

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE**

NUMBER: 03-1-0505 -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	:GH2 ENGINE I/F ISOLATION CHECK VALVE CIRCLE SEAL	ME284-0479-0012 P60-647

**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**

VALVE, CHECK, GH2 ENGINE ISOLATION (0.625 INCH DIA) (CV21, CV22, CV23)

**REFERENCE DESIGNATORS:** CV21  
CV22  
CV23

**QUANTITY OF LIKE ITEMS:** 3  
GH2

**FUNCTION:**

PREVENTS LOSS OF PRESSURANT FROM REMAINING OPERATING ENGINES THROUGH AN ENGINE WHICH HAS BEEN SHUT DOWN. EACH VALVE UNIT INCORPORATES TWO POPPETS IN SERIES WITH A TEST PORT BETWEEN THE POPPETS.

**FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE**

**NUMBER: 03-1-0505-04**

**REVISION#: 1 08/09/00**

**SUBSYSTEM NAME: MAIN PROPULSION**

**LRU: GH2 ENGINE I/F ISOLATION CHECK VALVE**

**ITEM NAME: GH2 ENGINE I/F ISOLATION CHECK VALVE**

**CRITICALITY OF THIS**

**FAILURE MODE: 1/1**

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**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, DAMAGED/DEFECTIVE SEAL WELD JOINT

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

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**REDUNDANCY SCREEN**

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:**

GH2 AND/OR GHE LEAKAGE INTO THE AFT COMPARTMENT. POSSIBLE OVERPRESSURIZATION OF THE AFT COMPARTMENT AND FIRE/EXPLOSION HAZARD. GHE LEAKAGE FROM ANTI-ICING PURGE DETECTABLE ON GROUND USING HAZARDOUS GAS DETECTION SYSTEM (HGDS).

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GH2 FLOW CONTROL VALVES WILL CYCLE TO HIGH FLOW 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.

**(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.

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**-DISPOSITION RATIONALE-**

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**(A) DESIGN:**

THE CHECK VALVE CONSISTS OF TWO SERIES REDUNDANT POPPETS WHICH ARE SPRING LOADED TO THE CLOSED POSITION. UPSTREAM PRESSURE OVERCOMES THE SPRING FORCE TO UNSEAT THE POPPETS FOR PRESSURES EXCEEDING 1.0 PSID. THE CHECK VALVE IS OPEN THROUGHOUT ASCENT EXCEPT FOR AN ENGINE OUT FAILURE WHERE PRESSURE FROM THE OTHER TWO ENGINES (UP TO 4500 PSIA) CLOSES THE FAILED ENGINE'S CHECK VALVE. THE VALVE IS REQUIRED TO CYCLE ONLY ONCE PER FLIGHT.

THE CHECK VALVE CONTAINS TWO LEAK DETECTION PORTS AND TWO TRANSDUCER PORTS.

THE BODY IS MANUFACTURED FROM 21-6-9 CRES AND THE TUBE END IS A286 CRES. THE ONLY POTENTIAL LEAK PATH IS THE BODY/TUBE INTERFACE. THE TUBE END IS THREADED INTO THE BODY, GAS TUNGSTEN ARC WELDED TO THE BODY, AND LEAK TESTED TO 1 SCCH MAX AT 4500 PSIA.

STRUCTURAL ANALYSIS INDICATES POSITIVE MARGINS OF SAFETY FOR ALL CONDITIONS OF VALVE OPERATION. THE VALVE HAS FACTORS OF SAFETY OF 2.0 PROOF (9000 PSIG) AND 3.55 BURST (16,000 PSIG).

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**(B) TEST:**

ATP

EXAMINATION OR PRODUCT

PROOF PRESSURE (9,375 PSIA)

CLOSURE PROOF PRESSURE (1320 PSIA)

REVERSE FLOW LEAKAGE (0 TO 600 PSIA, AT AMBIENT AND +310 DEG F)

EXTERNAL LEAKAGE (4500 PSIA, AMBIENT)

CRACK AND RESEAT PRESSURE (BODY TEMPERATURE -150 DEG F, 3 CYCLES)  
CRACK PRESSURE 1 PSID MAXIMUM  
RESEAT PRESSURE 0.2 PSID MINIMUM

CERTIFICATION

PERFORMANCE TEST

REVERSE PRESSURE LEAKAGE, CRACK PRESSURE, AND RESEAT PRESSURE  
TESTS (AMBIENT TEMPERATURE, AIR)

HIGH TEMPERATURE FLOW AND CHATTER TEST

1.20 LB/SEC MIN, GH2 AT +70 DEG F, 3650 PSIA INLET  
0.12 LB/SEC MIN, GH2 AT +300 DEG F, 1800 PSIA INLET  
RECORD FLOW RATE AT WHICH CHATTER IS DETECTED  
REPEAT PERFORMANCE TEST

ENDURANCE FLOW TEST (18 CYCLES EACH)

