

**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.

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**NUMBER: 03-1-0505-02**

**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: 1R3**

**FAILURE MODE:**  
FAILS TO CHECK.

**MISSION PHASE:** PL PRE-LAUNCH  
LO LIFT-OFF

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

**CAUSE:**  
BINDING, CONTAMINATION, PIECE PART STRUCTURAL FAILURE

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

**REDUNDANCY SCREEN** A) PASS  
B) N/A  
C) FAIL

**PASS/FAIL RATIONALE:**

**A)**

**B)**

SCREEN B IS N/A BECAUSE CHECK VALVE POPPETS ARE SERIES REDUNDANT AND ONE IS CONSIDERED STANDBY IN THE CHECK MODE.

**C)**

FAILS C SCREEN BECAUSE CONTAMINATION CAN CAUSE BOTH POPPETS TO FAIL TO CLOSE.

**- FAILURE EFFECTS -**

**(A) SUBSYSTEM:**

NO EFFECT. REMAINING SERIES REDUNDANT CHECK VALVE IN THE ASSEMBLY WILL PREVENT REVERSE LEAKAGE.

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**(B) INTERFACING SUBSYSTEM(S):**

SAME AS A.

**(C) MISSION:**

NO EFFECT, FIRST FAILURE.

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

NO EFFECT, FIRST FAILURE.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

1R/3 3 SUCCESS PATHS. TIME FRAME - OFF NOMINAL ENGINE SHUTDOWN.

- 1) ENGINE SHUTDOWN WITH UNCONTAINED DAMAGE (ASSUMES ENGINE IS DAMAGED ONLY TO THE EXTENT THAT ISOLATION OF THE DAMAGE WILL SAVE THE SYSTEM).
- 2) ONE ISO CHECK VALVE POPPET FAILS TO CLOSE ON SHUTDOWN ENGINE.
- 3) REMAINING ISO CHECK VALVE POPPET FAILS TO CLOSE ON SAME SHUTDOWN ENGINE.

RESULTS IN GH2 PRESSURIZATION GAS LEAKAGE (INTO THE AFT COMPARTMENT) FROM THE ET ULLAGE AND THE REMAINING TWO UNAFFECTED SSME'S. POSSIBLE OVERPRESSURIZATION OF THE AFT COMPARTMENT AND FIRE/EXPLOSIVE HAZARD. POSSIBLE LOSS OF ADJACENT CRITICAL COMPONENTS DUE TO IMPINGEMENT OF HIGH PRESSURE GAS.

GH2 LEAKAGE OVERBOARD COULD CAUSE FIRE AND EXPLOSIVE HAZARD EXTERNAL TO THE VEHICLE FOR PAD ABORTS OR DURING ASCENT.

POSSIBLE LOSS OF CREW/VEHICLE.

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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 DESIGN CONSISTS OF SEVEN PARTS: A TUBE END (A286 CRES, PASSIVATED), A BODY (CRES 21-6-9, PASSIVATED), A SPRING GUIDE/SEAT (INCONEL 718, PASSIVATED), TWO

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SPRINGS (INCONEL X), AND TWO POPPETS (BERYLLIUM COPPER ALLOY 172). THE SPRING GUIDE AND THE SEAT FOR ONE OF THE POPPETS ARE INCORPORATED INTO A SINGLE PART.

THE ONLY PARTS THAT COULD BIND ARE THE POPPETS. THE POPPETS ARE COMPLETELY GUIDED WITHIN THEIR BORES WHEN THEY ARE IN THE CLOSED POSITION. THE FIRST BORE IS MACHINED IN THE BODY (CRES 21-6-9). THE SECOND BORE IS MACHINED IN THE SPRING SEAT (INCONEL 718). BOTH ARE MACHINED TO A 16 MICROINCH SURFACE FINISH. BOTH POPPETS ARE BERYLLIUM COPPER ALLOY 172. ANALYSES PERFORMED BY THE SUPPLIER INDICATE POSITIVE CLEARANCES BETWEEN THE POPPETS AND BORES FOR ALL CONDITIONS OF VALVE OPERATION.

SYSTEM CONTAMINATION IS MINIMIZED DUE TO THE PRESENCE OF AN ET SCREEN, A PREVALVE SCREEN, A GSE DEBRIS PLATE, AND A GSE FILTER. CONTAMINANT PARTICLES CAN BE EMBEDDED INTO THE SOFT BERYLLIUM COPPER ALLOY POPPET TO A CERTAIN EXTENT WITHOUT LEAKAGE OR BINDING. HIGH OPERATING PRESSURE ENDURES ADEQUATE SEATING PRESSURE.

STRUCTURAL FAILURE OF EITHER POPPET OR SEAT COULD RESULT IN A FAILURE TO CHECK (SINCE DEBRIS FROM ONE POPPET/SEAT COULD PREVENT THE OTHER POPPET/SEAT FROM OPERATING). STRUCTURAL FAILURE OF THE SPRINGS WOULD HAVE LITTLE EFFECT (UNLESS SPRING DEBRIS PREVENTS THE POPPET/SEATS FROM OPERATING), SINCE REVERSE FLOW FORCES ACT TO CLOSE THE POPPETS. 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.

**(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)

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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)

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

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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:**

SEVERAL CHECK VALVES HAVE EXPERIENCED INTERNAL LEAKAGE FROM CONTAMINATION CAUSED BY EXTERNAL SOURCES SUCH AS TEST STANDS, FLIGHT SYSTEMS OR MPTA SYSTEM (CAR'S: QUALIFICATION - AB0367, AC1502; ATP - A5600; MPTA - AB6364; PALMDALE - AD2045; KSC - AD0696). METHODS HAVE BEEN DEVELOPED TO MINIMIZE PARTICLE GENERATION WHEN DEBRAZING/ REPLACING COMPONENTS AND PERSONNEL HAVE BEEN INSTRUCTED IN THESE LATEST TECHNIQUES. TEST STANDS WERE CLEANED, FLUSHED AND VERIFIED CLEAN.

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:**

NO CREW ACTION CAN BE TAKEN.

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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

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NASA SR&QA

: ERICH BASS

:/S/ ERICH BASS