

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE**NUMBER: 03-1-0303 -X****SUBSYSTEM NAME:** MAIN PROPULSION**REVISION:** 2 08/16/00**PART DATA**

PART NAME	PART NUMBER
VENDOR NAME	VENDOR NUMBER
LRU : DISCONNECT, FILL/DRAIN (ORB LO2)	MC276-0005-0032
UNITED SPACE ALLIANCE - NSLD	574006-108
LRU : DISCONNECT, FILL/DRAIN (ORB LH2)	MC276-0005-0041
UNITED SPACE ALLIANCE - NSLD	5740006-109
LRU : DISCONNECT, FILL/DRAIN (GND)	MC276-0005-0063
UNITED SPACE ALLIANCE - NSLD	5740005-108

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

FILL AND DRAIN DISCONNECT, LO2 AND LH2, GROUND AND AIRBORNE HALF, 8 INCH (PD11-LH2, PD12-LO2).

VALVE WAS ORIGINALLY DESIGNED AND MANUFACTURED BY PARKER-HANNIFIN. THE UNITED SPACE ALLIANCE-NSLD IS A CERTIFIED REPAIR DEPOT BUT HAS NOT YET BEEN CERTIFIED AS AN ALTERNATE PRODUCTION AGENCY.

REFERENCE DESIGNATORS: PD11
PD12

QUANTITY OF LIKE ITEMS: 4
1 MATED PAIR (ORB & GND) FOR LH2 & LO2

FUNCTION:

GROUND HALF INTERFACES WITH AIRBORNE HALF OF THE DISCONNECT TO TRANSFER PROPELLANTS THROUGH THE T-0 UMBILICALS TO THE FILL AND DRAIN LINE FOR ET LOADING AND DRAIN. GROUND HALF INCORPORATES A SPRING LOADED CLOSURE DEVICE WHICH IS HELD OPEN WHEN MATED TO THE AIRBORNE HALF BY A PUSH ROD THAT ENGAGES A SOCKET IN THE AIRBORNE REPLACEABLE INSERT ASSEMBLY. DISCONNECT ACTS AS A STRUCTURAL ATTACHMENT POINT FOR BOTH THE OUTBOARD FILL & DRAIN VALVE AND LINE.

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LRU: 8" FILL/DRAIN DISC (ORB/GND LH2/LO2, PD11,12)

CRITICALITY OF THIS

ITEM NAME: 8" FILL/DRAIN DISC (ORB/GND LH2/LO2, PD11,12)

FAILURE MODE: 1/1

FAILURE MODE:

RUPTURE/LEAKAGE OF THE DISCONNECT BODY (AIRBORNE AND GROUND HALF) DURING LOADING, DETANKING, DUMP, AND INERTING

MISSION PHASE: PL PRE-LAUNCH
LO LIFT-OFF

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

CAUSE:
FATIGUE, MATERIAL DEFECTS

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 HYDROGEN.

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RUPTURE/LEAKAGE OF THE GROUND HALF ASSEMBLY RESULTS IN EXTERNAL LEAKAGE OF EITHER LO2 OR LH2. GN2 (LO2) AND GHE (LH2) PURGES AT THE T-0 AND MLP HOOD WILL DISSIPATE SOME OF THE PROPELLANT. HAZARDOUS GAS DETECTION SYSTEM AT THE LH2 TSM/T-0 UMBILICAL. GROSS LH2 LEAKAGE MAY RESULT IN FIRE/EXPLOSION HAZARD AT THE VEHICLE EXTERIOR. POSSIBLE DAMAGE TO TILE AND SURROUNDING STRUCTURE FOR BOTH LH2 AND LO2 LEAKAGE.

(B) INTERFACING SUBSYSTEM(S):

SAME AS A.

(C) MISSION:

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

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

POSSIBLE LOSS OF CREW/VEHICLE.

(E) FUNCTIONAL CRITICALITY EFFECTS:

NONE.

