SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :MAIN PROPULSION

FMEA NO 03-1 -0412 -2 REV:05/04/8

ASSEMBLY :PARKER-HANNIFIN
P/N RI :MC284-0501-0001
P/N VENDOR:
QUANTITY :1
:ONE LO2
:

ABORT:
RTLS, TAL

	CRIT. FUNC:		
	CRIT. HDW:		
VEHICLE	102	103	1
EFFECTIVITY:	X	X	X

PHASE(S): PL LO X OO DO LS

REDUNDANCY SCREEN: A- B- C-

PREPARED BY:		APPROVED BY:		APPROVED BY (NASA):
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ITEM:
VALVE, RELIEF, 1 INCH, LO2 FEEDLINE MANIFOLD RELIEF. (RV5)

FUNCTION:
RELIEVES PRESSURE BUILDUP FROM LO2 MANIFOLD. NOT NORMALLY REQUIRED OPERATE. THE MAIN POPPET OF THE VALVE IS ISOLATED FROM THE FEED SYST UNTIL MECO BY THE UPSTREAM FEEDLINE RELIEF SHUTOFF VALVE (PV7). I RELIEF VALVE INCORPORATES A SENSE PORT WHICH SENSES THE LO2 MANIFO PRESSURE VIA A SENSE LINE. THE CRACKING AND RESEAT PRESSURES ARE BETWE 190 & 220 PSIG.

FAILURE MODE:
FAILS TO RESEAT/INTERNAL LEAKAGE OF MAIN POPPET POST MECO.

CAUSE(S):
PIECE PART STRUCTURAL FAILURE, BINDING, CONTAMINATION.

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

(A,B) RESULTS IN THE LOSS OF HELIUM OVERBOARD DURING MANIFO REPRESSURIZATION THROUGH THE FAILED MANIFOLD RELIEF VALVE (RV5). LOSS AFT COMPARTMENT PURGE (RTLS/TAL ABORT CRITICAL).

(C,D) NO EFFECT FOR NOMINAL MISSION. POSSIBLE LOSS OF CREW/VEHIC DURING RTLS/TAL ABORT.

SUBSYSTEM :MAIN PROPULSION FMEA NO 03-1 -0412 -2 REV:05/04/88

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

(A) DESIGN

VALVE

THE RELIEF VALVE CONSISTS OF TWO SECTIONS: A PRESSURE ACTUATED MAIN POPPET SECTION AND A PILOT SECTION WHICH SENSES MANIFOLD PRESSURE BY MEANS OF A SENSING LINE.

THE PILOT SECTION CONTROLS THE OPENING AND CLOSING OF THE MAIN POPPET BY ALLOWING THE MANIFOLD PRESSURE TO ENTER OR EXIT A CONTROL CHAMBER. WHEN THE MANIFOLD PRESSURE REACHES A PREDETERMINED PILOT SETTING, THE PILOT VENTS THE CHAMBER PRESSURE OVERBOARD ALLOWING THE PRESSURE DIFFERENTIAL ACROSS THE MAIN POPPET TO PUSH THE MAIN POPPET OPEN. ONCE THE MANIFOLD PRESSURE DROPS BELOW THE PILOT CONTROL SETTING, THE PILOT POPPET CLOSES, THE MANIFOLD PRESSURE ENTERS THE CONTROL CHAMBER, AND THE MAIN POPPET CLOSES.

THE FOLLOWING COMPONENTS MAY CAUSE A FAILURE TO RESEAT/REMAIN CLOSED OR LEAKAGE DUE TO STRUCTURAL FAILURE: MACHINED SPRING, STOP SPRING, STOP, PUSH ROD, PILOT POPPET SPRING, PILOT POPPET, PILOT SEAT, PILOT SEAT RETAINER, MAIN BELLOWS, MAIN SEAL, MAIN SEAT, PILOT SEAT ASSEMBLY SEAL, AND PILOT SEAT ASSEMBLY SEAL SPRING.

THE MACHINED SPRING CONTROLS THE CRACKING PRESSURE. IT IS OF INCONEL 718, HEAT TREATED AND PASSIVATED.

