SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :ORBITAL MANEUVER FMEA NO 03-3 -1004 -1 REV: 4/20/88

ASSEMBLY :PRESSURIZATION SUBSYSTEM
P/N RI :MC621-0059
P/N VENDOR:73P620002
QUANTITY :4
:2 PER POD
:

CRIT. FUNC: 1R
CRIT. HDW: 3

VEHICLE EFFECTIVITY:	102 X	103 X	104 X

PHASE(S): PL X LO X OO X DO X LS X

REDUNDANCY SCREEN: A-PASS B-FAIL C-PASS

PREPARED BY:		APPROVED BY:	APPROVED BY (NASA):
DES	D W CARLSON	DES	SSM
REL	C M AKERS	REL	REL
QE	W J SMITH	QE	QE

ITEM:
REGULATOR, HELIUM PRESSURE, SERIES STAGES.

FUNCTION:
THE PRIMARY REGULATOR REDUCES AND REGULATES THE HELIUM SUPPLY PRESSURE (4800-460 PSI) TO THE REQUIREDD PROPELLANT TANK ULLAGE PRESSURE OF 257 (PLUS OR MINUS 5) PSI. THE SECONDARY REGULATOR OPERATES 7 PSI HIGHER IF PRIMARY REGULATOR FAILS. THE REGULATOR LOCKS-UP AT A PRESSURE OF 266 PSIG (SERIES STAGES AND PARALLEL FLOW PATHS ARE PROVIDED).

FAILURE MODE:
INTERNAL LEAKAGE, FAILS OPEN, HIGH LOCK-UP, HIGH OUTLET PRESSURE OR PRESSURE SPIKE.

CAUSE(S):
CONTAMINATION, CORROSION, CHECK VALVE FAILURE ALLOWING PROPELLANT VAPOR EXPOSURE, MATERIAL DETERIORATION, FROZEN MOISTURE, PLUGGED SENSE LINE RESTRICTOR, STRUCTURAL FAILURE OR GALLING OF SPRINGS, STEMS, POPPETS. FLOW LIMITER FAILURE, DIAPHRAGM RUPTURE.

EFFECT(S) ON:
(A)SUBSYSTEM (B)INTERFACES (C)MISSION (D)CREW/VEHICLE

(A,B) LOSS OF REDUNDANCY (SERIES STAGES AND HELIUM ISOLATION VALVE PROVIDED).

(C,D) NO EFFECT UNLESS MULTIPLE FAILURES OCCUR.

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(E) FUNCTIONAL CRITICALITY EFFECT - POSSIBLE LOSS OF CREW/VEHICLE DUE TO POTENTIAL LOSS OF ENTRY CAPABILITY. LOSS OF SERIES ELEMENTS (2 FAILED OPEN REGULATORS) COULD RESULT IN VENTING OF HELIUM OVERBOARD SUCH THAT PROPELLANT REQUIRED FOR ENTRY COULD NOT BE UTILIZED. FAIL OPEN OF SECONDARY REGULATOR NOT DETECTABLE SINCE PRIMARY REGULATOR MAINTAINS CONTROL.

DISPOSITION & RATIONALE:
(A)DESIGN (B)TEST (C)INSPECTION (D)FAILURE HISTORY (E)OPERATIONAL USE

(A) DESIGN
REDUNDANT (SERIES) STAGE REGULATORS ARE UTILIZED TO LIMIT THE IMPACT OF LEAKAGE OR OPEN FAILURE MODES. ADDITIONALLY A RELIEF VALVE IS PROVIDED TO PREVENT DOWNSTREAM OVERPRESSURIZATION SHOULD A DOUBLE REGULATOR FAILURE OCCUR. THE UPSTREAM HELIUM ISOLATION VALVE CAN BE CLOSED AND IS NORMALLY CLOSED DURING NONFIRING PERIODS TO PREVENT CONTINUING PRESSURE LOSS THROUGH THE RELIEF VALVE. AN ACTIVE FLOW LIMITER IS PROVIDED TO LIMIT FLOW THROUGH A FAILED OPEN REGULATOR TO A MAX OF 1040 SCFM. A 25-MICRON INLET FILTER UPSTREAM OF THE REGULATOR IS PROVIDED TO LIMIT CONTAMINANTS CAUSING LEAKAGE, PLUGGING OF SENSE LINE ORIFICE, OR BINDING OF MOVING PARTS. A 10-MICRON PILOT FILTER AND 25 MICRON RESTRICTOR TUBE FILTERS ARE ALSO PROVIDED. TWO-PLY BELLOWS ARE UTILIZED TO LIMIT RUPTURE FAILURE WHICH COULD RESULT IN PRESSURE EQUALIZING, ALLOWING THE SENSOR SPRINGS TO CAUSE THE REGULATOR TO OPEN. A SMALL ORIFICE IN THE REGULATOR CAP ALLOWS OVERBOARD VENTING OF ANY LEAKAGE THROUGH THE BELLOWS TO PREVENT ANY PRESSURE BUILDUP IN THE SENSOR CAVITY THAT WOULD TEND TO CAUSE THE REGULATOR TO FAIL IN THE OPEN MODE. CHECK VALVES AND VAPOR ISOLATION VALVES LIMIT THE POTENTIAL OF PROPELLANT VAPOR REACHING THE REGULATOR. MANUAL ISOLATION VALVES PROVIDE ADDITIONAL VAPOR MIGRATION PROTECTION DURING INACTIVE GROUND PERIODS.

