

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE****NUMBER: 03-1-0406 -X****SUBSYSTEM NAME:** MAIN PROPULSION**REVISION:** 1 08/09/00**PART DATA**

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

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**FAILURE MODE:**

FAILS TO REMAIN OPEN DURING LO2 BLEED OPERATION.

**MISSION PHASE:** PL PRE-LAUNCH

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

**CAUSE:**

PIECE PART STRUCTURAL FAILURE OF THE GROUND HALF DISCONNECT

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

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<b>REDUNDANCY SCREEN</b>	A) N/A
	B) N/A
	C) N/A

**PASS/FAIL RATIONALE:**

A)

B)

C)

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**- FAILURE EFFECTS -**

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**(A) SUBSYSTEM:**

FAILURE OF THE GROUND HALF DISCONNECT CAN CAUSE THE FLIGHT HALF TO SLAM CLOSED. THE FLOW RATE THROUGH THE BLEED LINE DURING ENGINE CONDITIONING IS SUFFICIENT (APPROXIMATELY 130 GPM) TO CAUSE A WATER HAMMER EFFECT UPON SUDDEN CLOSURE OF THE DISCONNECT. PROBABLE RUPTURE OF THE ORBITER BLEED SYSTEM RESULTING IN LEAKAGE OF LO2 INTO THE AFT COMPARTMENT. POSSIBLE OVERPRESSURIZATION OF THE AFT COMPARTMENT AND FIRE/EXPLOSION HAZARD. POSSIBLE LOSS OF CRITICAL FUNCTIONS DUE TO ADJACENT COMPONENT EXPOSURE TO

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CRYOGENICS. LEAKAGE DETECTABLE USING AFT COMPARTMENT HAZARDOUS GAS DETECTION SYSTEM (HGDS).

**(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:**

CASE 1:

1R/3 3 SUCCESS PATHS. TIME FRAME - DETANK FOLLOWING FRF, PAD ABORT OR TANKING TEST.

- 1) LO2 OVERBOARD BLEED DISCONNECT (PD13) FAILS TO REMAIN OPEN.
- 2) INBOARD OR OUTBOARD FILL & DRAIN VALVES (PV9,10) FAIL TO OPEN/REMAIN OPEN.
- 3) ONE OF THREE PREVALVES (PV1,2,3) OR ONE OF TWO LO2 POGO VALVES (PV20,21) FAILS TO CLOSE/REMAIN CLOSED OR HELIUM INJECT FAILS TO RESUME/CONTINUE.

TO PREVENT GEYSERING, PREVALVE CLOSURE IS REQUIRED TO LIMIT HEAT SOAKBACK FROM THE MAIN ENGINES INTO THE FEED SYSTEM. FOR PREVALVE FAILURE TO CLOSE, HELIUM INJECTION IS NOT SUFFICIENT TO PREVENT GEYSERING AND OVERBOARD BLEED MUST BE INITIATED WITHIN 2 MINUTES OR FILL/DRAIN DETANK MUST BE INITIATED WITHIN 12 MINUTES.

GEYSERING MAY RESULT IN FEEDLINE RUPTURE, EXTERNAL LEAKAGE OF LO2, AND POSSIBLE AFT COMPARTMENT OVERPRESSURIZATION. FIRE/EXPLOSIVE HAZARD BOTH INTERIOR AND EXTERIOR TO THE VEHICLE. POSSIBLE LOSS OF CRITICAL ADJACENT COMPONENTS DUE TO CRYO EXPOSURE. POSSIBLE LOSS OF VEHICLE.

CASE 2:

1R/2 2 SUCCESS PATHS. TIME FRAME - PROPELLANT LOADING.

- 1) LO2 OVERBOARD BLEED DISCONNECT (PD13) FAILS TO REMAIN OPEN.
- 2) ONE OF 3 PREVALVES (PV1, 2, 3) OR ONE OF TWO LO2 POGO VALVES (PV20, 21) FAILS TO CLOSE/REMAIN CLOSED OR HELIUM INJECT FAILS TO CONTINUE.

TO PREVENT GEYSERING, PREVALVE CLOSURE IS REQUIRED TO LIMIT HEAT SOAKBACK FROM THE MAIN ENGINES INTO THE FEED SYSTEM. FOR PREVALVE FAILURE TO CLOSE, HELIUM INJECTION IS NOT SUFFICIENT TO PREVENT GEYSERING AND OVERBOARD BLEED MUST BE INITIATED WITHIN 2 MINUTES OR FILL/DRAIN DETANK MUST BE INITIATED WITHIN 12 MINUTES. FOR UNPLANNED DETANK, OPENING THE FILL AND DRAIN VALVES TO BEGIN DRAIN CANNOT BE COUNTED AS A SUCCESS PATH SINCE IT REQUIRES A CREW AND/OR GROUND ACTION.

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GEYSERING MAY RESULT IN FEEDLINE RUPTURE, EXTERNAL LEAKAGE OF LO2, AND POSSIBLE AFT COMPARTMENT OVERPRESSURIZATION. FIRE/EXPLOSIVE HAZARD BOTH INTERIOR AND EXTERIOR TO THE VEHICLE. POSSIBLE LOSS OF CRITICAL ADJACENT COMPONENTS DUE TO CRYO EXPOSURE. POSSIBLE LOSS OF VEHICLE.

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**-DISPOSITION RATIONALE-**

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**(A) DESIGN:**

FOR THIS FAILURE TO OCCUR, THE GROUND HALF POPPET OR POPPET BODY SUPPORT WEBS MUST FAIL STRUCTURALLY DURING FLOW. THE POPPET OF THE GROUND HALF DISCONNECT INCLUDES A PROBE THAT MECHANICALLY PUSHES THE ORBITER HALF POPPET OPEN DURING THE UMBILICAL ENGAGEMENT. BOTH POPPETS ARE SPRING LOADED TO THE CLOSED POSITION.

THE GROUND HALF POPPET (INCLUDING THE PROBE) IS MACHINED FROM A SINGLE PIECE OF 6061 ALUMINUM. THE GROUND HALF HOUSING IS MACHINED FROM 6061 ALUMINUM. POPPET BODY SUPPORT WEBS ARE AN INTEGRAL PART OF THE GROUND HALF HOUSING. TO REDUCE MASS THE INSIDE OF THE POPPET (INCLUDING THE PROBE) IS MACHINED SO THAT THE PROBE BECOMES A 0.625 INCH OD. CYLINDER WITH A 0.1 INCH WALL AND IS ABOUT 5 INCHES LONG.

STRUCTURAL ANALYSIS INDICATES POSITIVE MARGINS OF SAFETY FOR ALL CONDITIONS OF VALVE OPERATIONS. DURING QUAL TESTING 2000 MATE/DEMATE CYCLES WERE SUCCESSFULLY PERFORMED.

**(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)

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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

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

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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.

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.

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**(E) OPERATIONAL USE:**

FLIGHT:

NO CREW ACTION CAN BE TAKEN

GROUND:

GROUND WILL INITIATE DRAIN UPON FAILURE LO2 BLEED DISCONNECT OR LO2 POGO VALVE. GROUND OPERATIONS SAFING PROCEDURES CONTAIN SAFING SEQUENCE OF EVENTS FOR MAJOR LEAKS IN THE OXYGEN SYSTEM.

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**- APPROVALS -**

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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