

RANDOM: 20 TO 2,000 HZ 5.7 G RMS FOR X-AXIS, 5.2 G RMS FOR Y  
AND Z-AXIS, NO FLOW (LN2), FLAPPERS OPEN, LATCH  
ENGAGED

THE DISCONNECT IS CHILLED WITH LN2 AND STABILIZED AT  
-300 DEG F. 10 PSIG DISCONNECT, 740 PSIG ACTUATOR.  
THESE CONDITIONS ARE MAINTAINED THROUGHOUT SINUSOIDAL  
AND RANDOM VIBRATION. ACTUATOR VENTED DURING LAST TWO  
MINUTES OF VIBRATION.

THERMAL CYCLE: -400 TO 150 DEG F, 3 CYCLES

OPERATING LIFE: AMBIENT, 740 PSIG HE FOR A TOTAL OF 2,400 CYCLES FOR  
ORBITER AND 100 CYCLES FOR ET.  
THE RELIEF MECHANISM WAS CYCLED DURING ET  
VALVE CYCLING.

CRYO, 740 PSIG HE, -400 DEG F FOR A TOTAL OF 1000  
CYCLES FOR ORBITER AND 50 CYCLES FOR THE ET.  
THE RELIEF MECHANISM WAS CYCLED DURING ET  
VALVE CYCLING.

ELECTRICAL CHARACTERISTICS (INSULATION RESISTANCE AND VOLTAGE DROP)

LEAKAGE: EXTERNAL AND INTERNAL, AMBIENT AND CRYO

ENGAGE - DISENGAGE: ENGAGE FORCE = 1000 LBS MAX, DISENGAGE  
FORCE = 5000 LBS MAX

BURST TEST: PNEUMATIC ACTUATOR, 1700 PSIG HYDROSTATIC PRESSURE FOR  
2 MINUTES

TYPE I AND TYPE II MATED (OPEN POSITION) 450 PSIG HYDROSTATIC  
PRESSURE FOR 2 MINUTES

TYPE I AND TYPE II DEMATED (CLOSED POSITION) 330 PSID TO  
TYPE I, 68 PSID TO TYPE II FOR 2 MINUTES

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM : MAIN PROPULSION

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UMBILICAL SEPARATION TEST: (WITHOUT LATCH)  
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THE DISCONNECT WAS INSTALLED IN THE UMBILICAL ASSEMBLY DURING THE SEPARATION TEST PROGRAM. THE UMBILICAL ASSEMBLY WAS SUBJECTED TO RANDOM VIBRATION TESTS (4.4 HOURS PER AXIS) WHILE FILLED WITH LN<sub>2</sub>. THE DISCONNECT WAS ALSO SUBJECTED TO UMBILICAL RETRACT TESTS AT BOTH NOMINAL CONDITIONS AND SIMULATED HYDRAULIC RETRACT ACTUATOR FAILURES.

UMBILICAL SEPARATION TEST: (WITH LATCH)  
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FLAPPER PNEUMATICS/LATCH PNEUMATICS/PYROS/RETRACTOR HYDRAULICS

- (1) PNEUMATIC CLOSURE (NORMAL) - 4 CYCLES
- (2) MECHANICAL CLOSURE (BACKUP) - 5 CYCLES

BOTH PERFORMED AT AMBIENT, LN<sub>2</sub> AND LH<sub>2</sub> CONDITIONS.

TERMINAL DRAIN: (SATURATED LO<sub>2</sub>) (65% AND 109%) LATCH ENGAGED AND NOT ENGAGED.

FLOW LINER WATER FLOW TESTS:  
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DESIGN FLOW TO 19,600 GPM  
ALLOWABLE DELTA P IS 10 PSID AT THE LINER

TO DETERMINE THE STABILITY OF THE FLOW LINER. THE FLOW TUBE HAD NO PERMANENT DAMAGE AFTER BEING SUBJECTED TO WATER FLOWS UP TO 20,000 GPM (TEST TIME OF 2 MINUTES / 6 RUNS MINIMUM). AFTER VERIFYING PERFORMANCE AT 20,000 GPM, THE UNIT WAS SUBJECTED TO 22,700 GPM TO VERIFY DESIGN MARGIN (NO PERMANENT DAMAGE).