(B) TEST

QUALIFICATION TESTS
(3 UNITS - 2 FAIRCHILD & 1 C.C.C.). RANDOM VIBRATION, THERMAL CYCLES (-65 TO +150 DEGREE F.). ENDURANCE - 2100 FLOW CYCLES, 100 (MISSION EQUIVALENT) MISSION SIMULATIONS - PARALLEL OPERATION, BLOWDOWN, PROPELLANT COMPATIBILITY. ALSO QUALIFIED AS PART OF POD ASSY - VIBRO-ACOUSTIC TESTING AT JSC (131 EQUIVALENT MISSIONS). HOT-FIRE TEST PROGRAM AT WSTF - 517 TESTS (24 EQUIVALENT MISSION DUTY CYCLES). APPROX. 7 YEARS EXPOSURE TO OPERATING ENVIRONMENT.

ACCEPTANCE TEST
EACH UNIT - PROOF PRESSURE, EXTERNAL LEAKAGE, SET POINT VERIFICATION. LOCK-UP PRESSURE. INTERNAL LEAKAGE. PERFORMANCE - SLAM START, FLOW LIMITER VERIFICATION, NORMAL REGULATION, LOW TEMPERATURE, CLEANLINESS, DRYING.

GROUND TURNAROUND
V43CB0.030 PERFORMS REGULATOR LEAK AND FUNCTIONAL TEST EVERY FLIGHT.
V43CB0.035 PERFORMS REGULATOR RESPONSE TEST EVERY FLIGHT.
V43CB0.040 PERFORMS REGULATOR HIGH PRESSURE LEAK AND FUNCTIONAL TEST FOR THE FIRST FLIGHT.

V43CB0.045 PERFORMS REGULATOR FLOW LIMITER TEST EVERY FLIGHT.
V43CB0.050 PERFORMS REGULATOR LOW PRESSURE LEAK AND FUNCTIONAL TEST FOR THE FIRST FLIGHT AND CONTINGENCY.
V43CE0.045 PERFORMS HELIUM OFF LOADING WHICH PURGES THE HELIUM SYSTEM AND CLOSES THE MANUAL VALVE EVERY FLIGHT.
V43CF0.025 PERFORMS HELIUM SYSTEM ACTIVATION EVERY FLIGHT.
ULLAGE PRESSURES MONITORED DURING MISSION TO VERIFY PROPER REGULATOR PERFORMANCE. ON-ORBIT BURNS ARE PERFORMED WITH SINGLE (ALTERNATE) REGULATOR LEGS TO VERIFY INDIVIDUAL PRIMARY REGULATORS.

(C) INSPECTION

RECEIVING INSPECTION
MATERIALS AND PROCESSES CERTIFICATIONS ARE VERIFIED BY INSPECTION.

CONTAMINATION CONTROL
CLEANLINESS TO LEVEL 100A AND CORROSION PROTECTION PROVISIONS ARE VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
MANUFACTURING, ASSEMBLY AND INSTALLATION PROCEDURES ARE VERIFIED BY INSPECTION. CRITICAL DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION. COMPONENTS ARE VERIFIED VISUALLY AND DIMENSIONALLY BY INSPECTION DURING FABRICATION.

CRITICAL PROCESSES
THE WELDING PROCESS AND VERIFICATION THAT WELDS MEET SPECIFICATION REQUIREMENTS ARE VERIFIED BY INSPECTION. ADDITIONAL DETAILS OF CRITICAL PROCESS INSPECTIONS ARE LISTED BELOW:

(1) INSPECTION VISUALLY INSPECTS THE TIG (TUNGSTEN INERT GAS) WELDS WITHIN THE PILOT ACTUATOR ASSEMBLY AND WITHIN THE PILOT POPPET ASSEMBLY. ADDITIONAL TIG WELD INSPECTIONS INCLUDE THE WELDS THAT JOIN THE TUBING, BOTTOM CAPS, AND THE MAIN BELLOWS TO THE BODY. INSPECTION ALSO VERIFIES THE EB (ELECTRON BEAM) WELDS OF THE PILOT ACTUATOR BELLOWS INTO THE PILOT ACTUATOR ASSEMBLY. THE PROOF PRESSURE TEST/LEAK TEST PROVIDES FURTHER VERIFICATION OF WELD INTEGRITY.