-DISPOSITION RATIONALE-

(A) DESIGN:

THE AIRBORNE HALF INCLUDING REPLACEABLE INSERT IS MADE OF 356-T6 AND 6061-T6 ALUMINUM ALLOY. THE AIRBORNE HALF AND GROUND HALF BELLOWS ASSEMBLY ARE DESIGNED TO A MINIMUM FACTOR OF SAFETY OF 1.3 PROOF, 1.5 BURST FOR INTERNAL PRESSURE. THE GROUND DISCONNECT BELLOWS IS OF 4-PLY INCONEL 718 CONSTRUCTION AND IS PROOF PRESSURE TESTED AT 260 PSIG. THE GROUND HALF DISCONNECT BODY IS MADE OF ALUMINUM ALLOY 356-T6 CASTING AND DESIGNED TO A MINIMUM FACTOR OF SAFETY OF 2.0 PROOF AND 4.0 BURST FOR INTERNAL PRESSURE. FRACTURE AND FATIGUE ANALYSIS SHOW THAT ALL CRITICAL PARTS ARE SATISFACTORY FOR 4 TIMES EXPECTED LIFE.

BOTH T-0 UMBILICAL PLATES HAVE DEDICATED OTV FOR CONTINUOUS OBSERVATION OF LEAKS THROUGHOUT FILL, TOPPING AND REPLENISH. THE LH2 DISCONNECT IS MONITORED FOR LH2 LEAKAGE BY A HAZARDOUS GAS DETECTION SYSTEM AND IS OBSERVED WITH INFRA-RED DETECTORS FOR FIRE DETECTION. THE LH2 T-0 UMBILICAL GHE PURGE IS SUFFICIENT TO DILUTE LEAKS UP TO 5800 SCIM BELOW THE 3.6% HYDROGEN CONCENTRATION LCC. THE LO2 T-0 UMBILICAL IS PURGED WITH GN2 DURING LOADING OPERATIONS. THE INTERFACE SEAL IS INSPECTED PRIOR TO MATING AND IS LEAK CHECKED FOLLOWING MATING.

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(B) TEST:
ATP

EXAMINATION OF PRODUCT

PROOF PRESSURE: (AMBIENT)
AIRBORNE HALF DISCONNECT - 91 PSIG LH2, 260 PSIG LO2
AIRBORNE REPLACEABLE INSERT - 260 PSIG (LH2 AND LO2)
GROUND HALF DISCONNECT ASSEMBLY - 260 PSIG (LO2 AND LH2)
GROUND HALF CLOSURE DEVICE - 400 PSIG (LH2 AND LO2)

AMBIENT OPERATIONAL TESTS- SIX CYCLES (ENGAGE AND DISENGAGE) AT 5 PSIG

AIRBORNE HALF LEAKAGE (MATED):
MATING SEAL LEAKAGE (LO2 UNIT) - PERFORMED WITH LN2 (CRYO) AND GHE
(AMBIENT) AT 130 PSIG
MATING SEAL LEAKAGE (LH2 UNIT) - PERFORMED WITH LH2 (CRYO) AND GHE
(AMBIENT) AT 30 PSIG

GROUND HALF DISCONNECT LEAKAGE (MATED):
MATING SEAL LEAKAGE (LH2/LO2) - PERFORMED WITH LN2 (CRYO) AT 30 PSIG
AND 130 PSIG
EXTERNAL LEAKAGE (LH2/LO2) - PERFORMED WITH GN2 (AMBIENT) AT 130 PSIG

GROUND HALF DISCONNECT LEAKAGE (UNMATED):
EXTERNAL LEAKAGE (LH2/LO2) - PERFORMED WITH GN2 (AMBIENT) AT 130 PSIG
EXTERNAL LEAKAGE (CLOSURE DEVICE) - PERFORMED WITH LN2 (CRYO) AND GN2 (170
DEG F) AT 90 PSIG

CERTIFICATION

COMPONENT CERTIFICATION

SAND, DUST, AND SALT FOG

RANDOM VIBRATION - IN ALL THREE AXES (SEPARATE AND MATED)
MATED - LN2 40 MINUTES PER AXIS
GROUND HALF - LN2 5 MINUTES PER AXIS
AIRBORNE HALF - AMBIENT TEMP 52 MINUTES PER AXIS.