FLAPPER ANGLE STABILITY MARGIN WATER FLOW TESTS:  
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FOURTEEN (14) EXPLORATORY TEST SERIES (FLOW 4,000 TO 20,800 GPM)  
E.T. FLAPPER SETTING VARYING FROM 1.6 TO 5.8 DEG.  
ORB. FLAPPER SETTING VARYING FROM 0.9 TO 5.4 DEG.

CERTIFICATION TEST RUN AT WORST CASE PRODUCTION SETTING (FLOW RANGE TO 109% POWER LEVEL).

PROOF TEST SERIES - MAXIMUM FLOW 22,700 GPM, AT ANGLES BELOW MINIMUM FLIGHT SETTINGS

PRODUCTION ANGLE SETTINGS  
E.T. 4.5 +/- 0.25 DEG  
ORB. 3.0 +/- 0.25 DEG

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :MAIN PROPULSION

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FLAPPER TIP LOAD MARGIN WATER FLOW TEST:  
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EIGHT (8) EXPLORATORY TEST SERIES (FLOW RANGE TO 109% POWER LEVEL)

FLOW 4,000 TO 20,600 GPM

ORBITER: 3.0 +/- 0.1 DEG FOR SEVEN SERIES, 4.1 +/- 0.1 FOR ONE SERIES  
TIP LOAD RANGE: 20 TO 62 LBS

ET: 3.95 +/- 0.1 DEG  
TIP LOAD RANGE: 23 TO 61 LBS

RECOMMENDED TIP LOAD:

ORBITER: 40 LBS MINIMUM  
ET: 55 LBS MINIMUM

LATCH WATER FLOW TESTS:  
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TWENTY-FOUR (24) EXPLORATORY TEST SERIES (FLOW 4,000 TO 22,100 GPM)

CERTIFICATION TEST RUN AT MINIMUM PRODUCTION SETTING (FLOW RANGE TO 109% POWER LEVEL).

TWO TEST SERIES IN FILL DIRECTION (FLOW 4,000 TO 6,400 GPM), LATCH PNEUMATIC PRESSURE VENTED (BISTABILITY)

PROOF TEST - 23,200 GPM

LATCH CRYO FLOW TESTS:  
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SIXTEEN (16) TESTS WITH LN2/LO2 (FLOWS VARY FROM ONE ENGINE AT 65% TO THREE AT 109%):

DISCONNECT FLAPPER STABILITY/LOADS

CAVITATION

FRICTION PRESSURE LOSS

ENGINE CUTOFF SENSOR RESPONSE

STEADY STATE TEST: LN2 (65% AND 109% OF RATED POWER LEVEL), LATCH ENGAGED. LO2 (100%, 104% AND 109% OF RATED POWER LEVEL), LATCH ENGAGED AND NOT ENGAGED.

TERMINAL DRAIN: (SATURATED LO2) (65% AND 109%) LATCH ENGAGED AND NOT ENGAGED.

SHUTTLE CRITICAL ITEMS LIST - ORBITER

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OMRSD

V41AZO.071 HELIUM SYSTEM COMPONENT LEAK TEST (I10)  
V41AZO.100 MPS PNEUMATIC LOW PRESSURE DECAY (EVERY FLT)  
V41AZO.110 ACTUATOR INTERNAL LEAK TEST (IS)  
V41AZO.230 MPS PNEUMATIC LOW PRESSURE DECAY VERT POSITION (EVERY FLT)  
V41BIO.240 ORB/ET DISC RESPONSE TIME (POST FLT DATA ANALYSIS)  
V41BUO.010 MPS COMPONENT VISUAL INSPECTION (EVERY FLT)  
V41BUO.280 DISCONNECT FLAPPER ANGLE VERIFICATION (EVERY FLT)  
V41BUO.320 DISCONNECT INSPECTION AND TIP LOAD VERIF (EVERY FLT)  
V41BUO.370 LH2/LO2 17" DISC ACTUATOR OPERATIONAL VERIF (EVERY FLT)  
T41FUN.061 ET 17" TIP LOAD/FLAPPER ANGLE INSPECTION (EVERY FLT)  
S00000.090 PD1 RESPONSE TIME (MATED) (EVERY FLT)

