

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 03-1-0503 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 1 08/09/00

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
SRU	:GH2 2" ET PRESSURIZATION DISCONNECT (ORB) VACCO INDUSTRIES	MC284-0391-0001
SRU	:GH2 2" ET PRESSURIZATION DISCONNECT (ET) VACCO INDUSTRIES	MC284-0391-0032

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

DISCONNECT, ET PRESSURIZATION (GH2), ORBITER & ET HALF (2.0 INCH DIA).

REFERENCE DESIGNATORS: PD5

QUANTITY OF LIKE ITEMS: 1

FUNCTION:

PROVIDES THE FLOW PATH BETWEEN THE ET AND THE ORBITER FOR THE GH2 FROM THE MAIN ENGINES TO PRESSURIZE THE ET. ALSO USED FOR HE ANTI-ICING FLOW (PRELAUNCH) AND HE PREPRESSURIZATION PRIOR TO ENGINE START. THE DISCONNECT POPPETS ARE OPEN UNTIL ORBITER/ET SEPARATION, AT WHICH TIME THE DISCONNECT CLOSES TO PREVENT CONTAMINATION OF THE MPS DURING ENTRY. THE DISCONNECT INCORPORATES A PORT USED IN CONJUNCTION WITH THE GH2 PRESSURIZATION LINE VENT VALVE (LV52) TO VENT THE GH2 SYSTEM DURING VACUUM INERTING.

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SUBSYSTEM NAME: MAIN PROPULSION

LRU: GH2 2" ET PRESSURIZATION DISCONNECT (PD5)

CRITICALITY OF THIS

ITEM NAME: GH2 2" ET PRESSURIZATION DISCONNECT (PD5)

FAILURE MODE: 1/1

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:

FATIGUE, MATERIAL DEFECT, DISCONNECT BODY-TO-END-CAP SEAL FAILURE

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:

CASE 1:

1/1 TIME FRAME - LOADING, ASCENT, AND DEORBIT

GH2 AND/OR GHE LEAKAGE INTO THE AFT COMPARTMENT. POSSIBLE OVERPRESSURIZATION OF THE AFT COMPARTMENT AND FIRE/EXPLOSION HAZARD. GHE

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LEAKAGE FROM ANTI-ICING PURGE DETECTABLE ON GROUND USING HAZARDOUS GAS DETECTION SYSTEM (HGDS).

GH2 FLOW CONTROL VALVES WILL CYCLE TO THE HIGH FLOW POSITION IN AN ATTEMPT TO MAINTAIN ULLAGE PRESSURE. LOSS OF ET LH2 ULLAGE PRESSURE WILL RESULT IN VIOLATION OF TANK MINIMUM STRUCTURAL CAPABILITY REQUIREMENTS. POSSIBLE UNCONTAINED SSME SHUTDOWN DUE TO LOW LH2 NPSP.

ALSO RESULTS IN POSSIBLE LOSS OF HELIUM SUPPLY DURING MANIFOLD REPRESSURIZATION CAUSING LOSS OF AFT COMPARTMENT PURGE.

CASE 2:
3/3 TIME FRAME - ET SEPARATION

RUPTURE MAY RESULT IN BLOWDOWN OF THE RESIDUAL PROPELLANT IN THE ET THROUGH THE FAILED DISCONNECT. PROPULSIVE VENTING FROM THE DISCONNECT WILL NOT RESULT IN ET/ORBITER RECONTACT.

ALLOWS GH2 TO LEAK INTO THE DISCONNECT CAVITY AND OVERBOARD. AFTER MECO, VACUUM CONDITIONS AT UMBILICAL AND IN AFT COMPARTMENT ARE INSUFFICIENT TO ALLOW COMBUSTION.