THE STOP SPRING PRELOADS THE PILOT STOP. IT IS A BELLEVILLE SPRING OF HEAT TREATED INCONEL 718.

THE STOP PRELOADS THE INSIDE DIAMETER OF THE STOP SPRING. THE STOP IS CRES PH 15-5, HEAT TREATED AND PASSIVATED.

THE PUSH ROD PRELOADS THE PILOT POPPET SPRING. THE PUSH ROD IS A286 CRES, HEAT TEATED AND PASSIVATED.

THE PILOT POPPET SPRING IS THE RETURN SPRING FOR THE PILOT POPPET. THE SPRING IS OF ELGILOY 54-71A AND HEAT TREATED.

THE PILOT POPPET IS THE FLOW CONTROL DEVICE FOR THE PILOT VALVE, IT IS CRES PH 13-8 MO, HEAT TREATED AND PASSIVATED.

THE PILOT SEAT IS TEFLON (TFE).

THE PILOT SEAT RETAINER RETAINS THE PILOT SEAT IN THE PILOT SEAT ASSEMBLY. IT IS OF 6051-T651 ALUMINIUM ALLOY. THE PILOT SEAT RETAINER IS TORQUED, STRESS RELIEVED, AND RETORQUED.

THE PILOT BELLOWS (2 PLY) AND MAIN BELLOWS (3 PLY) ARE SIMILAR CONSTRUCTION AND OF THE SAME MATERIAL. BOTH BELLOWS ASSEMBLI CONSIST OF 3 PARTS; THE FLANGE, A BELLOWS, AND A CAP; ALL OF INCON 625 AND PASSIVATED. THE SEAMS OF THE BELLOWS ARE FUSION WELDED (FU PENETRATION). THE FLANGE AND CAP ARE FUSION WELDED TO THE BELLOW EACH BELLOWS ASSEMBLY IS TESTED FOR PROOF PRESSURE AND LEAKAGE BEFO BEING ASSEMBLED INTO A RELIEF VALVE. THE MAIN BELLOWS ASSEMBLY THEN ELECTRON BEAM WELDED TO THE MIDDLE HOUSING ASSEMBLY. THE WE IS DYE PENETRANT INSPECTED, PROOF PRESSURE TESTED, AND LEAK TESTED.

THE MAIN SEAL IS RULON-A, LAPPED TO A TWO MICROINCH SURFACE FINIS AND COMPLETELY RETAINED BETWEEN THE MAIN POPPET SEAL RETAINER AND T MAIN POPPET CAP.

THE MAIN SEAT IS CRES (PH 13-8 MO) PASSIVATED. THE SEALING SURFACE LAPPED TO A FOUR MICROINCH SURFACE FINISH.

THE PILOT SEAT ASSEMBLY SEAL PREVENTS INTERNAL LEAKAGE FROM THE PIL CAVITY BETWEEN THE PILOT SEAT ASSEMBLY AND THE HOUSING. THE "V" SE IS A TEFLON JACKETED INCONEL 718 SPRING.

THE PILOT SEAT ASSEMBLY SEAL SPRING PRELOADS THE PILOT SEAT ASSEME AGAINST THE PILOT SEAT ASSEMBLY SEAL. IT IS A BELLEVILLE SPRING 302 CRES AND PASSIVATED.

TWO COMPONENTS MAY CAUSE A FAILURE TO RESEAT DUE TO BINDING: THE MA POPPET ACTUATING ROD AND THE PILOT SPRING-SEAT. THE MAIN POPP ACTUATING ROD TRANSFERS FORCE FROM THE MAIN BELLOWS TO THE MAIN POPPE THE SPRING-SEAT PULLS THE PILOT POPPET COMPLETELY OPEN (WHICH DUMPS PIL PRESSURE TO ALLOW FULL FLOW THROUGH THE VALVE) BY EQUALIZING THE PRESSU WITHIN THE MAIN BELLOWS WITH THAT OF THE FEEDLINE, AS SENSED BY THE PIL BELLOWS. FAILURE OF THE SPRING SEAT TO RETURN WILL PREVENT THE PIL POPPET FROM SEATING CAUSING FAILURE OF THE MAIN POPPET TO RESEAT.