(C) INSPECTION

RECEIVING INSPECTION

RAW MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION. ALL MACHINED ITEMS ARE DIMENSIONALLY INSPECTED AND VERIFIED (MIL-STD-105). CHEMICAL/MECHANICAL PROPERTIES AND RECORDS OF RECEIVED MATERIALS ARE RETAINED FOR VERIFICATION. BODY FORGING IS ULTRASONICALLY AND DYE PENETRANT INSPECTED.

CONTAMINATION CONTROL

CLEANLINESS LEVEL TO 400A VIA FREON FLUSH AND SAMPLE VERIFIED. ALL SEAL GROOVES ARE INSPECTED FOR CLEANLINESS AND EVIDENCE OF DAMAGE.

ASSEMBLY/INSTALLATION

THREADED INSERTS AND CRITICAL DIMENSIONS VERIFIED BY INSPECTION. SEALING SURFACES ARE VISUALLY INSPECTED FOR DEFECTS. REPAIRED AND REWORKED ITEMS ARE DIMENSIONALLY CHECKED. LOG OF CLEAN ROOM VERIFIED. ALL ENGINEERING-DEFINED FEATURES AND SURFACE FINISHES AND TORQUE REQUIREMENTS ARE COMPLETELY INSPECTED AND VERIFIED.

THE PRIMARY INTERFACE SEAL IS CHECKED FOR ID, OD AND ROUNDNESS. ALL DIMENSIONS DEFINED IN DRAWING ARE VERIFIED BY INSPECTION.

CRITICAL PROCESSES

HEAT TREATMENT AND PART PASSIVATION ARE VERIFIED BY INSPECTION.

NON-DESTRUCTIVE EVALUATION

PARTS ARE RADIOGRAPHICALLY AND DYE PENETRANT INSPECTED AS IMPOSED BY ENGINEERING IN THE DRAWING REQUIREMENTS.

TESTING

ATP AND TEST MEASUREMENT EQUIPMENT CALIBRATION VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PACKAGING FOR SHIPMENT VERIFIED BY INSPECTION.

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :MAIN PROPULSION

FMEA NO:03-1 -0408 -L2 REV:12/17/87

(D) FAILURE HISTORY

A FAILURE OF THE PORT BLOCK STATIC SEAL ON THE 17 INCH DISCONNECT ACTUATOR OCCURRED DURING ATP (REFERENCE CAR A5376). A DRAWING REVISION WAS MADE TO UTILIZE FLUOROCARBON SEAL (WAS RAYCO/JAYCO). NO FURTHER INCIDENTS HAVE OCCURRED.

A FAILURE OCCURRED DURING ATP WHEN A SEAL HAD SHEARED DURING ASSEMBLY DUE TO MISALIGNMENT OF THE DETAIL PARTS (REFERENCE CAR AB1054). THE ASSEMBLY PROCEDURE WAS CORRECTED TO REQUIRE USE OF A TOOL TO CONTROL ALIGNMENT OF THE END CAP OVER THE PISTON. NO FURTHER INCIDENTS HAVE OCCURRED.

(E) OPERATIONAL USE

HELIUM BOTTLE PRESSURE IS ON DEDICATED DISPLAY IN COCKPIT. CREW ACTION CAN CLOSE ISOLATION VALVES (LV7,LV8) DURING ASCENT. PRIOR TO MECO, ISOLATION VALVES CAN BE REOPENED OR THE LEFT ENGINE LOW PRESSURE HELIUM CROSSOVER VALVE (LV10) CAN BE OPENED.