

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 03-1-0502 -X

SUBSYSTEM NAME: MAIN PROPULSION**REVISION:** 1 08/10/00**PART DATA**

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	:GH2/GO2 PRE-PRESSURIZATION CHECK VALVE	ME284-0472-0005
	CIRCLE SEAL	P85-180

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

VALVE, CHECK, HELIUM PRESSURIZATION, GH2/GO2 (1.0 INCH DIA)

REFERENCE DESIGNATORS: CV16
CV17**QUANTITY OF LIKE ITEMS:** 2
ONE GH2, ONE GO2**FUNCTION:**

ACTS AS SERIES REDUNDANT CLOSURE DEVICE WITH THE PREPRESSURIZATION DISCONNECT (PD9, 10) TO PREVENT THE LOSS OF PRESSURANT OVERBOARD.

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE

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SUBSYSTEM NAME: MAIN PROPULSION

LRU: GH2/GO2 PRE-PRESS CHECK VALVE (CV17 & 16)

CRITICALITY OF THIS

ITEM NAME: GH2/GO2 PRE-PRESS CHECK VALVE (CV17 & 16)

FAILURE MODE: 1R2

FAILURE MODE:

FAILS TO CLOSE/FAILS TO REMAIN CLOSED/INTERNAL LEAKAGE UPON T-0 UMBILICAL SEPARATION.

MISSION PHASE: LO LIFT-OFF

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

CAUSE:

FAILS TO CLOSE/LEAKAGE - BINDING, CONTAMINATION, PIECE PART STRUCTURAL FAILURE

FAILS TO REMAIN CLOSED - 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)

CHECK VALVE IS STANDBY REDUNDANT TO PRE-PRESSURIZATION DISCONNECT LEAKAGE. FAILURE IS NOT DETECTABLE BECAUSE THERE IS NO INSTRUMENTATION BETWEEN CHECK VALVE AND DISCONNECT. IN ADDITION, THE CHECK VALVE HAS NO POSITION INDICATION INSTRUMENTATION.

C)

FAILS C SCREEN BECAUSE CONTAMINATION COULD CAUSE CHECK VALVE AND DISCONNECT TO FAIL OPEN.

- FAILURE EFFECTS -

(A) SUBSYSTEM:

NO EFFECT. SERIES REDUNDANT T-0 PREPRESSURIZATION DISCONNECT (PD10/PD9) WILL PREVENT OVERBOARD LEAKAGE.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0502-02**

(B) INTERFACING SUBSYSTEM(S):

SAME AS A.

(C) MISSION:

NO EFFECT.

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

SAME AS C.

(E) FUNCTIONAL CRITICALITY EFFECTS:

CASE 1:

1R/2 2 SUCCESS PATHS. TIME FRAME - ASCENT.

- 1) PRE PRESSURIZATION CHECK VALVE (CV17/CV16) FAILS TO CLOSE/REMAIN CLOSED/INTERNAL LEAKAGE.
- 2) GH2/GO2 PRE PRESSURIZATION DISCONNECT (PD10/PD9) FAILS TO CLOSE/REMAIN CLOSED/INTERNAL LEAKAGE.

GH2/GO2 WILL VENT OVERBOARD. THE GH2 FLOW CONTROL VALVES WILL CYCLE TO THE HIGH FLOW POSITION IN AN ATTEMPT TO MAINTAIN ET ULLAGE PRESSURE. LOSS OF ET LH2/LO2 ULLAGE PRESSURE MAY RESULT IN VIOLATION OF TANK MINIMUM STRUCTURAL CAPABILITY REQUIREMENTS.

ON THE H2 SYSTEM, LOW NPSP MAY RESULT IN UNCONTAINED SSME SHUTDOWN.

MASS OF LO2 AND VEHICLE ACCELERATION SHOULD BE SUFFICIENT TO MAINTAIN PROPER ENGINE NPSP, MAY RESULT IN LOW NPSP LATE IN POWERED FLIGHT.

GH2/GO2 LEAKAGE OVERBOARD COULD CAUSE FIRE AND EXPLOSIVE HAZARD EXTERNAL TO THE VEHICLE DURING ASCENT.

POSSIBLE LOSS OF CREW/VEHICLE.

CASE 2:

1R/2 2 SUCCESS PATHS. TIME FRAME - ASCENT.

- 1) PREPRESSURIZATION CHECK VALVE (CV17/CV16) FAILS TO CLOSE/REMAIN CLOSED/INTERNAL LEAKAGE.
- 2) RUPTURE/LEAKAGE OF THE T-0 PREPRESSURIZATION DISCONNECT (PD10/PD9) OR LINE CONNECTING T-0 DISCONNECT TO CHECK VALVE.

GH2/GO2 WILL VENT OVERBOARD. THE GH2 FLOW CONTROL VALVES WILL CYCLE TO THE HIGH FLOW POSITION IN AN ATTEMPT TO MAINTAIN ET ULLAGE PRESSURE. LOSS OF ET LH2/LO2 ULLAGE PRESSURE MAY RESULT IN VIOLATION OF TANK MINIMUM STRUCTURAL CAPABILITY REQUIREMENTS.

