FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 03-1-0406 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 1 08/09/00

PART DATA

	PART NAME / **VENDOR NAME**	**PART NUMBER** / **VENDOR NUMBER**
LRU	:LO2 BLEED DISCONNECT, 1.5 INCH (ORB)	MC276-0004-0001
	UNITED SPACE ALLIANCE - NSLD	74338000-101
LRU	: LO2 BLEED DISCONNECT, 1.5 INCH (GND)	MC276-0004-0002
	UNITED SPACE ALLIANCE - NSLD	74353000-101

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
DISCONNECT, LO2 BLEED, 1.5 INCH, SELF SEALING, FLIGHT AND GROUND HALF.

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

REFERENCE DESIGNATORS: PD13

QUANTITY OF LIKE ITEMS: 1

FUNCTION:
THE DISCONNECT PROVIDES A PATH FOR LO2 TO BLEED OVERBOARD FROM THE LO2 OVERBOARD BLEED VALVE (PV19) IN TO THE GROUND VENT SYSTEM. LO2 IS BLED OVERBOARD TO MAINTAIN PROPER SSME CRYOGENIC START CONDITIONS. THE POGO ACCUMULATOR RETURN LINE IS ALSO FLUSHED PRIOR TO ENGINE START THROUGH THIS DISCONNECT. PRIOR TO LIFTOFF THE DISCONNECT IS ISOLATED FROM THE LO2 SYSTEM BY CLOSING THE LO2 OVERBOARD BLEED VALVE (PV19) AT T-9.4 SECONDS. THE DESIGN INCORPORATES A POPPET TO PREVENT FLOW OF LO2 OVERBOARD AFTER T-0 UMBILICAL DISENGAGEMENT AND LIFTOFF.

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SUBSYSTEM NAME: MAIN PROPULSION
LRU: LO2 BLEED DISCONNECT, 1.5 INCH ORB (PD13) **CRITICALITY OF THIS**
ITEM NAME: LO2 BLEED DISCONNECT, 1.5 INCH ORB (PD13) **FAILURE MODE:** 1/1

FAILURE MODE:
RUPTURE/LEAKAGE OF THE DISCONNECT ASSEMBLY DURING BLEED OPERATION.

MISSION PHASE:
PL PRE-LAUNCH
LO LIFT-OFF

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

CAUSE:
FATIGUE, MATERIAL DEFECTS, DAMAGED/DEFECTIVE GROUND HALF BODY/POPPET SEAL

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN
A) N/A
B) N/A
C) N/A

PASS/FAIL RATIONALE:
A)

B)

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
RUPTURE/LEAKAGE OF THE AIRBORNE DISCONNECT BODY RESULTS IN LEAKAGE INTO THE AFT COMPARTMENT. POSSIBLE LOSS OF ADJACENT CRITICAL FUNCTIONS DUE TO EXPOSURE TO CRYOGENICS. POSSIBLE AFT COMPARTMENT OVERPRESS AND FIRE/EXPLOSION HAZARD. ON GROUND, HAZARDOUS GAS DETECTION SYSTEM (HGDS) IN THE AFT COMPARTMENT WILL DETECT THE PRESENCE OF OXYGEN.

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RUPTURE/LEAKAGE OF THE GROUND HALF ASSEMBLY AND/OR LEAKAGE OF THE FLIGHT HALF BODY/POPPET SEAL RESULTS IN EXTERNAL LEAKAGE OF LO2. GN2 PURGE AT THE LO2 T-0 AND MLP HOOD WILL DISSIPATE SOME OF THE PROPELLANT. THERE IS NO HGDS ON THE LO2 TSM/T-0 UMBILICAL. HOWEVER, LEAKAGE MAY BE DETECTED VISUALLY BY TV MONITORING. LO2 LEAKAGE MAY RESULT IN FIRE/EXPLOSION HAZARD AT THE VEHICLE EXTERIOR, AND POSSIBLE DAMAGE TO TPS AND SURROUNDING STRUCTURE.

(B) INTERFACING SUBSYSTEM(S):
SAME AS A.

(C) MISSION:
POSSIBLE LOSS OF CREW/VEHICLE.

(D) CREW, VEHICLE, AND ELEMENT(S):
SAME AS C.