OPERATIONAL TESTS (ENGAGE AND DISENGAGE):
AMBIENT - 40 CYCLES
CRYO - 400 CYCLES

14 HOUR HOLD TEST (MATED) - AT LN2 AND LH2 TEMPS

EXTERNAL AND MATING SEAL LEAKAGE - AT AMBIENT AND CRYO CONDITIONS

CLOSURE DEVICE LEAKAGE - AT CRYO AND 160 DEG F

ELECTRICAL BONDING

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BURST TEST

LH2 AIRBORNE HALF - 105 PSIG

LO2 AIRBORNE HALF - 300 PSIG

GROUND HALF (OPEN) - 300 PSIG

GROUND HALF (CLOSED) - 800 PSIG APPLIED TO FACILITY SIDE

LO2 T-0 UMBILICAL ASSEMBLY

MATED DISCONNECT PRESSURE DECAY TEST - 130 PSIG HELD FOR 30 MINUTES AT AMBIENT TEMPERATURE.

SEPARATION AT LN2 TEMPERATURE - PERFORM AMBIENT LEAK TESTS AND PRESSURE DECAY AT 130 PSIG FILL WITH LN2 AND STABILIZE TEMPERATURE, PERFORM LEAK TEST AT 10 PSIG DURING CHILLDOWN. PURGE DISCONNECTS AND DEPRESSURIZE TO 5 PSIG. PERFORM NOMINAL SEPARATION.

RANDOM VIBRATION TESTS - PERFORMED TWO TIMES IN EACH AXIS

FILL WITH LN2 AND STABILIZE FOR 30 MINUTES.

CRYO LEAK CHECK AT 50-115 PSIG.

TWO MINUTE GN2 PURGE.

60 SECOND RANDOM VIBRATION.

LN2 CHILLDOWN AND STABILIZE FOR 30 MINUTES.

CRYO LEAK TEST AT 50-115 PSIG.

TWO MINUTE GN2 PURGE THEN HOT GAS PURGE AND AMBIENT LEAK TEST AT 130 PSIG.

LN2 CHILLDOWN AND STABILIZE FOR 30 MINUTES.

CRYO LEAK TEST AT 50-115 PSIG.

TWO MINUTE HE PURGE.

20 SECOND RANDOM VIBRATION. PERFORM SEPARATION DURING LAST SECOND OF RANDOM VIBRATION.

LH2 T-0 UMBILICAL ASSEMBLY

MATED DISCONNECT PRESSURE DECAY TEST - 70 PSIG HELD FOR 30 MINUTES AT AMBIENT TEMPERATURE.

SEPARATION AT LH2 TEMPERATURE (24 HOUR HOLD) - PERFORM PRESSURE DECAY AND AMBIENT LEAK TESTS. FILL WITH LH2 AND STABILIZE TEMPERATURE. PERFORMED LEAK CHECK AT 10 PSIG DURING CHILLDOWN AND AT 40-65 PSIG DURING TEMPERATURE

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STABILIZATION. PURGE DISCONNECT, PRESSURIZE TO 5 PSIG AND PERFORM NORMAL SEPARATION.

SEPARATION WITH ICING CONDITIONS AT LH2 TEMPERATURE - FILL WITH LH2 AND STABILIZE TEMPERATURE TO -423 DEG F. INITIATE RAIN MIST FOR 10 MINUTES, PURGE DISCONNECTS. PERFORM SEPARATION TEST. TEST WAS PERFORMED TWICE.

SALT FOG AT LH2 TEMPERATURE - MIXED A SALT SOLUTION (1% BY WEIGHT) AND SPRAYED EXPOSED SURFACES OF CARRIER. MAINTAINED TEMPERATURE AT 95 DEG F AND RELATIVE HUMIDITY OF 90%. AFTER 24 HOURS REPEATED SALT SPRAY AND MAINTAINED TEMPERATURE AND RELATIVE HUMIDITY FOR ANOTHER 24 HOURS. FILLED DISCONNECT WITH LH2 AND ALLOWED TEMPERATURE TO STABILIZE. PURGE DISCONNECT AND PERFORM NORMAL SEPARATION.