ON THE H2 SYSTEM, LOW NPSP MAY RESULT IN UNCONTAINED SSME SHUTDOWN.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0502-02**

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GH2/GO2 LEAKAGE OVERBOARD COULD CAUSE FIRE AND EXPLOSIVE HAZARD EXTERNAL TO THE VEHICLE DURING ASCENT.

POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(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 END CAP PROVIDES A GUIDE FOR THE POPPET TRAVEL. THE VALVE BODY AND END CAP ARE 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 21-6-9 CRES 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. FAILURE TO CLOSE/ INTERNAL LEAKAGE DUE TO CONTAMINATION IS AVOIDED BY THE FILTRATION OF THE FACILITY SUPPLIED GASSES TO 25 MICRONS ABSOLUTE IN THE GROUND SYSTEM.

(B) TEST:

ATP

EXAMINATION OF PRODUCT

AMBIENT TEMPERATURE TESTS:

- BODY PROOF PRESSURE (1515 PSIG)
- CLOSURE DEVICE PROOF PRESSURE (1515 PSIG)
- EXTERNAL LEAKAGE (750 PSIG)
- INTERNAL LEAKAGE (5, 25, 100, 750 PSIG)

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0502-02**

LOW TEMPERATURE TESTS (-100 DEG F)
CRACKING PRESSURE(5 PSID MAX)
RESEATING PRESSURE (2 PSID MIN)
INTERNAL LEAKAGE (5, 25, 100, 750 PSIG)

CERTIFICATION

FLOW (1.5 LB/SEC HELIUM)
MAX INLET PRESSURE 425 PSIA
PRESSURE DROP (167 PSID MAX)

CHATTER TEST (750 TO 0 PSIG)
RECORD FLOW RATE WHEN CHATTER OCCURS

CRACKING AND RESEAT PRESSURE
LOW TEMPERATURE (-100 DEG F): 3 CYCLES EACH
CRACKING PRESSURE 5 PSID MAX
RESEAT PRESSURE 2 PSID MIN

INTERNAL LEAKAGE
AMBIENT (0 TO 650 PSIG)
LOW TEMPERATURE (-100 DEG F, 0 TO 650 PSIG)

LIFE CYCLE TEST

58,400 CYCLES (AMBIENT)

ONE CYCLE CONSISTS OF PRESSURIZING (WITH GN2) THE INLET TO 72 PSIG,
VENTING THE INLET TO AMBIENT, PRESSURIZING THE OUTLET TO 57 PSIG, AND
VENTING THE OUTLET TO AMBIENT.

FOLLOWED BY CRACKING, RESEATING, AND INTERNAL LEAKAGE TESTS

1600 CYCLES (AMBIENT)

ONE CYCLE CONSISTS OF PRESSURIZING (WITH GN2) THE INLET TO 425 PSIA,
VENTING THE INLET TO AMBIENT, PRESSURIZING THE OUTLET TO 650 PSIG, AND
VENTING THE OUTLET TO AMBIENT.

FOLLOWED BY CRACKING, RESEATING, AND INTERNAL LEAKAGE TESTS

EXTERNAL LEAKAGE TEST (750 PSIG)

VIBRATION (AMBIENT, 2 AXES)

TRANSIENT
5 TO 35 HZ AT +/- 0.25 GS PEAK

RANDOM
13.3 HOURS FOR EACH OF 2 AXES

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0502-02**

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

BURST PRESSURE (3000 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.

CONTAMINATION CONTROL

ALL PARTS ARE MAINTAINED TO CLEANLINESS LEVEL OF 100A. INLET AND OUTLET ARE PROTECTED AFTER TESTS TO MAINTAIN INTERNAL CLEANLINESS.

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 WELDS ARE INSPECTED PER DRAWING SPECIFICATIONS. ELECTROPOLISHING IS PERFORMED PER DRAWING SPECIFICATIONS. TEFLON SPRAY LUBRICANT IS APPLIED TO THREADS PER SPECIFICATIONS. HEAT TREATMENT AND PARTS PASSIVATION 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 PNEUMATIC PANEL TESTING AT DOWNEY, A CHECK VALVE WAS FOUND TO HAVE AN ALUMINUM SPRING GUIDE INSTALLED. IT WAS DETERMINED THAT THE MANUFACTURER HAD INSTALLED AN ALUMINUM PART 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.

DURING TESTING AT KSC, A CHECK VALVE FAILED OPEN. FAILURE WAS DUE TO GALLING OF THE POPPET AND END PIECE. THE FAILURE WAS ATTRIBUTED TO INSUFFICIENT FLOW CAUSING POPPET MODULATION AND PARTICLE GENERATION (REFERENCE CAR AD3509).

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0502-02**

ANOTHER UNIT FAILED OPEN AT KSC DURING VEHICLE CHECKOUT. THE POPPET WAS DRIVEN INTO THE SPRING GUIDE AND REMAINED IN THE OPEN POSITION.

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. THE PROBLEM WAS CORRECTED BY INCREASING THE FLOW RATES AND USING A STEP INPUT FLOW RATE TO OPEN AND CLOSE THE VALVE (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, AD4079 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.

GENERAL SYSTEM CONTAMINATION

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 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

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
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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.

- 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