(E) FUNCTIONAL CRITICALITY EFFECTS:
1R/2 2 SUCCESS PATHS. TIME FRAME - ASCENT
1) BLEED DISCONNECT (PD13) RUPTURE/LEAKAGE.
2) LO2 BLEED SHUTOFF VALVE (PV19) FAILS TO REMAIN CLOSED.

GO2/LO2 (TWO PHASE FLOW FROM POGO SYSTEM) WILL DUMP OVERBOARD RESULTING IN LOSS OF APPROXIMATELY 3,000 LBS. OF PROPELLANT, WHICH MAY BE SUFFICIENT TO CAUSE PREMATURE SSME SHUTDOWN. FIRE/EXPLOSION HAZARD BOTH INTERIOR AND EXTERIOR TO THE VEHICLE. POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:
THE MATED FLIGHT HALF AND GROUND HALF ARE DESIGNED FOR 100 PSIG OPERATING, 200 PSIG PROOF, AND 400 PSIG BURST. THE UNMATED FLIGHT HALF IS DESIGNED FOR 400 PSIG OPERATING, 520 PSIG PROOF, AND 600 PSIG BURST. THE FLIGHT HALF BODY IS CAST A357 OR MACHINED A367 ALUMINUM; THE GROUND HALF BODY IS MACHINED 6061 ALUMINUM. THE GROUND HALF BELLOWS (TWO PLY) IS MANUFACTURED FROM INCONEL. THE GROUND HALF/FLIGHT HALF BODY/POPPET SEALS ARE MADE OF SP-21 VESPEL.

STRUCTURAL ANALYSIS INDICATES POSITIVE MARGINS OF SAFETY FOR ALL CONDITIONS OF VALVE OPERATION; FRACTURE/FATIGUE ANALYSES SHOW THAT ALL CRITICAL PARTS ARE SATISFACTORY FOR FOUR TIMES EXPECTED LIFE. THE DISCONNECT ASSEMBLY (INCLUDING THE BELLOWS) HAS BEEN SUBJECTED TO A FLOW INDUCED VIBRATION TEST FOR THE CENTAUR PROGRAM AT FLOW RATES THAT EXCEED SHUTTLE REQUIREMENTS. THE VALVE WAS DESIGNED AND TESTED FOR 2,000 CYCLES (OVER 100 MISSIONS) UNDER

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BOTH CRYOGENIC AND AMBIENT CONDITIONS. AMBIENT PROOF AND LEAKAGE TESTS ARE PERFORMED DURING ATP.

THE LAUNCH FACILITY HAS DEDICATED, CONTINUOUS TV OBSERVATION OF THE UMBILICAL AREA THROUGHOUT BLEED OPERATION SO THAT MASSIVE LEAKAGE WOULD BE OBSERVED. A CONTINUAL GN2 PURGE IS MAINTAINED TO MINIMIZE ANY HAZARDOUS CONDITION.

(B) TEST:
ATP

DISCONNECT DISENGAGED

ORBITER HALF

AMBIENT PROOF (520 PSIG)

AMBIENT HOUSING LEAKAGE (400 PSIG)

AMBIENT CLOSURE DEVICE LEAKAGE (20 & 400 PSIG)

GROUND HALF

AMBIENT PROOF (200 PSIG)

AMBIENT HOUSING LEAKAGE (100 PSIG)

AMBIENT CLOSURE DEVICE LEAKAGE (100 PSIG)

DISCONNECT ENGAGED (WITH RADIAL AND ANGULAR MISALIGNMENT AT MINIMUM AND MAXIMUM BELLOWS COMPRESSION)

PROOF PRESSURE (200 PSIG)

AMBIENT EXTERNAL LEAKAGE (25 & 100 PSIG)

CRYO (-255 DEG F) EXTERNAL LEAKAGE (100 PSIG)

ENGAGE - DISENGAGE CYCLE

CERTIFICATION

DURING ALL MATED TESTS THE ORBITER HALF IS RIGIDLY MOUNTED AND THE GROUND HALF IS MOUNTED WITH RADIAL AND ANGULAR MISALIGNMENT.