THE MAIN POPPET ACTUATING ROD PASSES THROUGH A HOLE IN THE THERM ISOLATOR. THE THERMAL ISOLATOR IS VESPEL SP-21. THE HOLE IS OVER SEV DIAMETERS IN LENGTH, PRECLUDING COCKING. THE ROD IS INCONEL 718 A PASSIVATED. THE CENTER SECTION IS SMALLER IN DIAMETER THAN THE ENDS REDUCE CONTACT AREA, PRECLUDING BINDING DUE TO CONTAMINANT PARTICL TRAPPED BETWEEN THE ROD AND ISOLATOR. THE CONTACT SURFACE HAS A MICROINCH FINISH WHICH MATES SMOOTHLY WITH THE THERMAL ISOLATOR.

THE SEAT-SPRING SLIDES SMOOTHLY AND FREELY WITHIN THE BORE OF T RETAINER. THE RETAINER IS CRES (PH 13-8 MO), HEAT TREATED A PASSIVATED. ITS BORE IS APPROXIMATELY ONE DIAMETER IN LENGTH AND HAS 16 MICROINCH SURFACE FINISH. THE SPRING-SEAT IS 304 CRES AND PASSIVATE THE UPPER AND LOWER CIRCUMFERENTIAL CONTACT SURFACES ARE POLISHED TO A MICROINCH FINISH.

SYSTEM CONTAMINATION IS MINIMIZED DUE TO THE PRESENCE OF AN ET SCREEN, GSE DEBRIS PLATE, AND A GSE FILTER.

STRUCTURAL ANALYSIS INDICATES POSITIVE MARGINS OF SAFETY FOR ALL CONDITIONS OF VALVE OPERATIONS.

SYSTEM

PRESENT SYSTEM CONFIGURATION ALLOWS 12 INCH FEEDLINE VENTING THROUGH SSME HPOT SEALS. PRESENT DUMP SEQUENCE PREVENTS EXCESSIVE MANIFOLD PRESSURE BUILDUP. FLIGHT AND GROUND TEST EXPERIENCE HAS SHOWN THAT MANIFOLD PRESSURE DOES NOT INCREASE TO MINIMUM RELIEF VALVE CRACKING PRESSURE FOR NOMINAL OPERATION.

(B) TEST

ATP

VISUAL INSPECTION
STROKE VERIFICATION OF MAIN POPPET (0.225 +/- 0.002 INCH)

AMBIENT TEST

PROOF PRESS: VALVE BODY, 440 PSIG INLET & SENSE PORT, 450 PSIG OUTLET

INTERNAL LEAKAGE:
1 TO 180 PSIG GHe AT INLET AND SENSE PORT;
10 SCIM MAX AT OUTLET PORT

EXTERNAL LEAKAGE: 220 PSIG GHe; 5 SCIM MAX

CRACK/RESEAT: 190 TO 220 PSIG

REVERSE FLOW LEAKAGE:
10 PSID GHe OUTLET TO INLET
MAIN SEAT LEAKAGE 50 SCIM MAX
PILOT REVERSE LEAKAGE 1700 SCIM MAX.

CRYOGENIC TEST (GHe AT -300 DEG F):

CRACK/RESEAT: 190 TO 220 PSIG, VALVE BODY AMBIENT

EXTERNAL LEAKAGE: 220 PSIG, 10 SCIM MAX, VALVE BODY -100 DEG F

INTERNAL LEAKAGE: 180 PSIG, 10 SCIM MAX, VALVE BODY -100 DEG F

CERTIFICATION

LIFE TEST

CRYO - 4500 CYCLES OPEN AND CLOSED USING LN2, VALVE CHECKED FOR INTERNAL LEAKAGE AFTER EACH 500 CYCLES, VALVE CHECKED FOR CRYO INTERNAL LEAKAGE AFTER EACH 1500 CYCLES.

AMBIENT - 500 CYCLES, VALVE INTERNAL LEAK CHECK EACH 50 CYCLES.

