

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 03-1-0201 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 2 08/09/00

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	:GHE 1" SUPPLY FILL DISCONNECT (ORB) UNITED SPACE ALLIANCE - NSLD	MC276-0003-0006 74332000-109
LRU	:GHE 1" SUPPLY FILL DISCONNECT (GND) UNITED SPACE ALLIANCE - NSLD	MC276-0003-0008 74343000-103

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

DISCONNECT, HELIUM FILL, 1 INCH SELF SEALING WITH REVERSE FLOW CHECK VALVE.

VALVE WAS ORIGINALLY DESIGNED AND MANUFACTURED BY FAIRCHILD BUT IS NOW MANUFACTURED BY UNITED SPACE ALLIANCE-NSLD AS AN ALTERNATE PRODUCTION AGENCY.

REFERENCE DESIGNATORS: PD8

QUANTITY OF LIKE ITEMS: 1

FUNCTION:

CONNECTS WITH GSE TO PROVIDE THE FLOW PATH FOR FILLING THE FLIGHT HELIUM SUPPLY TANKS. ACTS AS A REDUNDANT CLOSURE DEVICE WITH HELIUM SYSTEM CHECK VALVES (CV1,2,3,4) AFTER FLOW CESSATION TO PREVENT OVERBOARD LOSS OF HELIUM SUPPLIES. PRESSURE ACTUATED POPPET IN DISCONNECT REQUIRES A DELTA P TO OPEN.

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE

NUMBER: 03-1-0201-04

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LRU: GHE 1" SUPPLY FILL DISCONNECT (ORB/GND)

CRITICALITY OF THIS

ITEM NAME: GHE 1" SUPPLY FILL DISCONNECT (ORB/GND)

FAILURE MODE: 1R2

FAILURE MODE:

RUPTURE/LEAKAGE

MISSION PHASE:

PL PRE-LAUNCH
LO LIFT-OFF
DO DE-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102 COLUMBIA
103 DISCOVERY
104 ATLANTIS
105 ENDEAVOUR

CAUSE:

MATERIAL DEFECT, FATIGUE

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN

A) PASS
B) N/A
C) PASS

PASS/FAIL RATIONALE:

A)

B)

THE DISCONNECT IS STANDBY REDUNDANT TO THE HELIUM FILL CHECK VALVES, CV1-4. LEAKAGE FROM THE DISCONNECT IS NOT DETECTABLE.

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

NO EFFECT. BACKUP CHECK VALVES (CV1,2,3,4) WOULD PREVENT OVERBOARD LEAKAGE FROM ONBOARD HELIUM SUPPLY TANKS. GROUND HELIUM FILL IS LIMITED TO LESS THAN 0.5 LB/SEC AND IS INSUFFICIENT TO OVERPRESSURIZE THE AFT COMPARTMENT.

(B) INTERFACING SUBSYSTEM(S):

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0201-04**

SAME AS A.

(C) MISSION:

POSSIBLE LAUNCH SCRUB OR DELAY IF FAILURE OCCURS PRIOR TO T-13 SECONDS. HELIUM LEAKAGE IS DETECTABLE IN THE AFT COMPARTMENT BY USING HAZARDOUS GAS DETECTION SYSTEM (HGDS). IF LEAKAGE RATE IS GREATER THAN 0.5 LB/SEC, GROUND HELIUM FILL WILL NOT BE ABLE TO KEEP UP WITH THE LEAK. BOTTLE SUPPLY PRESSURES WILL DROP BELOW THE LCC REQUIREMENT (LESS THAN 4100 PSIA) WHICH IS VERIFIED DOWN TO T-13 SECONDS. LEAKAGE RATES LESS THAN 0.5 LB/SEC MAY NOT BE DETECTED.

(D) CREW, VEHICLE, AND ELEMENT(S):

SAME AS A.

(E) FUNCTIONAL CRITICALITY EFFECTS:

CASE 1:

1R/2 2 SUCCESS PATHS. TIME FRAME - PRELAUNCH, ASCENT, ENTRY

- 1) HELIUM DISCONNECT VALVE RUPTURES.
- 2) ONE OF FOUR CHECK VALVES (CV1,2,3,4) FAILS TO CHECK.