CRYO LEAKAGE (-400 DEG F)
MATED: 100 PSIG
ORBITER HALF: 25 AND 100 PSIG
GROUND HALF: 25 AND 100 PSIG

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AMBIENT LEAKAGE
MATED: 25 AND 100 PSIG
ORBITER HALF: 20 AND 400 PSIG
GROUND HALF: 25 AND 100 PSIG

AMBIENT EXTERNAL BODY LEAKAGE
ORBITER HALF: 400 PSIG
GROUND HALF: 100 PSIG

LIFE CYCLES
2000 CYCLES (10 SERIES):
199 CYCLES AT AMBIENT TEMPERATURE
ONE CYCLE AT CRYO TEMPERATURE (-255 DEG F)

VIBRATION
TRANSIENT SINUSOIDAL VIBRATION
ORBITER HALF: 5 TO 35 HZ AT ZERO PSIG AND AMBIENT TEMPERATURE

RANDOM VIBRATION IN EACH OF TWO AXES AT -280 DEG F
MATED: 40 PSIG, 9 MINUTES
ORBITER HALF: 80 PSIG, 52 MINUTES
GROUND HALF: 0 PSIG, 9 MINUTES

THERMAL CYCLE TEST: 3 CYCLES (+70 TO -280 TO +70 TO +350 DEG F)

SALT FOG, BENCH HANDLING SHOCK AND DESIGN SHOCK PER MIL-STD-810, SAND AND DUST TEST

FLOW CAPACITY TEST (8 TO 18.5 LBS/SEC)

BURST TEST
MATED: 400 PSIG
ORBITER HALF: 600 PSIG
GROUND HALF: 400 PSIG

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

(C) INSPECTION:
RECEIVING INSPECTION
RAW MATERIALS, INCLUDING CHEMICAL AND MECHANICAL REQUIREMENTS, ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION. INSPECTION VERIFIES CERTIFICATION OF ULTRASONIC INSPECTION OF BODY HOUSING FORGING.

CONTAMINATION CONTROL

CLEANING PROCEDURES AND CONTAMINATION CONTROL REQUIREMENTS ARE VERIFIED. CLEANLINESS TO LEVEL 800A (FLIGHT HALF) AND 400A (GROUND HALF) FOR THE DISCONNECT ASSEMBLY IS VERIFIED BY INSPECTION.

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ASSEMBLY/INSTALLATION

ALL PARTS ARE PROTECTED FROM DAMAGE AND CONTAMINATION. ALL CRITICAL DIMENSIONS AND FINISHES ARE VERIFIED BY INSPECTION. SEALING SURFACE OF THE POPPET IS INSPECTED USING 10X MAGNIFICATION. DRAWING TORQUE REQUIREMENTS ARE VERIFIED. SEALS ARE VISUALLY EXAMINED, PRIOR TO INSTALLATION, FOR DAMAGE AND CLEANLINESS USING 10X MAGNIFICATION. MANDATORY INSPECTION POINTS ARE INCLUDED IN THE ASSEMBLY PROCEDURE. LOG OF CLEAN ROOM AND TOOL CALIBRATION IS REQUIRED AND VERIFIED. ALL SPRINGS ARE LOAD TESTED AND VERIFIED BY INSPECTION.

CRITICAL PROCESS

HEAT TREATMENT, PARTS PASSIVATION, AND ANODIZING ARE VERIFIED. CHEMICAL FILM PROTECTANT AND DRY FILM LUBRICANT ARE VERIFIED.

NONDESTRUCTIVE EVALUATION

BODY HOUSING IS FLUORESCENT PENETRANT INSPECTED. WELDS ARE VISUALLY EXAMINED AND VERIFIED BY X-RAY AND DYE PENETRANT. BELLOWS ASSEMBLY IS PROOF PRESS TESTED AND LEAK CHECKED.

TESTING

ATP VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PACKAGING FOR SHIPPING IS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:
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:
FLIGHT:
NO CREW ACTION CAN BE TAKEN.

GROUND:
GROUND OPERATIONS SAFING PROCEDURES CONTAIN SAFING SEQUENCE OF EVENTS FOR MAJOR LEAKS IN THE OXYGEN SYSTEM.

- APPROVALS -

S&R ENGINEERING	: W.P. MUSTY	: /S/ W. P. MUSTY

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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