

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

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 1 5/11/94

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
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 -2 REV: 02/19/89

ASSEMBLY :
P/N RI : MC284-0389-XXXX CRIT. FUNC: 1
ORB HALF 0551 CRIT. HDW: 1
ET HALF 0552

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 OSLUND
REL L H FINEBERG
QE E M GUTIERREZ

REDUNDANCY SCREEN: A- B- C-
APPROVED BY: APPROVED BY (NASA):
DES *[Signature]* SSM *[Signature]*
REL *[Signature]* REL *[Signature]*
QE *[Signature]* QE *[Signature]*

ITEM: DISCONNECT, LO2 FEED (WITH LATCH) 17 INCH, ORBITER & ET HALF. (PD1) *2-1-85*

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 (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.

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.

FAILURE MODE

FAILS TO REMAIN OPEN DURING ET CHILLDOWN, LOADING, DRAINING, AND ENGINE OPERATION.

CAUSE(S)

PIECE PART STRUCTURAL FAILURE OF FLAPPER OR FLAPPER STRUCTURAL SUPPORT ELEMENTS (LATCH WILL NOT PREVENT CLOSURE FOR FAILURE OF THESE SPECIFIC PIECE PARTS).

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :MAIN PROPULSION

FMEA NO:03-1 -0408 -2

REV:02/19/8

EFFECT(S): ON

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

(A,B)

CASE I: 1/1. TIME FRAME - ENGINE OPERATION.

LO2 FLOW WILL BE TERMINATED. SURGE PRESSURE FROM VALVE CLOSURE MAY CAUSE DAMAGE OR RUPTURE TO THE MPS AND/OR ET SYSTEM, DEPENDING ON THE RATE OF CLOSURE. SHUTDOWN OF ALL THREE ENGINES WITH UNCONTAINED DAMAGE DUE TO STARVATION CUTOFF.

CASE II: 1/1. TIME FRAME - LOADING/DRAINING

LO2 FLOW WILL BE TERMINATED. SURGE PRESSURE FROM VALVE CLOSURE MAY CAUSE DAMAGE OR RUPTURE TO THE MPS AND/OR ET SYSTEM, DEPENDING ON THE RATE OF CLOSURE. UNABLE TO PERFORM ET DRAIN. RUPTURE OF MPS LINES WILL LEAK LO2 INTO THE AFT. POSSIBLE AFT COMPARTMENT OVERPRESS AND FIRE/EXPLOSIVE HAZARD. POSSIBLE LOSS OF ADJACENT CRITICAL FUNCTIONS DUE TO CRYO EXPOSURE. LEAKAGE DETECTABLE USING HAZARDOUS GAS DETECTION SYSTEM (HGDS). RUPTURE OF ET FEEDLINE WILL LEAK LO2 OUTSIDE OF THE VEHICLE. FIRE/EXPLOSIVE HAZARD AND POSSIBLE DAMAGE TO VEHICLE EXTERIOR

CASE III: 3/3. TIME FRAME - CHILLDOWN

RESULTS IN TERMINATION OF LO2 CHILLDOWN, LAUNCH SCRUB.

(C,D) FOR CASE I AND II, POSSIBLE LOSS OF CREW/VEHICLE. FOR CASE III, LAUNCH SCRUB.

(E)FUNCTIONAL CRITICALITY EFFECTS

CASE I: 1R/2, 2 SUCCESS PATHS. TIME FRAME - LOADING

- 1) LATCH FAILS TO REMAIN LOCKED.
- 2) FLAPPER FAILS TO REMAIN OPEN.

LO2 LOADING WILL BE TERMINATED. SURGE PRESSURE FROM VALVE CLOSURE MAY CAUSE DAMAGE OR RUPTURE TO THE MPS SYSTEM, DEPENDING ON THE RATE OF CLOSURE. UNABLE TO PERFORM ET DRAIN. RUPTURE OF MPS LINES WILL LEAK LO2 INTO THE AFT COMPARTMENT. POSSIBLE AFT COMPARTMENT OVERPRESSURIZATION AND FIRE/EXPLOSION HAZARD. POSSIBLE LOSS OF CRITICAL FUNCTIONS DUE TO ADJACENT COMPONENT EXPOSURE TO CRYOS. LEAKAGE DETECTABLE USING HGDS. RUPTURE OF ET FEEDLINE WILL LEAK LO2 OUTSIDE OF VEHICLE. FIRE/EXPLOSION HAZARD AND POSSIBLE DAMAGE TO VEHICLE EXTERIOR. POSSIBLE LOSS OF VEHICLE.

