

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

NUMBER: 03-1-0259 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 2 08/10/00

**PART DATA**

	<b>PART NAME</b>	<b>PART NUMBER</b>
	<b>VENDOR NAME</b>	<b>VENDOR NUMBER</b>
LRU	:SSME GHE SUPPLY INTERCONNECT "IN"	ME284-0472-0002, -0012
	CHECK VALVE	
	CIRCLE SEAL	P69-180

**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**

INTERCONNECT "IN" CHECK VALVE, 0.375 INCH DIAMETER.

**REFERENCE DESIGNATORS:** CV27  
CV38  
CV43

**QUANTITY OF LIKE ITEMS:** 3  
ONE PER ENGINE HE SUPPLY

**FUNCTION:**

THE FUNCTION OF THE CHECK VALVE (CV27,38,43) IS TO PREVENT REVERSE FLOW INTO THE PNEUMATIC SYSTEM. THE CHECK VALVES ARE LOCATED DOWNSTREAM OF THE SOLENOID VALVES (LV59,61,63) WHICH ALLOW HELIUM TRANSFER INTO A PARTICULAR ENGINE SUPPLY SYSTEM FROM EITHER THE PNEUMATIC ACTUATION SUPPLY OR ANOTHER ENGINE SUPPLY SYSTEM.

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**SUBSYSTEM NAME: MAIN PROPULSION**

**LRU: SSME GHE SUPPLY I/C "IN" CHECK VALVE**

**CRITICALITY OF THIS**

**ITEM NAME: SSME GHE SUPPLY I/C "IN" CHECK VALVE**

**FAILURE MODE: 1R2**

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**FAILURE MODE:**

FAILS TO OPEN/REMAIN OPEN

**MISSION PHASE: LO LIFT-OFF**

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

**CAUSE:**

BINDING, CONTAMINATION

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

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**REDUNDANCY SCREEN**

- A) PASS
- B) FAIL
- C) PASS

**PASS/FAIL RATIONALE:**

A)

B)

FAILS SCREEN B DUE TO LACK OF INSTRUMENTATION.

C)

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**- FAILURE EFFECTS -**

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**(A) SUBSYSTEM:**

LOSS OF SUPPLEMENTAL HELIUM TO ONE ENGINE.

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

SAME AS A.

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**(C) MISSION:**  
NO EFFECT.

**(D) CREW, VEHICLE, AND ELEMENT(S):**  
SAME AS C.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**  
1R2 2 SUCCESS PATHS. TIME FRAME - MECO

- 1) ENGINE HELIUM SYSTEM LEAK (ASSUMES RATE SUCH THAT DEPLETION OCCURS SIMULTANEOUS WITH MECO)
- 2) INTERCONNECT "IN" CHECK VALVE FAILS TO OPEN/REMAIN OPEN.

FAILS TO MAINTAIN INJECTED HELIUM AND LO2 PRESSURE TO THE HIGH PRESSURE OXYGEN TURBOPUMP TO PREVENT PUMP OVERSPEED AND CAVITATION AT MECO. RESULTS IN UNCONTAINED ENGINE DAMAGE, AFT COMPARTMENT OVERPRESSURIZATION, AND FIRE/EXPLOSION HAZARD. POSSIBLE LOSS OF CREW/VEHICLE.

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**-DISPOSITION RATIONALE-**

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**(A) DESIGN:**  
THE CHECK VALVE IS A POPPET TYPE, SPRING LOADED AND PRESSURE ASSISTED TO THE CLOSED POSITION. THE POPPET AND SPRING ARE CONTAINED IN A THREADED HOUSING AND END CAP. THE POPPET SEAL IS A SELF-CENTERING TEFLON O-RING. THE VALVE BODY PROVIDES A GUIDE FOR THE POPPET TRAVEL. THE VALVE BODY IS DESIGNED TO A FACTOR OF SAFETY OF 2.0 PROOF AND 4.0 BURST.

FAILURE OF THE CHECK VALVE TO OPEN WOULD REQUIRE BINDING BETWEEN THE POPPET GUIDE AND THE POPPET. THE MOVING PARTS HAVE LITTLE TENDENCY TO GALL DUE TO THE LIGHT SIDE LOADS RESULTING FROM THE SYMMETRICAL GEOMETRY. THE USE OF 316 CRES FOR THE POPPET AGAINST INCONEL 718 FOR THE END PIECE ALSO REDUCES THE GALLING TENDENCY.

CONTAMINATION IS MINIMIZED BY THE USE OF MULTI-FILTERED HELIUM. GROUND SUPPLIED HELIUM (EITHER THROUGH THE T-0 UMBILICAL OR THE TEST POINT COUPLINGS) IS FILTERED TO 25 MICRONS ABSOLUTE. VEHICLE FILTERS (25 MICRONS ABSOLUTE) ARE LOCATED UPSTREAM OF THE REGULATOR INLET.