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

(C) MISSION:
ON GROUND, 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 DISCONNECT CONSISTS OF A TANK HALF AND AN ORBITER HALF. THE DISCONNECT IS A MECHANICAL DEVICE, EACH HALF CONTAINING A POPPET ASSEMBLY WHICH IS SPRING LOADED TO THE CLOSED POSITION. EACH POPPET IS ACTUATED TO THE OPEN POSITION DURING THE MATING OF THE ET AND ORBITER UMBILICALS. THE ORBITER HALF IS MOUNTED TO A BELLEVILLE WASHER ARRANGEMENT WHICH PROVIDES THE CLAMPING FORCE TO MAINTAIN INTERFACE SEAL REQUIREMENTS TO PREVENT LEAKAGE.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0503-07**

THE CLOSURE SEAL (301 CRES, FULL HARD), POPPET (316 CRES INVESTMENT CAST), POPPET RETURN SPRING (302 CRES CONDITION B), BUSHINGS (ALUMINUM BRONZE), AND BODY (316 CRES INVESTMENT CAST) ARE IDENTICAL FOR EACH HALF. THE TWO HALVES DIFFER ONLY IN THEIR CAP SECTIONS. THE ORBITER CAP SECTION CONTAINS THE WASHER TYPE INTERFACE SEAL (301 CRES, FULL HARD) RETAINED AGAINST THE CAP SECTION BY A RETAINER (304 CRES, CONDITION A) WHICH SCREWS ON THE CAP SECTION AND IS TORQUED TO 275 FOOT-POUNDS. LEAKAGE PAST THE RETAINER AND SEAL IS PREVENTED BY A SOFT COPPER GASKET. THE ET CAP SECTION INCORPORATES A GUIDE SECTION AT THE INTERFACE, TO PROPERLY ALIGN AND MAINTAIN THE ORBITER SECTION, AND A SEAT SURFACE COATED WITH TEFLON. EACH OF THE CAP SECTIONS IS MATED TO ITS RESPECTIVE BODY USING A SOFT COPPER GASKET AND 18 INCONEL 718 SCREWS TORQUED TO 30 INCH-POUNDS MAXIMUM. THE COPPER GASKET IS UTILIZED TO PREVENT EXTERNAL LEAKAGE AT HIGH TEMPERATURES.

EACH POPPET IS GUIDED BY TWO LINEAR BUSHINGS. THESE BUSHINGS ARE INSTALLED IN AND SUPPORTED BY A PAIR OF RADIAL STRUTS. EACH RADIAL STRUT CONSISTS OF TWO SUPPORTING LEGS WHICH ARE 120 DEGREES APART. THE STRUTS ARE AN INTEGRAL PART OF THE BODY AND CAP SECTION AND ARE ALIGNED DURING ASSEMBLY OF THE CAP SECTION TO THE BODY TO MINIMIZE THERMAL STRESSES AND PREVENT COCKING BETWEEN THE POPPET SHAFT AND BUSHING. INDEX MARKS ARE LOCATED ON EACH FLANGE TO INSURE PROPER CLOCKING OF THE ET AND ORBITER SECTIONS.

THE DISCONNECT HAS DESIGN PRESSURE FACTORS OF SAFETY OF 1.5 PROOF (900 PSIG) AND 2.0 BURST (1,200 PSIG). STRUCTURAL ANALYSIS INDICATES POSITIVE MARGINS OF SAFETY FOR ALL CONDITIONS OF DISCONNECT OPERATION. FRACTURE ANALYSES SHOW THAT ALL CRITICAL PARTS ARE SATISFACTORY FOR FOUR TIMES THE ORBITER LIFE OF 100 MISSIONS.

(B) TEST:

ATP

EXAMINATION OF PRODUCT

PROOF PRESSURE

920 PSIG MATED
500 PSIG ORBITER HALF
56 PSIG ET HALF

INTERNAL LEAKAGE (ACROSS CLOSURE, DEMATED), BOTH HALVES

20 PSIG GHE (15 SCIM MAX)
40 PSIG GHE (100 SCIM MAX)

EXTERNAL LEAKAGE, MATED

600 PSIG GHE (100 SCIM MAX)

OPERATIONAL TEST (3 CYCLES)