CASE II: 1R/2, 2 SUCCESS PATHS. TIME FRAME - ENGINE OPERATION

- 1) LATCH FAILS TO REMAIN LOCKED.
- 2) FLAPPER FAILS TO REMAIN OPEN.

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :MAIN PROPULSION

FMEA NO:03-1 -0408 -2

REV:02/19/88

SURGE PRESSURE FROM VALVE CLOSURE MAY CAUSE DAMAGE OR RUPTURE TO THE MPS SYSTEM, DEPENDING ON THE RATE OF CLOSURE. RUPTURE OF MPS LINES WILL LEAK LO2 INTO THE AFT COMPARTMENT. POSSIBLE AFT COMPARTMENT OVERPRESSURIZATION AND FIRE/EXPLOSION HAZARD. POSSIBLE LOSS OF CRITICAL FUNCTIONS DUE TO ADJACENT COMPONENT EXPOSURE TO CRYOS. POSSIBLE LOSS OF CREW/VEHICLE.

DISPOSITION & RATIONALE:

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

(A) DESIGN

A PNEUMATIC ACTUATOR MOUNTED ON THE ORBITER HALF OF THE DISCONNECT DRIVES THE ET FLAPPER THROUGH A ROLLER/CLEVIS LINKAGE. THIS ACTION IN TURN DRIVES A SECOND ROLLER/CLEVIS LINKAGE WHICH OPERATES THE ORBITER FLAPPER AND THE POSITION INDICATOR ASSEMBLY.

THE FLAPPERS ARE CANTED IN THE FLOW STREAM SUCH THAT FLUID DYNAMIC FORCES ASSIST THE MECHANICAL LINKAGE FORCES IN MAINTAINING THE OPEN POSITION DURING SYSTEM OPERATION. THE FLAPPERS ARE SPRING LOADED IN THE OPEN POSITION AGAINST THE MECHANICAL STOPS BY A 55 LBS FORCE MINIMUM FOR ET AND 40 LBS FOR ORBITER. FORCE IS MEASURED AT THE FLAPPER TIP.

THE DISCONNECT VALVE CONSISTS OF COMPONENTS MANUFACTURED FROM 2024-T651 AL ALLOY (FLAPPER ASSEMBLY), INCONEL 718 (ARM FOLLOWER) AND A286 CRES (ARM DRIVE ASSEMBLY). THE VALVE HOUSING IS MANUFACTURED FROM 2219 AL ALLOY. THE STOP ASSEMBLY IS MANUFACTURED FROM 6061-T6 AL ALLOY, 300 SERIES CRES AND INCONEL 718.

DESIGN FACTORS OF SAFETY FOR INTERNAL PRESSURE ARE 1.3 PROOF, 1.5 BURST FOR THE DISCONNECT. THE ORBITER FLAPPERS HAVE A MINIMUM USEFUL LIFE OF 3500 CYCLES WHICH IS EQUIVALENT TO 100 ORBITER MISSIONS. THE ET FLAPPERS HAVE A MINIMUM LIFE OF 150 CYCLES WHICH IS EQUIVALENT TO ONE ORBITER MISSION. STRUCTURAL ANALYSIS INDICATES POSITIVE MARGINS OF SAFETY FOR ALL CONDITIONS OF VALVE OPERATION; FRACTURE/FATIGUE ANALYSIS SHOW THAT ALL CRITICAL PARTS ARE SATISFACTORY FOR FOUR TIMES EXPECTED LIFE (ET - ONE MISSION, ORBITER - 100 MISSIONS).

THE DISCONNECT FEATURES A MECHANICAL LATCH (REFERENCE FMEA/CIL 0454) WHICH ENHANCES SAFETY OF THE VALVE OPERATION BY REDUCING THE NUMBER OF PIECE PART STRUCTURAL FAILURES WHICH CAN CAUSE INADVERTENT FLAPPER CLOSURE. THE ACTUATOR AND RELATED MECHANISMS (FORKS, ROLLERS, TORSION BARS AND SHAFTS) INVOLVED IN APPLICATION OF PRELOAD ARE NOT CONSIDERED CRITICAL WITH LATCH INSTALLED. IN THE LOCKED POSITION THE LATCH PREVENTS INADVERTENT FLAPPER CLOSURE BY MECHANICAL INTERFERENCE. DURING NORMAL CONDITIONS THE LATCH DOES NOT CONTACT THE FLAPPER.