RESULTS IN LOSS OF HELIUM FROM ONE MAIN ENGINE'S HELIUM SUPPLY (CV1,2,3) OR PNEUMATIC HELIUM SUPPLY (CV4). MAY RESULT IN UNCONTAINED ENGINE SHUTDOWN. EXCESSIVE HELIUM LEAKAGE WILL BE DETECTABLE USING HAZARDOUS GAS DETECTION SYSTEM (HGDS). POSSIBLE OVERPRESSURIZATION OF THE AFT COMPARTMENT (PRELAUNCH, ASCENT, AND ENTRY). POSSIBLE LOSS OF CREW/VEHICLE.

DURING ENTRY, VENT DOORS ARE CLOSED TO PREVENT INGESTION OF RCS AND APU GASES. THIS FAILURE DURING THE TIME PERIOD THAT THE VENT DOORS ARE CLOSED MAY RESULT IN OVERPRESSURIZATION OF AFT COMPARTMENT. VENT DOORS ARE OPENED WHEN VEHICLE VELOCITY DROPS BELOW 2400 FT/SEC.

CASE 2:

1R/3 3 SUCCESS PATHS. TIME FRAME - ASCENT.

- 1) HELIUM DISCONNECT RUPTURES/LEAKS EXTERNALLY.
- 2) ONE OF THREE SSME GHE SUPPLY CHECK VALVES (CV1,2,3) FAILS TO CHECK. IF LEAK OCCURS EARLY IN ASCENT CREW WILL BE DIRECTED TO OPEN SSME INTERCONNECT "IN" VALVE SUPPLYING ENGINE WITH GHE FROM THE PNEUMATIC SUPPLY IN AN ATTEMPT TO EXTEND ENGINE RUN TIME. A SSME CAN SHUTDOWN SAFELY UNDER REDLINE MODE WITH VEHICLE ACCELERATION. IF LEAK OCCURS LATE IN ASCENT AND THE SSME GHE SUPPLY IS BELOW 2000 PSIA AT MECO, VEHICLE SOFTWARE WILL OPEN THE SSME INTERCONNECT "IN" VALVE TO SUPPLY THE ENGINE ZERO-G SHUTDOWN PURGES FROM THE PNEUMATIC SUPPLY.
- 3) SSME INTERCONNECT "IN" VALVE FAILS TO OPEN WHEN COMMANDED BY SOFTWARE RESULTING IN ZERO-G SHUTDOWN WITHOUT SUFFICIENT GHE SUPPLY FOR SHUTDOWN PURGES.

RESULTS IN INSUFFICIENT HELIUM SUPPLY TO THE AFFECTED ENGINE AT MECO. INTERRUPTION OF GHE INJECT FLOW TO THE LO2 TURBOPUMP MAY RESULT IN HPOTP

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0201-04**

TURBINE OVERSPEED AND UNCONTAINED ENGINE FAILURE. POSSIBLE LOSS OF CREW/VEHICLE.

CASE 3:

1R/3 4 SUCCESS PATHS. TIME FRAME-ASCENT.

- 1) HELIUM DISCONNECT VALVE RUPTURES.
- 2) PNEUMATIC SUPPLY CHECK VALVE (CV4) FAILS TO CHECK. RESULTS IN LOSS OF PNEUMATIC HELIUM SUPPLY.
- 3) MPS PNEUMATIC REG OUT CHECK VALVE (CV8) LEAKS. RESULTS IN BLEEDING OF PNEUMATIC REG LEG PRESSURE BACKWARDS THROUGH REGULATOR (PR4) AND ISO VALVE (LV7 & 8).
- 4) MPS ACCUMULATOR CHECK VALVE (CV9) LEAKS.

