

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

NUMBER: 03-1-0632 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 1 08/10/00

**PART DATA**

	<b>PART NAME</b>	<b>PART NUMBER</b>
	<b>VENDOR NAME</b>	<b>VENDOR NUMBER</b>
LRU	:LH2 RECIRCULATION MANIFOLD GHE REPRESSURIZATION ISOLATION CHECK VALVE	ME284-0472-0011
	CIRCLE SEAL	P196-180

**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**

VALVE, CHECK HELIUM REPRESSURIZATION SYSTEM ISOLATION

REFERENCE DESIGNATORS: CV14

QUANTITY OF LIKE ITEMS: 1

**FUNCTION:**

PREVENTS LH2 IN THE RECIRCULATION SYSTEM FROM ENTERING THE GHE REPRESS SYSTEM AND THE LH2 MANIFOLD VIA THE HELIUM PURGE LINES.

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**SUBSYSTEM NAME: MAIN PROPULSION**

**LRU: LH2 RECIRC MANIF GHE REPRESS ISO CK VLV**

**CRITICALITY OF THIS**

**ITEM NAME: LH2 RECIRC MANIF GHE REPRESS ISO CK VLV**

**FAILURE MODE: 1R2**

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**FAILURE MODE:**

FAILS TO REMAIN CLOSED/CHECK/INTERNAL LEAKAGE

**MISSION PHASE:**

PL PRE-LAUNCH  
LO LIFT-OFF

**VEHICLE/PAYLOAD/KIT EFFECTIVITY:**

102 COLUMBIA  
103 DISCOVERY  
104 ATLANTIS  
105 ENDEAVOUR

**CAUSE:**

PIECE PART STRUCTURAL FAILURE, CONTAMINATION, BINDING

**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:**

LH2 ENTERS THE MANIFOLD REPRESS LINE.

**(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:**  
1R/2 2 SUCCESS PATHS. TIME FRAME: PRIOR TO MPS DUMP.  
1) CHECK VALVE (CV14) FAILS TO CHECK.  
2) LH2 MANIFOLD REPRESS LINE RUPTURES.

RESULTS IN LH2 LEAKAGE INTO THE AFT COMPARTMENT FROM MANIFOLD REPRESS LINE. POSSIBLE AFT COMPT OVERPRESS AND FIRE/EXPLOSION HAZARD. POSSIBLE LOSS OF CRITICAL ADJACENT COMPONENTS DUE TO CRYO EXPOSURE. 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 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 REMAIN CLOSED WOULD REQUIRE STRUCTURAL FAILURE OF THE POPPET AND POPPET SPRING. THE REVERSE PRESSURE, HOWEVER, WILL RESIST ANY TENDENCY FOR THE POPPET TO UNSEAT.

FAILURE OF THE VALVE TO CHECK/INTERNAL LEAKAGE WOULD REQUIRE PIECE PART STRUCTURAL FAILURE OF THE POPPET AND/OR THE TEFLON O-RING. THE POPPET IS MADE OF 316 CRES AND HAS A DESIGN FACTOR OF SAFETY OF 2.0 PROOF AND 4.0 BURST. IF THE TEFLON O-RING DISINTEGRATES, PIECES MAY PREVENT POPPET FROM CHECKING. THE MOVING PARTS HAVE LITTLE TENDENCY TO GALL DUE TO THE LIGHT SIDE LOADS RESULTING FROM THE SYMMETRICAL GEOMETRY. THE USE OF CRES 316 FOR THE POPPET AGAINST INCONEL 718 FOR THE END PIECE ALSO REDUCES THE GALLING TENDENCY.

INTERNAL LEAKAGE MAY BE CAUSED BY CONTAMINATION ON THE SEAL/SEAT INTERFACE AND IN THE GUIDED SECTION OF THE POPPET. THERE IS A 25 MICRON ABSOLUTE FILTER UPSTREAM OF THE CHECK VALVE TO CONTROL CONTAMINATION.