(B) TEST

ATP (ACTUATOR)

PROOF: AMBIENT, 1275 PSIG

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :MAIN PROPULSION

FMEA NO:03-1 -0408 -2

REV:02/19/8

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
286 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, 5
SCIMS OF GHE AT 50 PSIG; LATCH SHAFT SEAL, 80 SCIMS
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
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
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)

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :MAIN PROPULSION

FMEA NO:03-1 -0408 -2

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

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 = 6000 LBS MAX

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :MAIN PROPULSION

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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

UMBILICAL SEPARATION TEST: (WITHOUT LATCH)

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 LN2.
DISCONNECT WAS ALSO SUBJECTED TO UMBILICAL RETRACT TESTS AT BOTH
NOMINAL CONDITIONS AND SIMULATED HYDRAULIC RETRACT ACTUATOR FAILURES

UMBILICAL SEPARATION TEST: (WITH LATCH)

FLAPPER PNEUMATICS/LATCH PNEUMATICS/PYROS/RETRACTOR HYDRAULICS

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

BOTH PERFORMED AT AMBIENT, LN2 AND LH2 CONDITIONS.

FLOW LINER WATER FLOW TESTS:

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:

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).

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :MAIN PROPULSION

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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

FLAPPER TIP LOAD MARGIN WATER FLOW TEST:

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:

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:

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

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :MAIN PROPULSION

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REV:02/19/1

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.

OMRSD

V41BIO.240 ORB/ET DISC RESPONSE TIME (POST FLT DATA ANALYSIS)
V41BUO.270 FLOW LINER INSPECTION (EVERY FLT)
V41BUO.280 DISCONNECT FLAPPER ANGLE VERIFICATION (EVERY FLT)
V41BUO.320 DISCONNECT INSPECTION AND TIP LOAD VERIF (EVERY FLT)
V41BUO.330 MPS COMPONENT CAVITY INSPECTION (EVERY FLT)
V41BUO.370 ORB/ET DISC PREPARATION FOR OPF ROLLOUT (EVERY FLT)
V41BVO.020 MPS ORB/ET DISC CLEANING (EVERY FLT)
V41BVO.030 ORB/ET UMBILICAL DISC AND SEAL INSPECTION (EVERY FLT)
T41FUN.040 OPENING TORQUE BEFORE MATING (EVERY FLT)
T41FUN.061 ET 17" TIP LOAD/FLAPPER ANGLE INSPECTION (EVERY FLT)
T41FUN.070 ROLLER ARM INSPECTION (EVERY FLT)
T41QAL.090 LO2/LH2 17" DISCONNECT INSPECTION (EVERY FLT)
T41QAL.100 LO2/LH2 17" DISCONNECT CLEANING (EVERY FLT)
S00000.090 PD1 RESPONSE TIME (MATED) (EVERY FLT)
S00HCO.400 VERIFY ET/ORB DISC POSITIONS (PRIOR TO MATING) (EVERY FLT)
S00000.085 17" DISCONNECT OVER CENTER VERIFICATION (EVERY FLIGHT)
S00000.087 PD1 LO2 DISCONNECT INTERNAL INSPECTION (EVERY FLIGHT)

(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 SE GROOVES ARE INSPECTED FOR CLEANLINESS AND EVIDENCE OF DAMAGE.

ASSEMBLY/INSTALLATION

THREADED INSERTS AND CRITICAL DIMENSIONS VERIFIED BY INSPECTION. SEAL SURFACES ARE VISUALLY INSPECTED FOR DEFECTS. REPAIRED AND REWORKED IT ARE DIMENSIONALLY CHECKED. LOG OF CLEAN ROOM VERIFIED. ALL ENGINEER 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.

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :MAIN PROPULSION

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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.

(D) FAILURE HISTORY

DURING INITIAL WATER FLOW TESTS IN 1977, THE ORBITER FLAPPER PARTIALLY CLOSED (CAR A9472). CAUSE WAS ATTRIBUTED TO HYDRODYNAMIC FLOW FORCES THAT CAUSED DISCONNECT FLAPPER INSTABILITY. CORRECTIVE ACTION INCLUDED: REDESIGN OF THE FLAPPER FOLLOWER ARM TO INCREASE THE STRENGTH; ADDITION OF CONTOURED FAIRINGS TO THE FLAPPERS (WHICH CHANGED THE PRESSURE LOADS) TO BIAS THE VALVE TOWARDS THE OPEN POSITION; STREAMLINING OF FLAPPERS TO REDUCE FLOW TURBULENCE; AND SPECIFICATION OF FLAPPER ANGLE REQUIREMENTS WHICH PROVIDE FLOW FORCES ON FLAPPERS TO BIAS THE VALVE TOWARDS THE OPEN POSITION.

THE ET FLAPPER CLOSED DURING A RUN WITH 12,400 GPM FLOWRATE. THE TEST FACILITY LINE THEN FAILED. CAUSE ATTRIBUTED TO OUT-OF-SPEC FLAPPER ANGLE SETTINGS (1-26-78, NO CAR WRITTEN).