RESULTS IN INSUFFICIENT HELIUM REMAINING IN THE PNEUMATIC ACCUMULATOR LEG TO CLOSE THE LO2 PREVALVES AT MECO WITHIN TIMING REQUIREMENTS. FAILURE TO MAINTAIN LO2 PRESSURE AT HPOTP AND TURBOPUMP OVERSPEED. POSSIBLE UNCONTAINED ENGINE FAILURE, FIRE/EXPLOSION HAZARD, LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:

THE ORBITER HALF HOUSING IS MADE OF HEAT TREATED INCONEL 718. THE GROUND HALF HOUSING IS MADE OF A286 CRES. THE FLIGHT AND GROUND DISCONNECT HALVES INCORPORATE A SWIVEL WHICH ACTS AS A SELF-ALIGNING DEVICE FOR PROPER ENGAGEMENT (THE TWO HALVES CAN ACCOMMODATE 0.062 INCH RADIAL AND 0.5 DEGREE MISALIGNMENT). THE SWIVEL IS PROTECTED AGAINST LEAKAGE (EXTERNAL TO THE VEHICLE) WITH A RACO SEAL. THE FLIGHT HALF HAS A FLOW-ACTUATED POPPET (15 PSID) WITH A VESPEL SEAL. THE GROUND HALF DISCONNECT IS OPENED UPON ENGAGEMENT WITH THE FLIGHT HALF AND IT HAS A POPPET SEAL MADE OF VESPEL.

THE GROUND HALF INTERFACE MATING SEAL IS A RACO TYPE SEAL MADE OF FEP TEFLON AND A 301 CRES SPRING. THE FLIGHT DISCONNECT HALF INTERFACE SEALING SURFACE UTILIZES AN 8 MICRO-INCH SURFACE FINISH. VENT HOLES ARE INCORPORATED IN THE FLIGHT HALF FOR RELIEVING PRESSURE ON THE INTERFACE MATING SEAL DURING PRESSURIZED DISENGAGEMENT.

DESIGN FACTORS OF SAFETY ARE: PROOF - 1.5 (6750 PSIG) FLIGHT HALF, 2.0 (9000 PSIG) GROUND HALF; BURST - 2.4 (10,800 PSIG) FLIGHT HALF, 4.0 (18,000 PSIG) GROUND HALF. STRUCTURAL ANALYSIS, PERFORMED BY THE VALVE SUPPLIER, INDICATES POSITIVE MARGINS OF SAFETY FOR ALL CONDITIONS OF VALVE OPERATION, AND FRACTURE ANALYSES SHOW THAT ALL CRITICAL PARTS ARE SATISFACTORY FOR FOUR TIMES THE ORBITER LIFE OF 100 MISSIONS.

(B) TEST:

ATP

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EXAMINATION OF PRODUCT

PROOF PRESSURE

DEMATED

FLIGHT HALF: 6,750 PSIG

GROUND HALF: 9,000 PSIG

MATED: 6,750 PSIG

OPERATION TEST

MATE, PRESSURIZE TO 4500 PSIG WITH GHE, AND MEASURE

EXTERNAL LEAKAGE (200 SCIM MAX)

CRACK/RESEAT PRESSURE (15 PSID MIN)

DEMATE

EXTERNAL LEAKAGE

DEMATED

FLIGHT HALF

1 SCIM AT 5 PSIG

5 SCIM AT 4500 PSIG

GROUND HALF

200 SCIM AT 4500 PSIG

MATED: 200 SCIM AT 4500 PSIG

CERTIFICATION

SHOCK PER MIL-STD-810

DESIGN

BENCH HANDLING

AT COMPLETION PERFORM OPERATION AND EXTERNAL LEAKAGE TESTS

FLOW CAPACITY (MATED)

4110 PSIG INLET, 1.0 LB/SEC GHE, 18 TO 20 PSID

VIBRATION

RANDOM (TWO AXES)

9 MIN. IN EACH AXIS, MATED

52 MIN. IN EACH AXIS, FLIGHT HALF

9 MIN. IN EACH AXIS, GROUND HALF

TRANSIENT (TWO AXES)

