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PRINT DATE: 11/10/88

SHUTTLE CRITICAL ITEMS LIST - ORBITER NUMBER: 03-1CB-0629-X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION : 11/10/88

CLASSIFICATION	NAME	PART NUMBER
LRU :	REGULATOR, PURGE	MC284-0399-0004

REFERENCE DESIGNATORS: PR6

QUANTITY OF LIKE ITEMS: 1
ONE

DESCRIPTION/FUNCTION:

LH2 HELIUM MANIFOLD REPRESSURIZATION REGULATOR, 20 PSIG (0.5 INCH DIAMETER INLET, 0.75 INCH DIAMETER OUTLET, 0.25 INCH DIAMETER SENSE PORT). VENDOR P/N: 76500-0004.

REGULATES THE HELIUM SUPPLY PRESSURE FROM 750 PSI DOWN TO 20 PSI TO PURGE THE MPS FOLLOWING ENGINE SHUTDOWN AND TO PROVIDE SYSTEM REPRESSURIZATION DURING REENTRY. SENSES LH2 MANIFOLD PRESSURE TO CONTROL PURGE FLOW. REGULATOR OPENS AT MANIFOLD PRESSURES BELOW 17 PSI AND CLOSSES AT PRESSURES ABOVE 10 PSI.

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SUBSYSTEM: MAIN PROPULSION
LRU :REGULATOR, PURGE
ITEM NAME: REGULATOR, PURGE

CRITICALITY OF THIS
FAILURE MODE:1 1

FAILURE MODE:
RUPTURE/LEAKAGE.

MISSION PHASE:

PL PRELAUNCH
LO LIFT-OFF
EO DE-ORBIT

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

CAUSE:
FATIGUE, MATERIAL DEFECTS, DAMAGED/DEFECTIVE SEALS.

CRITICALITY 1/1 DURING ANY MISSION PHASE OR ABORT?

REDUNDANCY SCREEN A) N/A

B) N/A

C) N/A

A)

B)

C)

- FAILURE EFFECTS -

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(A) SUBSYSTEM:

DURING PRELAUNCH AND ASCENT, RUPTURE OF THE SENSE PORTION OF THE REGULATOR RESULTS IN LH2 FROM THE MANIFOLD (VIA THE REGULATOR SENSE LINE) LEAKING INTO THE AFT FUSELAGE. POSSIBLE LOSS OF CRITICAL FUNCTIONS DUE TO COMPONENT EXPOSURE TO CRYOGENICS. POSSIBLE AFT FUSELAGE FIRE/EXPLOSION HAZARD.

LEAKAGE DETECTABLE ON GROUND PRIOR TO T-38 SECONDS USING HAZARDOUS GAS DETECTION SYSTEM (HGDS).

DURING ENTRY, VENT DOORS ARE CLOSED TO PREVENT INGESTION OF RCS AND APU GASES. RUPTURE OF THE REGULATOR DURING THE TIME PERIOD THAT THE VENT DOORS ARE CLOSED AND MANIFOLD REPRESSURIZATION VALVES (LV42,43) HAVE BEEN COMMANDED OPEN MAY RESULT IN OVERPRESSURIZATION OF THE AFT COMPARTMENT. VENT DOORS ARE OPENED WHEN VEHICLE VELOCITY DROPS BELOW 2400 FT/SEC.

(B) INTERFACING SUBSYSTEM(S):

SAME AS A.

(C) MISSION:

POSSIBLE LAUNCH SCRUB DUE TO LCC VIOLATION.

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

POSSIBLE LOSS OF CREW/VEHICLE.

RATIONALE FOR CRITICALITY:

FUNCTIONAL CRITICALITY EFFECTS:

CASE I: 1R/2, 2 SUCCESS PATHS. TIME FRAME - PRELAUNCH, ASCENT.

- 1) REGULATOR RUPTURES.
- 2) CHECK VALVE (CV15) FAILS TO CHECK/LEAKS INTERNALLY
OR CHECK VALVE (CV14) FAILS TO CHECK/LEAKS INTERNALLY

LH2 FROM THE FEEDLINE MANIFOLD (THROUGH CV15) OR FROM THE RECIRCULATION LINE (THROUGH CV14) WILL ENTER THE AFT COMPARTMENT. POSSIBLE LOSS OF CRITICAL FUNCTIONS DUE TO COMPONENT EXPOSURE TO CRYOGENICS. POSSIBLE FIRE/EXPLOSION HAZARD.