DURING A DEVELOPMENT TEST IN 1978 (WITH THE FLOW LINER MOUNTED IN THE ET HALF OF THE DISCONNECT) THE FLOW LINER AND ORBITER FLAPPER FAIRING EXPERIENCED FAILURES WHEN THE FLOW RATE REACHED 30,000 GPM. ONE THIRD OF THE FLOW LINER WAS DISTORTED (NO CAR WRITTEN). THE FAILURE WAS ATTRIBUTED TO EXCESSIVE FLOW DURING RUN CONDITIONS. THE CORRECTIVE ACTION WAS TO INCREASE THE FLOW LINER THICKNESS FROM 0.020 INCHES TO 0.040 INCHES. FOR ALL PRODUCTION DISCONNECTS THE REDESIGNED FLOW LINER WAS INCORPORATED AND MOUNTED ON THE ORBITER HALF OF THE DISCONNECT.

A FLOW LINER WAS FOUND DISTORTED UPON REMOVAL FROM NSTL. DAMAGE WAS ATTRIBUTED TO INCORRECT MATING PROCEDURE (REFERENCE CAR A88941). ET/ORB MATING PROCEDURE WAS IMPROVED.

THE LO2 FLOW LINER ON OV102 (FLT STS-4) WAS FOUND TO BE DISTORTED DURING POST-FLIGHT CHECKOUT (REFERENCE CAR 04F001). DAMAGE WAS ATTRIBUTED TO AN INCORRECT MATING PROCEDURE OR INTERFERENCE WITH FERRY PLATES. POST MATING BOROSCOPE INSPECTION REQUIREMENT OF FLOW LINER WAS ADDED TO THE OMRSD. FLOW LINER WAS AGAIN REDESIGNED AND INCORPORATED INTO THE PROGRAM. THE FLOW LINER THICKNESS WAS INCREASED FROM 0.040 TO 0.080 INCHES AND CONTOURED FOR RESISTANCE TO BUCKLING.

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :MAIN PROPULSION

FMEA NO:03-1 -0408 -2 REV:02/19/

DURING THE FLOW LINER CERTIFICATION WATER FLOW TEST PROGRAM CONDUCTED 1983 ALL THREE SEGMENTS OF THE LINER DISTORTED INTO THE FLOW STREAM CAUSING THE ORBITER FLAPPER TO PARTIALLY CLOSE (REFERENCE CAR AC5377). THE FAILURE WAS ATTRIBUTED TO INCORRECT TEST ARTICLE/FACILITY FILL AND RUN PROCEDURE. CORRECTIVE ACTION WAS TO CORRECT WATER FLOW TEST PROCEDURES AND INCORPORATE THE REDESIGNED FLOW LINER.

DURING CERTIFICATION TESTING, THE ET FLAPPER FAILED CLOSED AT A FLOW OF 12,900 GPM OF WATER (CAR AC5600). CAUSE ATTRIBUTED TO OUT-OF-SPEC FLAPPER ANGLE SETTINGS. EXTENSIVE WATER FLOW TESTING WAS CONDUCTED TO DETERMINE ADEQUATE FLAPPER ANGLE AND TIP LOAD STABILITY MARGINS. FLAP ANGLE SETTING REQUIREMENTS WERE MODIFIED AND MINIMUM FLAPPER TIP LOAD REQUIREMENTS WERE INCORPORATED. IN ADDITION, REQUIREMENTS TO MEASURE FLAPPER ANGLE/TIP LOADS AND PERFORM DETAILED INSPECTION OF DISCONNECT WERE ADDED TO THE OMRSD. OUT OF SPEC CONDITIONS HAVE BEEN DOCUMENTED CARS AC5740, AC5860, AC5861, AC5862, AC5876, AD2282, AD2281, AC8239, AC7596, AC7274, AC5699, AC8719, AC8810, AND AC7915.

ONE INCIDENT OCCURRED DURING QUALIFICATION TESTING WHEN THE FLAPPER FAIRINGS WERE INADVERTENTLY INSTALLED ON THE WRONG FLAPPERS (REFERENCE CAR AC7165). PARKER REDESIGNED THE FLAPPERS AND FAIRINGS SO THAT THEY WOULD NOT BE INTERCHANGEABLE BETWEEN LO2 AND LH2. THE UNITS IN THE F. WERE VERIFIED TO BE CORRECTLY INSTALLED BY MCR 10473.

(E) OPERATIONAL USE

NO CREW ACTION CAN BE TAKEN.