**(B) TEST:**  
ATP

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EXAMINATION OF PRODUCT

AMBIENT TEMPERATURE TESTS:

BODY PROOF PRESSURE (1313 PSIG)  
CLOSURE DEVICE PROOF PRESSURE (1313 PSIG)  
EXTERNAL LEAKAGE (650 PSIG)  
INTERNAL LEAKAGE (5, 25, 100, 650 PSIG)

CRYOGENIC TESTS (-300 DEG F):

CRACKING AND RESEAT PRESSURE: 3 CYCLES  
CRACKING PRESSURE 5 PSID MAX  
RESEAT PRESSURE 2 PSID MIN  
INTERNAL LEAKAGE (5, 25, 100, 650 PSIG)

CERTIFICATION

FLOW (0.005 LB/SEC HELIUM, MIN)

MAXIMUM INLET PRESSURE OF 100 PSIG  
PRESSURE DROP (11 PSID MAX)

CHATTER TEST (650 TO 0 PSIG)

RECORD FLOW RATE WHEN CHATTER OCCURS

CRACKING AND RESEAT PRESSURE (CRYO: -300 DEG F): 3 CYCLES

CRACKING PRESSURE 5 PSID MAX  
RESEAT PRESSURE 2 PSID MIN

INTERNAL LEAKAGE

AMBIENT (0 TO 650 PSIG)  
CRYO (-300 DEG F, 0 TO 650 PSIG)

LIFE CYCLE TEST

ONE CYCLE CONSISTS OF INLET PRESSURE OF 100 PSIG FOLLOWED BY  
CHECKING PRESSURE OF 650 PSIG

AMBIENT

7000 CYCLES FOLLOWED BY CRACKING, RESEATING, AND LEAKAGE  
TESTS

CRYO (-300 DEG F)

3000 CYCLES FOLLOWED BY CRACKING, RESEATING, INTERNAL  
LEAKAGE, FLOW, PRESSURE DROP, AND EXTERNAL LEAK TESTS

VIBRATION (-300 DEG F, 2 AXES)

QUALIFIED BY SIMILARITY TO TYPE III CHECK VALVE. TYPE III VALVES ARE  
CERTIFIED BY THE FOLLOWING TESTS:

TRANSIENT

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5 TO 35 HZ AT +/- 0.25 GS PEAK

RANDOM  
48 MINUTES FOR EACH OF 2 AXES

UPON COMPLETION OF VIBRATION TESTS PERFORM CRACK, RESEAT, AND  
INTERNAL LEAKAGE TEST.

EXTERNAL LEAKAGE TEST (650 PSIG)

BURST PRESSURE (2600 PSIG)

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.  
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:**

SEVERAL INTERNAL LEAKAGES HAVE OCCURRED BECAUSE OF SELF-GENERATED  
METALLIC PARTICLES DUE TO POPPET OSCILLATION/CHATTER. CAUSE WAS INSUFFICIENT  
FLOW DURING PNEUMATIC PANEL GAS PURGE CLEANLINESS VERIFICATION. CORRECTIVE  
ACTION WAS TO REVISE THE CHECKOUT PROCEDURE BY INCREASING THE FLOW RATES

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AND USING A STEP INPUT FLOW RATE TO PRECLUDE VALVE CHATTER (REFERENCE CARS AC0538 AND AC3559 AT DOWNEY AND AC7147 AT KSC).

SEVERAL INTERNAL LEAKAGES HAVE OCCURRED DUE TO CONTAMINATION FROM EXTERNAL SOURCES SUCH AS TEST EQUIPMENT, BRAZING PARTICLES, PREFORMS, A TEFLON WASHER FROM SOME GSE AND METALLIC CHIPS FROM COMPONENT REPLACEMENT. (REFERENCE CAR'S AC0725, AB0561, AB0576, AB1326, AB0371 AT THE SUPPLIER; AB1451, AB4910, AB1452 AT NSTL; AC4347 AT DOWNEY; AD2169, AC2172, AC2864 AT PALMDALE; AC8572, AC9108, AC9781, AD3880, AD0495, AC1154 AT KSC.) METHODS HAVE BEEN IMPROVED TO MINIMIZE PARTICLE GENERATION WHEN DEBRAZING/REPLACING COMPONENTS. PERSONNEL HAVE BEEN INSTRUCTED IN THE LATEST TECHNIQUES TO MINIMIZE GENERATION OF CONTAMINANTS.

DURING PNEUMATIC PANEL TESTING AT DOWNEY, A CHECK VALVE WAS FOUND TO HAVE AN ALUMINUM SPRING GUIDE INSTALLED INSTEAD OF CRES (REFERENCE CAR AC1355). ALL CHECK VALVES WERE X-RAYED AND NO OTHER DISCREPANT PARTS WERE FOUND ON ANY VEHICLES OR IN STOCK. MANUFACTURING PLANNING DOCUMENTS HAVE BEEN REVISED TO INSURE INSTALLATION OF CORRECT DETAIL PARTS.

**GENERAL SYSTEM CONTAMINATION**

THIS FAILURE MODE HAS OCCURRED ON THIS COMPONENT DUE TO CONTAMINATION. ADDITIONALLY, 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 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 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.

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

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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