LEAKAGE DETECTABLE ON GROUND PRIOR TO T-38 SECONDS USING HAZARDOUS GAS DETECTION SYSTEM (HGDS).

POSSIBLE LAUNCH SCRUB DUE TO LCC VIOLATION.

POSSIBLE LOSS OF CREW/VEHICLE.

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CASE II: 1R/3, 3 SUCCESS PATHS. TIME FRAME - ASCENT

- 1) REGULATOR RUPTURES
- 2,3) LV42 AND LV43 FAIL TO REMAIN CLOSED

POSSIBLE OVERPRESSURIZATION OF THE AFT COMPARTMENT. RESULTS IN LOSS OF HELIUM FROM THE PNEUMATIC HELIUM SUPPLY.

PRIOR TO T-9 MINUTES, EXCESSIVE HELIUM LEAKAGE WILL BE DETECTABLE USING HAZARDOUS GAS DETECTION SYSTEM (HGDS). AFTER LIFTOFF, EXCESSIVE HELIUM TANK AND/OR REGULATOR PRESSURE DECAY WILL NOT BE INDICATED BY SM ALERT OR CAUTION AND WARNING.

POSSIBLE LAUNCH SCRUB DUE TO LCC VIOLATION.

POSSIBLE LOSS OF CREW/VEHICLE.

CASE III: 1R/3, 3 SUCCESS PATHS. TIME FRAME - ASCENT

- 1) REGULATOR RUPTURES
- 2) CHECK VALVE (CV13) FAILS TO CHECK/INTERNAL LEAKAGE
- 3) CHECK VALVE (CV24) FAILS TO CHECK/INTERNAL LEAKAGE

RESULTS IN GH2 LEAKAGE INTO THE AFT COMPARTMENT. POSSIBLE OVERPRESSURIZATION, POSSIBLE FIRE/EXPLOSION HAZARD.

PRIOR TO T-9 MINUTES, EXCESSIVE HELIUM LEAKAGE WILL BE DETECTABLE USING HAZARDOUS GAS DETECTION SYSTEM (HGDS).

POSSIBLE LAUNCH SCRUB DUE TO LCC VIOLATION.

POSSIBLE LOSS OF CREW/VEHICLE.

 - DISPOSITION RATIONALE -

(A) DESIGN:

THE 20 PSI HELIUM REGULATOR IS A PILOT OPERATED PRESSURE CONTROL VALVE THAT REGULATES 750 PSI HELIUM TO 17-30 PSIG IN THE O2 AND H2 PROPELLANT FEED MANIFOLDS.

WHEN THE MANIFOLD PRESSURE FALLS BELOW 17 PSIG THE SENSOR DIAPHRAGM COLLAPSES, PUSHING THE PILOT VALVE OPEN. THIS ACTION RELIEVES PRESSURE ON THE CLOSING SIDE OF THE MAIN POPPET AND ALLOWS INLET PRESSURE TO OPEN THE MAIN POPPET. WHEN THE SENSE PRESSURE REACHES 17-30 PSIG, THE DIAPHRAGM EXPANDS CLOSING THE PILOT POPPET. THIS ALLOWS INLET PRESSURE TO THE CLOSING SIDE OF THE POPPET CLOSING THE MAIN POPPET. THE REGULATOR ALSO CONTAINS AN INTERNAL RELIEF VALVE THAT RELIEVES THE OUTLET PRESSURE THROUGH THE SENSE PORT AT PRESSURES BETWEEN 100 AND 200 PSID.

THE REGULATOR HOUSING IS DESIGNED TO WITHSTAND 3400 PSIG ON THE INLET

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SIDE AND 1140 PSIG ON THE OUTLET AND SENSE PORTS WITHOUT RUPTURE. THIS YIELDS A BURST SAFETY FACTOR OF 4.0. THE HOUSING MATERIAL IS 6061-T651 ALUMINUM. THE MANIFOLD IS MANUFACTURED FROM 21-6-9 CRES. THE HOUSING/MANIFOLD INTERFACE IS SEALED TO A LEAKAGE ALLOWABLE OF 3 SCIM BY USE OF SPRING LOADED RACO SEALS. THE HOUSING ASSEMBLY IS DESIGNED AGAINST FATIGUE FAILURES WITH THE SUPPLIER PERFORMING A 100 MISSION LIFE CYCLE PRESSURE TEST (1552 TOTAL CYCLES) DURING CERTIFICATION.