**(B) TEST:**  
ATP

EXAMINATION OF PRODUCT  
AMBIENT TEMPERATURE TESTS  
BODY PROOF PRESSURE (9090 PSIG)

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CLOSURE DEVICE PROOF PRESSURE (9090 PSIG)  
EXTERNAL LEAKAGE (4500 PSIG)  
INTERNAL LEAKAGE (5, 50, 300, 4500 PSIG)

LOW TEMPERATURE TESTS (-160 DEG F)  
CRACKING AND RESEAT PRESSURE: 3 CYCLES  
CRACKING PRESSURE 5 PSID MAX  
RESEAT PRESSURE 2 PSID MIN  
INTERNAL LEAKAGE (5, 50, 300, 4500 PSIG)

CERTIFICATION

FLOW TEST (0.05 LB/SEC HE)  
MAX INLET PRESSURE 4200 PSIG  
PRESSURE DROP (10 PSID MAX)

CHATTER TEST (4200 TO 0 PSIG)  
RECORD FLOW RATE WHEN CHATTER OCCURS

CRACKING AND RESEAT PRESSURE  
AMBIENT AND LOW TEMPERATURE (-160 DEG F): 3 CYCLES EACH  
CRACKING PRESSURE 5 PSID MAX  
RESEAT PRESSURE 2 PSID MIN

INTERNAL LEAKAGE  
AMBIENT (0 TO 4500 PSIG)  
LOW TEMPERATURE (-160 DEG F, 0 TO 4500 PSIG)

LIFE CYCLE TEST

ONE CYCLE CONSISTS OF INLET PRESSURE OF 4200 PSIG FOLLOWED BY CHECKING  
PRESSURE OF 4500 PSIG

AMBIENT  
4000 CYCLES FOLLOWED BY CRACKING, RESEATING, AND LEAKAGE TESTS

LOW TEMPERATURE (-160 DEG F)  
1000 CYCLES FOLLOWED BY CRACKING, RESEATING, INTERNAL LEAKAGE, FLOW,  
PRESSURE DROP, AND EXTERNAL LEAK TESTS

EXTERNAL LEAKAGE TEST (1 SCCH MAXIMUM AT 4500 PSIG)

VIBRATION AND SHOCK (AMBIENT TEMPERATURE AND PRESSURE)  
BY SIMILARITY TO VALVE TYPES III, IVR, AND V (RI DASH NUMBERS -0003, - 0005, AND -0014  
RESPECTIVELY). THESE UNITS WERE TESTED IN EACH OF TWO AXIS 48 MINUTES FOR  
RANDOM VIBRATIONS AND SUBJECTED TO A SWEEP CYCLE TO COVER SHOCK  
REQUIREMENTS.

BURST PRESSURE (18,000 PSIG)

GROUND TURNAROUND TEST

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ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

**(C) INSPECTION:**

RECEIVING INSPECTION

ALL RAW MATERIALS ARE VERIFIED FOR MATERIAL AND PROCESS CERTIFICATION. RECEIVING INSPECTION VERIFIES CERTIFICATION OF SPRING HEAT TREATMENT AND PERFORMS LOAD TEST OF SPRINGS.

CONTAMINATION CONTROL

ALL PARTS AND ASSEMBLIES ARE MAINTAINED TO CLEANLINESS LEVEL OF 100A.

ASSEMBLY/INSTALLATION

DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION. REQUIRED TORQUES ARE VERIFIED PRIOR TO WELDING. INSPECTION POINTS ARE ESTABLISHED TO VERIFY ASSEMBLY PROCESS. WELDS ARE VISUALLY VERIFIED BY 10X MAGNIFICATION.

CRITICAL PROCESSES

ALL WELDING, ELECTROPOLISHING AND PARTS PASSIVATION ARE VERIFIED BY INSPECTION. DRY FILM LUBRICANT COATED THREADS ARE VERIFIED PER DRAWING REQUIREMENT.

NONDESTRUCTIVE EVALUATION

HELIUM LEAKAGE DETECTION IS PERFORMED.

TESTING

ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PACKAGING FOR SHIPMENT IS VERIFIED BY INSPECTION.

**(D) FAILURE HISTORY:**

GENERAL MPS SYSTEM CONTAMINATION HAS OCCURRED WHICH MAY LODGE ANYWHERE IN THE SYSTEM CAUSING THIS FAILURE MODE (REFERENCE THE FOLLOWING PARAGRAPHS).

CONTAMINATION FAILURES HAVE OCCURRED AT ALL PHASES OF MANUFACTURING AND PARTS REPLACEMENT. IN ALL CASES, STRICT ADHERENCE TO CLEANLINESS CONTROL PROCEDURES IS THE PRIMARY METHOD OF CONTAMINATION PREVENTION.