10 MINUTES FLOW AT 0.25 LBS/SEC MIN, AIR AT +70 DEG F, 3000 PSIA INLET  
REPEAT PERFORMANCE TEST AFTER TEST COMPLETION

VIBRATION

RANDOM (AMBIENT TEMPERATURE)

13.3 HOURS FOR EACH OF 2 AXES (12 TO 15 PSIG INLET, AIR AT AMBIENT)

REPEAT PERFORMANCE TEST AFTER COMPLETION OF EACH AXIS OF  
VIBRATION

TRANSIENT SHOCK TEST

ALONG X AND Y AXIS, SINUSOIDAL SWEEP, 5 TO 35 HZ, +/- 0.25 G

REPEAT PERFORMANCE TEST AFTER TEST COMPLETION

LIFE CYCLE TEST (1800 CYCLES)

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ONE CYCLE CONSISTS OF: FLOW AT 60 SCFM (CLEAN DRY AIR), THEN REDUCE FLOW AND INLET PRESSURE TO ZERO WHILE INCREASING OUTLET PRESSURE TO 600 PSID.

REPEAT PERFORMANCE TEST AFTER EVERY 50 CYCLES

BURST TEST (18,240 PSIG, AMBIENT TEMPERATURE)

CLOSURE BURST TEST (2736 PSIG, AMBIENT TEMPERATURE)

GROUND TURNAROUND TEST

ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

**(C) INSPECTION:**

RECEIVING INSPECTION

ALL RAW MATERIALS ARE VERIFIED FOR MATERIAL AND PROCESS CERTIFICATION.

CONTAMINATION CONTROL

ALL PARTS ARE MAINTAINED TO CLEANLINESS LEVEL 100A.

ASSEMBLY/INSTALLATION

DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION. DETAIL PARTS ARE PROTECTED FROM DAMAGE AND CONTAMINANTS BY PRODUCTION PROCEDURES DURING MANUFACTURING AND TESTING. POPPET-TO-BODY CLEARANCE AND SEALING SURFACES ARE CHECKED AND VERIFIED. SURFACES AND WELD ARE INSPECTED UNDER 10X MAGNIFICATION. MANDATORY INSPECTION POINTS ARE ESTABLISHED TO VERIFY ASSEMBLY PROCESS.

CRITICAL PROCESSES

THE WELD IS VERIFIED PER DRAWING SPECIFICATIONS. ELECTRO-NICKEL PLATED TUBE SURFACE IS VERIFIED PER DRAWING SPECIFICATIONS. HEAT TREATMENT AND PARTS PASSIVATION ARE VERIFIED BY INSPECTION. DRY FILM LUBRICANT APPLIED TO THREADS ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

HELIUM LEAKAGE DETECTION IS PERFORMED PER REQUIREMENT.

TESTING

ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PACKAGING FOR SHIPMENT IS VERIFIED BY INSPECTION.

**(D) FAILURE HISTORY:**

DURING QUALIFICATION TESTING, A VALVE BURST AT 16,200 PSI (CAR AB0368). PROCUREMENT SPECIFICATION'S BURST REQUIREMENT WAS 18,090 PSI MINIMUM. A REVISED STRESS ANALYSIS UTILIZING UPDATED VALUES FOR THE LOADS AND ENVIRONMENT DETERMINED A BURST VALUE OF 16,000 PSI WAS ACCEPTABLE.

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RESULTANT MARGIN OF SAFETY IS 1.73 (FACTOR OF SAFETY IS 3.55), WHICH MEETS ALL REQUIREMENTS. THE PROCUREMENT SPECIFICATION WAS CHANGED TO INCORPORATE THE REVISED REQUIREMENT.

EXTERNAL LEAKAGE DUE TO WELD DEFECTS HAVE BEEN DETECTED DURING ATP (CAR AC5123). THE UNITS WERE AT THE SUPPLIER FOR RETROFITTING OF POPPET. THE ORIGINAL WELD JOINT WAS MACHINED FOR EB WELDING AND THE DRAWING SPECIFIES TIG WELDING. CORRECTIVE ACTION REVISED THE DRAWINGS TO SPECIFY TIG WELD CONFIGURATION FOR THE WELD JOINTS.

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:**

LH2 ULLAGE PRESSURE IS ON SYSTEMS MANAGEMENT (SM) ALERT. CREW WILL OPEN THE LH2 FLOW CONTROL VALVES (VIA COCKPIT SWITCH S53 ON PANEL R2) FOR A LOW LH2 ULLAGE PRESSURE CONDITION.

IF THE LH2 NPSP DROPS BELOW THE PRE-FLIGHT ACCEPTED LEVELS (PER FLIGHT RULES), THE CREW WILL MANUALLY THROTTLE THE ENGINES TO KEEP THE NPSP HIGH ENOUGH TO PREVENT LH2 TURBOPUMP CAVITATION.

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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	:MICHAEL FISCHER	:/S/ MICHAEL 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