(B) TEST:
ATP

AMBIENT TEMPERATURE TESTS

PROOF PRESSURE (1700 PSIG INLET, 570 PSIG OUTLET AND SENSE)

INTERNAL LEAKAGE

INLET TO OUTLET (850 AND 500 PSIG INLET, 30 PSIG SENSE)
INLET TO SENSE (850 AND 500 PSIG INLET)
SENSE TO INLET (180 PSIG SENSE)

EXTERNAL LEAKAGE (850 PSIG INLET, 285 PSIG OUTLET AND SENSE)

FUNCTIONAL

REGULATION (500 TO 850 PSIG INLET PRESSURE AND 17 TO 30 PSIG SENSE PRESSURE)

TRANSIENT RESPONSE (SLAM START WITH 500 AND 850 PSIG INLET AND 17 TO 30 PSIG SENSE)

ELECTRICAL BONDING

LOW TEMPERATURE TESTS (-140 DEG F MAX FLUID TEMPERATURE AND BODY TEMPERATURE -100 DEG F MAX)

INTERNAL LEAKAGE

INLET TO OUTLET (850 AND 500 PSIG INLET, 30 PSIG SENSE)
INLET TO SENSE (850 AND 500 PSIG INLET)
SENSE TO INLET (180 PSIG SENSE)

FUNCTIONAL TEST

REGULATION (500 TO 850 PSIG INLET PRESSURE AND 17 TO 30 PSIG SENSE PRESSURE)

TRANSIENT RESPONSE (SLAM START WITH 500 AND 850 PSIG INLET AND 17 TO 30 PSIG SENSE)

CERTIFICATION

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TWO UNITS CERTIFIED

VIBRATION AND SHOCK TESTING

RANDOM VIBRATION - 13.3 HOURS IN EACH OF TWO AXES (REGULATOR CENTERLINE AXIS AND MOUNTING HOLE CENTERLINE) [TWO UNITS]
ONE UNIT PRESSURIZED TO 190 PSIG (ALL PORTS)
ONE UNIT PRESSURIZED TO 43 PSIG (ALL PORTS)

TRANSIENT VIBRATION - 5 TO 35 HZ AT p 0.25 g IN EACH OF TWO AXES WITH THE INLET AND OUTLET PORTS PLUGGED. [TWO UNITS]
ONE UNIT WITH SENSE PORT PRESSURIZED TO 190 PSIG
ONE UNIT WITH SENSE PORT PRESSURIZED TO 43 PSIG

DESIGN SHOCK - PER MIL-STD-810 IN EACH OF 2 AXES. [TWO UNITS]

PERFORM AMBIENT INTERNAL AND EXTERNAL LEAKAGE AND FUNCTIONAL TESTS (SEE ATP ABOVE) AFTER VIBRATION AND SHOCK TESTING IN EACH AXIS.

THERMAL CYCLE TEST - WITH INLET AT 750 PSIG AND THE REGULATOR FLOWING, CYCLE +70 F TO -140 F TO +250 F TO -140 F TO +250 F TO -140 F TO +250 F TO -140 F TO 70 F. UPON COMPLETION, PERFORM AMBIENT INTERNAL AND EXTERNAL LEAKAGE AND FUNCTIONAL TESTS (SEE ATP ABOVE). [ONE UNIT]

LIFE CYCLE TESTS

1500 TRANSIENT CYCLES

INCREASE INLET PRESSURE FROM 0 TO 850 PSIG IN 8 MS MAXIMUM PERFORM AMBIENT INTERNAL AND EXTERNAL LEAKAGE TESTS AFTER EACH 500 CYCLES.

50 CYCLES

DECAY THE INLET PRESSURE FROM 850 PSIG TO 30 PSIG WITH THE OUTLET PLUGGED.

MAX FLOW TEST

700 PSIG INLET PRESSURE, MAX FLOW RATE OF 0.32 LB/SEC GHE, MEDIA TEMPERATURE 80 DEG F

UPON COMPLETION OF ALL CYCLING, PERFORM AMBIENT AND LOW TEMPERATURE INTERNAL AND EXTERNAL LEAKAGE, AND LOW TEMPERATURE FUNCTIONAL TESTS.