5 TO 35 HERTZ Ñ 0.25 G IN EACH AXIS

BEFORE/AFTER PERFORM OPERATION AND EXTERNAL LEAKAGE TESTS

THERMAL CYCLE (5 CYCLES EACH)

FLIGHT HALF: PRESSURIZE TO 2000 PSIG; +70°F TO -250°F;

PRESSURIZE TO 4500 PSIG; -250°F TO +70°F TO +190°F;

REDUCE PRESSURE TO 2000 PSIG; VENT; +190°F TO +70°F

GROUND HALF: PRESSURIZE TO 2,000 PSIG; +70°F TO -250°F; PRESSURIZE TO 4,500 PSIG;

VENT; -250°F TO +70°F

AT CONCLUSION, PERFORM OPERATION & EXTERNAL LEAKAGE TESTS

LIFE TEST

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LOW TEMPERATURE (-250°F): 100 CYCLES
AMBIENT: 1,900 CYCLES
MATE, PRESSURIZE TO 4500 PSIG, VENT, DEMATE
AFTER EACH 500 CYCLES, PERFORM EXTERNAL LEAKAGE TEST AND HIGH TEMPERATURE EXTERNAL LEAKAGE TEST

HIGH TEMPERATURE EXTERNAL LEAKAGE TEST
MATED: PRESSURIZE TO 4500 PSIG WITH +165°F GHE; 200 SCIMS MAX
FLIGHT HALF: HEAT TO +190°F, PRESSURIZE TO 4500 PSIG; 2 SCIMS MAX

BURST
10,800 PSIG MATED
10,800 PSIG FLIGHT HALF
18,000 PSIG GROUND HALF

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

(C) INSPECTION:

RECEIVING INSPECTION
INCOMING COMPONENTS AND MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIALS AND PROCESSES CERTIFICATION.

CONTAMINATION CONTROL
ALL PARTS AND ASSEMBLIES ARE VERIFIED TO CLEANLINESS LEVEL 100A.

ASSEMBLY/INSTALLATION
DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION. TORQUES APPLIED TO COUPLINGS ARE VERIFIED PER DRAWING SPECIFICATIONS. PRIOR TO INSTALLATION, SEALS ARE VISUALLY EXAMINED FOR DAMAGE AND CLEANLINESS USING 10X MAGNIFICATION. SEALING SURFACE OF THE POPPET IS INSPECTED. THE CLEAN ROOM LOG AND TOOL CALIBRATION RECORDS ARE VERIFIED BY INSPECTION. INSPECTION POINTS ARE ESTABLISHED TO VERIFY ASSEMBLY PROCESSES. SEALS AND SEALING SURFACES PROTECTION ARE ALSO VERIFIED BY INSPECTION.

CRITICAL PROCESSES
APPLICATION OF DRY FILM LUBRICANT TO PARTS IS VERIFIED BY INSPECTION. HEAT TREATMENT AND PART PASSIVATION ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
FLUORESCENT PENETRANT INSPECTION OF THE BODY HOUSING IS VERIFIED.

TESTING
ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING
PACKAGING FOR SHIPMENT IS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

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CURRENT DATA ON TEST FAILURE, FLIGHT FAILURE, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATABASE.

(E) OPERATIONAL USE:
NO CREW ACTION CAN BE TAKEN.

- APPROVALS -

S&R ENGINEERING	: W.P. MUSTY	:/S/ W. P. MUSTY
S&R ENGINEERING ITM	: P. A. STENGER-NGUYEN	:/S/ P. A. STENGER- NGUYEN
DESIGN ENGINEERING	: MIKE FISCHER	:/S/ MIKE FISCHER
MPS SUBSYSTEM MGR.	: TIM REITH	:/S/ TIM REITH
MOD	: BILL LANE	:/S/ BILL LANE
USA SAM	: MIKE SNYDER	:/S/ MIKE SNYDER
USA ORBITER ELEMENT	: SUZANNE LITTLE	:/S/ SUZANNE LITTLE
NASA SR&QA	: ERICH BASS	:/S/ ERICH BASS