(2) INSPECTION VERIFIES HEAT TREATMENT OF THE DETAIL PARTS, INCLUDING THE HOUSING FORGING TO DRAWING REQUIREMENTS.

(3) THE FORGING SUPPLIER CERTIFIES THAT THE HOUSING FORGING MEETS THE REQUIREMENTS OF MIL-F-7190, AMENDMENT 1, GRADE A TESTING OF EACH FORGING LOT FOR CHEMISTRY. AFTER HEAT TREATMENT HARDNESS AND TENSILE STRENGTH IS VERIFIED BY INSPECTION.

(4) INSPECTION VERIFIES THAT BELLEVILLE WASHERS ARE CADMIUM PLATED TO DRAWING REQUIREMENTS.

NONDESTRUCTIVE EVALUATION
PENETRANT AND RADIOGRAPHIC INSPECTION OF WELDS ARE VERIFIED BY INSPECTION. INSPECTION ALSO VERIFIES PENETRANT INSPECTION OF THE MAIN BELLOWS WELDS, AND THE HOUSING FORGINGS AT THE FORGING LEVEL.

TESTING
TEST EQUIPMENT AND TOOL CALIBRATION ARE VERIFIED BY INSPECTION. ACCEPTANCE TEST IS VERIFIED BY INSPECTION (INCLUDES FUNCTIONAL OPERATION AND VERIFICATION OF NO EXTERNAL LEAKAGE).

HANDLING/PACKAGING
HANDLING, PACKAGING, STORAGE AND SHIPPING REQUIREMENTS ARE VERIFIED BY INSPECTION.

(D) FAILURE HISTORY
CAR AB7624 IDENTIFIES AN INTERNAL LEAKAGE FAILURE DURING QUALIFICATION PROPELLANT COMPATIBILITY WHICH OCCURRED AS A RESULT OF GOLD FLAKING FROM PLATED WASHER. THE GOLD WASHER HAS BEEN ELIMINATED FROM REGULATORS ON ALL VEHICLES, EXCEPT POD E.T. 11 AND 23.

CAR AC3128 IDENTIFIES TWO REGULATORS REMOVED FROM PODS DUE TO INTERNAL LEAKAGE AS A RESULT OF ATTACK OF THE TUNGSTEN CARBIDE SEAT BY NITRIC ACID (OXIDIZER PLUS MOISTURE). PROCEDURES FOR GROUND/FLIGHT SYSTEMS WERE REVISED TO REDUCE CHANCES OF MOISTURE INTRODUCTION/FORMATION.

CAR26F008 IDENTIFIES A TRANSIENT FAIL OPEN WHICH OCCURRED DURING MISSION 51F OMS-6 BURN. THE ULLAGE PRESSURE REACHED 265 PSI BEFORE THE REGULATOR SHUT OFF FLOW. SUBSEQUENT PERFORMANCE ON DEORBIT BURN WAS NORMAL. FAILURE WAS NOT REPRODUCIBLE DURING FAILURE ANALYSIS AT VENDOR. NO CAUSE FOR OBSERVED PERFORMANCE WAS DETERMINED. PROPELLANT RESIDUE IN THE SENSING TUBE WAS SUSPECTED BUT THERE WAS NO EVIDENCE OF THIS CONDITION UPON DISASSEMBLY. POST FLIGHT HELIUM PURGE AND CLOSURE OF THE MANUAL VALVE LIMIT THE POTENTIAL FOR PROPELLANT RESIDUE FORMATION.

CAR AD0918 IDENTIFIES A REGULATOR REMOVED FROM THE OV-103 OMS FOR EXCESSIVE CREEP RATE. FAILURE ANALYSIS REVEALED A BROKEN FLOW LIMITER. THIS ANALYSIS IS STILL IN PROCESS. A PRIOR FAILURE OF THIS TYPE (CAR AB1424) RESULTED IN A PREVIOUS DESIGN CHANGE TO ELIMINATE A STRESS RISER CONDITION.

(E) OPERATIONAL USE
CLOSE HELIUM ISOLATION VALVE IN LEG HAVING FAILED OPEN REGULATOR-EXCESSIVE ULLAGE PRESSURE ANNUNCIATED BY C&W. CONTINUE MISSION USING PARALLEL FLOW PATH.