BURST TEST - 3400 PSIG (INLET), 1140 PSIG (OUTLET AND SENSE) [ONE UNIT]

OMRSD

V41AYO.140 LH2 PROPELLANT SYSTEM DECAY CHECK (EVERY FLIGHT)

V41AYO.221 HELIUM SIGNATURE LEAK CHECK (EVERY FLIGHT)

V41AYO.310 LH2 REPRESS SYSTEM LEAK TEST (15)

V41BGO.021 PR6 LH2 MANIFOLD REPRESS REGULATOR FUNCTIONAL (PRIOR TO FIRST REFLIGHT OF EACH VEHICLE)

V41BGO.010 MPS COMPONENT VISUAL INSPECTION (EVERY FLIGHT)

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(C) INSPECTION:

RECEIVING INSPECTION

INCOMING MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION.

CONTAMINATION CONTROL

ALL PARTS ARE CLEANED PRIOR TO ASSEMBLY AND ARE MAINTAINED TO CLEANLINESS LEVEL 100A.

ASSEMBLY/INSTALLATION

PARTS ARE VISUALLY INSPECTED. PRIOR TO ASSEMBLY, TESTS ARE PERFORMED TO PRECLUDE FAILURES OF THE MAIN POPPET STATIC SEAL, BELLOWS ASSEMBLY AND BELLEVILLE SPRINGS. TORQUE IS VERIFIED PER APPLICABLE REQUIREMENTS. ALL MANDATORY INSPECTION POINTS ARE INCLUDED TO ENSURE THAT CORRECT MANUFACTURING PROCEDURES ARE FOLLOWED. SEALS ARE VISUALLY EXAMINED PRIOR TO INSTALLATION FOR DAMAGE.

CRITICAL PROCESSES

TIG WELDED PARTS ARE WITNESSED BY INSPECTION. ALL CRES DETAILS ARE PASSIVATED TO PRECLUDE CORROSION. ANODIZE IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

HELIUM LEAK DETECTION IS VERIFIED BY INSPECTION. WELDING SAMPLES ARE EXAMINED AND VERIFIED BY INSPECTION.

TESTING

ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PACKAGING FOR SHIPMENT IS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

DURING ATP THE EXTERNAL LEAKAGE EXCEEDED REQUIREMENTS (CAR'S A8573, A8597). IT WAS CONCLUDED THAT THE DESIGN CANNOT CONSISTENTLY MEET ONE SCIM REQUIREMENT AT TEMPERATURES COLDER THAN -100 F. THE SPECIFICATION REQUIREMENT WAS RELAXED TO ALLOW THREE SCIMS EXTERNAL LEAKAGE AT TEMPERATURES COLDER THAN -100 F.

DURING ATP EXTERNAL LEAKAGE EXCEEDED REQUIREMENTS (CAR A9962). THE ANODIZING PROCESS ETCHED THE SEALING SURFACE CAUSING IRREGULARITIES SUFFICIENT TO ALLOW LEAKAGE PAST THE SEAL. THE DRAWING WAS CHANGED TO SPECIFY BRUSH ALODINE TO THE SEAL AREA. THE CHANGE IS EFFECTIVE FOR ALL PRODUCTION PARTS.

(E) OPERATIONAL USE:

PNEUMATIC ACTUATION HELIUM BOTTLE PRESSURE IS ON A DEDICATED DISPLAY IN COCKPIT. CREW ACTION IS TO FOLLOW NORMAL LEAK ISOLATION PROCEDURE.

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PRIOR TO MECO, ISOLATION VALVES (LV7, LV8) WILL BE REOPENED AND THE LEFT ENGINE HELIUM CROSSOVER VALVE (LV10) WILL BE OPENED.

EFFECTIVE FOR OI-8D SOFTWARE, CR 89397B "MPS PNEUMATIC SYSTEM FDA AND DISPLAY - BFS" ADDS PNEUMATIC TANK, REGULATOR, AND ACCUMULATOR PRESSURE TO THE S/M ALERT FDA SYSTEM AND ADDS THE 3 PRESSURE MEASUREMENTS TO THE BFS SYSTEM SUMMARY DISPLAY. THIS ALLOWS THE FLIGHT CREW TO RESPOND TO A PNEUMATIC HELIUM SYSTEM LEAK INDEPENDENT OF GROUND CONTROL.

- APPROVALS -

RELIABILITY ENGINEERING: L. H. FINEBERG
DESIGN ENGINEERING : J. E. OSLUND
QUALITY ENGINEERING : R. WILLIAMS
NASA RELIABILITY :
NASA DESIGN :
NASA QUALITY ASSURANCE :

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11/15/88