NUMEROUS LARGE PARTICLES OF BLACK RUBBER MATERIAL WERE FOUND DURING A POST FLIGHT EXAMINATION OF THE LH2 17 INCH DISCONNECT OF OV099 (FLIGHT 7, REFERENCE CAR AC9800). THE LO2 AND LH2 SYSTEMS OF ALL VEHICLES WERE EXAMINED. NO RUBBER WAS FOUND IN ANY OTHER VEHICLES. AFTER EXTENSIVE INVESTIGATION THE ORIGIN WAS NOT DETERMINED.

METAL SHAVINGS HAVE BEEN DISCOVERED IN LINES AND COMPONENTS, WHICH WAS MOST LIKELY GENERATED WHEN THEY WERE CUT OUT AND/OR REPLACED (REFERENCE CARS AC9868, A9654, AC2210, AB1706; DR AD2226). METHODS HAVE BEEN REVISED TO MINIMIZE PARTICLE GENERATION WHEN INSTALLING/REPLACING COMPONENTS, LINES, AND

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FITTINGS REQUIRING WELDED OR BRAZED JOINTS (PRODUCT QUALITY IMPROVEMENT COUNCIL). PERSONNEL HAVE BEEN CAUTIONED. ROCKWELL PROBLEM ACTION CENTER WILL CONTINUE TO MONITOR BRAZING/WELDING REWORK CONTAMINATION. PROCEDURES ARE BEING REVISED TO IMPROVE CLEANLINESS MAINTENANCE DURING COMPONENT BUILD UP AND REWORK (REFERENCE MCR 12512). SUPPLIER DOCUMENTS/PROCEDURES HAVE BEEN REVIEWED AND CLEANLINESS MAINTENANCE PROCEDURES HAVE BEEN IMPROVED.

A PIECE OF A BRAZING PREFORM LODGED IN A 2-WAY SOLENOID VALVE ON OV- 099 AT PALMDALE CAUSING A LEAKAGE FAILURE (REFERENCE CARS AC2111, AB2538). STEEL AND ALUMINUM PARTICLES CAUSED EXCESSIVE LEAKAGE ON THE 850 PSIG HELIUM RELIEF VALVE (REF CAR AC2229). FOR BOTH FAILURES CORRECTIVE ACTION WAS TO ADD SPECIAL PURGE PORTS TO THE MPS HELIUM PANEL ASSEMBLIES TO IMPROVE THE QUALITY OF FINAL CLOSEOUT BRAZES.

SEVERAL FOREIGN MATERIALS WERE INTRODUCED INTO THE MPS SYSTEM DURING MANUFACTURE AND PARTS REPLACEMENT. EXAMPLES ARE: GLASS CLOTH IN LINE TO PREVENT TRAVEL OF CHIPS DOWN LINE; POLYSTYRENE OBJECT TO HOLD VALVE

POPPET OPEN WHILE PURGING; COTTON SWAB MATERIAL AND GLASS BEADS FROM CLEANING OPERATION; MISCELLANEOUS PLASTIC; FOAM; AND TAPE (REFERENCE CARS AB4751, AC2217, AC6768, AC9868, MPS3A0005, AC7912, AB0530). MATERIALS WERE REMOVED AND PERSONNEL WERE CAUTIONED. A HIGH FLOW DELTA P TEST AT PALMDALE WAS ADDED TO VERIFY THAT LINES WERE NOT PLUGGED. GRIT BLASTING (GLASS BEADS AND SAND USED TO CLEAN A LINE) IS NO LONGER PERFORMED. PROCEDURES HAVE BEEN REVISED TO IMPROVE CLEANLINESS MAINTENANCE DURING COMPONENT BUILD UP AND REWORK (REFERENCE MCR 12512). SUPPLIER DOCUMENTS/PROCEDURES HAVE BEEN REVIEWED AND CLEANLINESS MAINTENANCE PROCEDURES HAVE BEEN IMPROVED.

ONE PIECE OF WIRE WAS FOUND IN THE INTERNAL RELIEF VALVE OF THE LO2 PREVALVE ON OV103 (REFERENCE CAR AC9101). THE SOURCE OF THE CONTAMINATION WAS NEVER FOUND, BUT IT WAS BELIEVED TO BE FROM THE ET. OTHER CONTAMINATION HAS BEEN FOUND ON THE FEEDLINE SCREENS, SUCH AS AN UNIDENTIFIED ROUND OBJECT AND VARIOUS METALLIC PARTICLES (REFERENCE CARS AB0529 AND AB0530). SOURCE OF CONTAMINATION WAS UNDETERMINED. BORESCOPE EXAMINATIONS ARE CONDUCTED ON ALL FEEDLINE SCREENS EVERY FIFTH FLIGHT TO VERIFY CLEANLINESS. CONTAMINATION WAS REMOVED WHEN POSSIBLE.

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	: 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