PRESSURIZE BOTH HALVES TO 5 PSIG
MATE
RAISE PRESSURE TO 37 PSIG

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DEMATE
RECORD ENGAGE (120 LB MAX) AND DISENGAGE (50 LB MAX) FORCES

ROSAN INSERT TORQUE VERIFICATION

CERTIFICATION

COMPONENT

HIGH TEMPERATURE LEAKAGE (500°F)
MATED WITH 600 PSIG GHE (183 SCIM MAX AT INTERFACE)
DEMATED, ACROSS CLOSURE (EACH HALF)
20 PSIG GHE (18 SCIM MAX)
40 PSIG GHE (201 SCIM MAX)

VIBRATION
RANDOM: 48 MINUTES IN EACH OF TWO AXES AT 600 PSIG, 500°F FOLLOWED
BY ATP OPERATIONAL AND LEAKAGE TESTS AT BOTH 500°F AND
AMBIENT

THERMAL CYCLE (100 CYCLES)
MATE
REDUCE BODY TEMPERATURE TO -100°F
FLOW 8 LB/SEC GO2 AT 600 PSIG AND 500°F (26 PSID MAX PRESSURE DROP)
THROUGH UNIT UNTIL BODY TEMPERATURE IS STABILIZED (700
SECONDS MAX)
REDUCE PRESSURE TO 37 PSIG
DEMATE
AFTER EACH 25 CYCLES PERFORM HIGH TEMPERATURE LEAKAGE TEST
AND OPERATIONAL, INTERNAL LEAKAGE, AND EXTERNAL LEAKAGE
TESTS

LIFE CYCLE
380 OPERATIONAL TESTS AT AMBIENT
100 OPERATIONAL TESTS AT 500°F
AFTER EACH 25 CYCLES PERFORM INTERNAL AND EXTERNAL LEAKAGE
TESTS

BURST (MATED): 1,200 PSIG

SYSTEM

UMBILICAL SEPARATION TEST
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). THE DISCONNECT WAS ALSO
SUBJECTED TO UMBILICAL RETRACT TESTS AT BOTH NOMINAL CONDITIONS AND
SIMULATED HYDRAULIC RETRACT ACTUATOR FAILURES.

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

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**(C) INSPECTION:
COMPONENT**

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

CONTAMINATION CONTROL
THE DISCONNECT INTERNAL SURFACES ARE MAINTAINED TO LEVEL 400A PER REQUIREMENT. CORROSION PROTECTION IS IMPLEMENTED AND VERIFIED. PROTECTIVE CAPS ARE PROVIDED TO PREVENT CONTAMINATION AND PROTECT SEALING SURFACES.

ASSEMBLY/INSTALLATION
CRITICAL DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION. MANUFACTURING PROCESSES AND INSTALLATION AND ASSEMBLY OPERATIONS, INCLUDING PARTS PROTECTION, ARE VERIFIED BY INSPECTION. TORQUE FORCES APPLIED TO PARTS ARE VERIFIED BY INSPECTION.

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

NONDESTRUCTIVE EVALUATION
THE BODY CASTING IS X-RAYED AND PRESSURE TESTED. THE BODY CASTING IS PENETRANT INSPECTED AFTER PRELIMINARY MACHINING.

TESTING
ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING
PACKAGING FOR SHIPMENT IS VERIFIED BY INSPECTION.

UMBILICAL ASSEMBLY

HEAT TREATED AND DRY FILM LUBE COATED BELLEVILLE SPRINGS ARE VISUALLY INSPECTED AND LOAD TESTED PRIOR TO ASSEMBLY. CORRECT INSTALLATION OF THE BELLEVILLE SPRINGS IS A MANDATORY INSPECTION POINT. THE SHIMS, WHICH ARE REQUIRED TO SET THE HEIGHT OF THE 2 INCH DISCONNECT MATING SURFACE ABOVE THE 17 INCH DISCONNECT MATING SURFACE AS EXTERNAL FORCE IS APPLIED TO THE 2 INCH DISCONNECT, ARE DIMENSIONALLY INSPECTED. THE SHIMS, WHICH ARE REQUIRED TO SET THE PRELOAD IN THE UNMATED CONDITION, ARE DIMENSIONALLY INSPECTED.

(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:

WHEN GH2 ULLAGE LEAK IS IDENTIFIED, CREW WILL ENABLE THE SSME LIMIT SHUTDOWN CONTROL AND ABORT TAL OR ACLS.

- 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