RANDOM VIBRATION TESTS - PERFORMED TWO TIMES IN EACH AXIS

FILL WITH LH2 AND DRAIN AND GHE PURGE

60 SECOND RANDOM VIBRATION.

LH2 CHILLDOWN AND STABILIZE FOR 30 MINUTES.

TWO MINUTE GHE PURGE THEN HOT GAS PURGE AND AMBIENT LEAK TEST AT 30 PSIG.

LH2 CHILLDOWN AND STABILIZE FOR 30 MINUTES.

CRYO LEAK TEST AT 10-35 PSIG.

TWO MINUTE HE PURGE.

20 SECOND RANDOM VIBRATION. PERFORM SEPARATION DURING LAST SECOND OF RANDOM VIBRATION.

GROUND TURNAROUND TEST

ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:

RECEIVING INSPECTION

RAW MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION. MACHINED ITEMS ARE DIMENSIONALLY CHECKED. BOTH CHEMICAL AND MECHANICAL PROPERTIES ARE TESTED AND RECORDS ARE RETAINED FOR VERIFICATION. BODY FORGING VERIFIED BY ULTRASONIC AND PENETRANT INSPECTION.

CONTAMINATION CONTROL

CONTAMINATION CONTROL PROVISIONS ARE VERIFIED. CLEANLINESS LEVEL (400 FOR LH2 AIRBORNE HALF, 400A FOR EACH GROUND HALF, AND 800A FOR LO2 AIRBORNE HALF) VIA FREON FLUSH AND SAMPLE ARE TESTED.

ASSEMBLY/INSTALLATION

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PARTS PROTECTION FROM DAMAGE AND CONTAMINATION ARE VERIFIED. SEALING SURFACES, ROSAN INSERT CONDITION, CRITICAL DIMENSIONS AND REWORK/REPAIR ITEMS ARE VERIFIED BY INSPECTION. LOG OF CLEAN ROOM AND TOOL CALIBRATION ARE VERIFIED BY INSPECTION. THREADED FASTENER TORQUE VERIFICATION IS CERTIFIED BY INSPECTION. CORROSION PROTECTION OF EXPOSED PARTS VERIFIED BY INSPECTION. TRACEABILITY ALSO VERIFIED.

NONDESTRUCTIVE EVALUATION
WELDS ARE RADIOGRAPHICALLY AND DYE PENETRANT INSPECTED. CERTAIN DETAIL PARTS ARE DYE PENETRANT INSPECTED.

CRITICAL PROCESSES
PARTS PASSIVATION, CHEM FILM, AND ANODIZE VERIFIED BY INSPECTION.

TESTING
TEST AND MEASUREMENT EQUIPMENT CALIBRATION CONDITION AND ATP VERIFIED BY INSPECTION.

HANDLING/PACKAGING
PACKAGING FOR SHIPMENT VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

DURING PERFORMANCE OF THE INTERFACE SEAL LEAK TEST AT KSC A 304 SCIM LEAK (S/B 10 SCIM MAX) (CARS AC8718, AC8717) WAS DETECTED. FAILURE INVESTIGATION DISCLOSED THAT THE FAILURE WAS DUE TO INCORRECT REMOVAL OF THE PURGE ASSIST FILTER FROM THE GSE/PURGE ASSIST TUBE. THIS CAUSED ROTATION AND LOOSENING OF THE FITTING AT THE DISCONNECT BODY. A REDESIGN TO PREVENT THE TUBE/FITTING FROM BEING ROTATED IS BEING INCORPORATED.

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:

GROUND OPERATIONS SAFING PROCEDURES CONTAIN SAFING SEQUENCE OF EVENTS FOR MAJOR LEAKS IN THE HYDROGEN OR OXYGEN SYSTEMS.

- 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	: MICHAEL SNYDER	: /S/ MICHAEL SNYDER
USA ORBITER ELEMENT	: SUZANNE LITTLE	: /S/ SUZANNE LITTLE

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NASA SR&QA

: ERICH BASS

: /S/ ERICH BASS