CRYO STEADY STATE FLOW TEST

SENSES PORT PRESS AT 230 PSIG GHe AT -320 DEG F
FLOW RATE OF 197 GPM LN2 AT 103 PSID

CRYO RESPONSE TEST

1.5 SEC TO INDICATE STEADY FLOW AFTER CRACKING WITH LN2

CRYO FUNCTIONAL TEST USING LN2

CRACKED AT 208 PSIG; RESEAT AT 192 PSIG

RANDOM VIBRATION 13.3 HOURS IN EACH OF THE THREE AXES

FIRST 4 HOUR AND 26 MINUTE PERIOD
ENVIRONMENT: AMBIENT
SENSE PORT: 180 PSIG GHe AT -320 DEG F
MAIN INLET: AMBIENT

SECOND 4 HOUR AND 26 MINUTE PERIOD
ENVIRONMENT: AMBIENT TO +100 TO -100 TO AMBIENT
SENSE PORT: 180 PSIG GHe AT -320 DEG F
MAIN INLET: 180 PSIG GHe AT -320 DEG F

THIRD 4 HOUR AND 26 MINUTE PERIOD
ENVIRONMENT: AMBIENT
SENSE PORT: 180 PSIG GHe AT -320 DEG F
MAIN INLET: 180 PSIG LN2

CRACK/RESEAT AND INTERNAL LEAKAGE PERFORMED AT COMPLETION OF EACH AXIS OF VIBRATION.

BENCH HANDLING AND DESIGN SHOCK PER MIL-STD-810
FOLLOWED BY AMBIENT CRACK/RESEAT AND INTERNAL LEAKAGE TESTS.

THERMAL CYCLE TEST (3 CYCLES)

VALVE AT 70 DEG F; SHOCKED WITH -300 DEG F FLUID FOR 20 MINUTES MIN; VALVE ALLOWED TO WARM UP TO 70 DEG F; VALVE HEATED TO 275 DEG F FOR 15 MINUTES. DURING THE 15 MINUTES THE VALVE WAS TESTED FOR AMBIENT CRACK/RESEAT PRESSURE.

ELECTRICAL BONDING

BURST TEST
880 PSIG ON SENSE AND INLET PORTS, 1200 PSIG ON OUTLET PORT

OMRSD
V41AY0.140 LH2 PROP SYS DECAY CHECK (EVERY FLIGHT)
V41BE0.020 RV5 LO2 MANIFOLD RELIEF VALVE INTERNAL LEAK TEST (I5)
V41BH0.070 RV5 LO2 MANIFOLD RELIEF VALVE FUNCTIONAL (I5)
V41BU0.160 LO2 FEEDLINE SCREEN INSPECTION (I5)
V41BU0.162 LO2 FEEDLINE SCREEN INSPECTION - VERTICAL (I25)

(C) INSPECTION

RECEIVING INSPECTION

RAW MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION. PART PROTECTION COATING AND PLATING REQUIREMENTS ARE VERIFIED BY INSPECTION.

CONTAMINATION CONTROL

CONTAMINATION CONTROL PROCESS AND CORROSION PROTECTION PROVISIONS ARE VERIFIED. CLEANLINESS TO LEVEL 400A (PROCUREMENT SPECIFICATION REQUIREMENT IS 800A) VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

ALL CRITICAL DIMENSIONS ARE VERIFIED BY INSPECTION. LOG OF CLEAN ROOM AND TOOL CALIBRATION IS VERIFIED BY INSPECTION. TORQUE PER DRAWING REQUIREMENTS AND SURFACE FINISH ARE VERIFIED BY INSPECTION. SURFACES REQUIRING CORROSION PROTECTION ARE VERIFIED BY INSPECTION. ALL SEALING SURFACES AND SEALS ARE VISUALLY EXAMINED BEFORE INSTALLATION USING 10X MAGNIFICATION. MANDATORY INSPECTION POINTS ARE INCLUDED IN THE MANUFACTURING PROCEDURE.

CRITICAL PROCESSES

HEAT TREATMENT, WELDING, PARTS PASSIVATION, AND ANODIZING ARE VERIFIED. DRY FILM LUBRICANT APPLICATIONS ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

ALL WELDS ARE VISUALLY EXAMINED AND VERIFIED BY DYE PENETRANT. ADDITION, BELLOWS WELDS (EXCLUDING END FITTING WELDS) ARE X-RAYED.

TESTING

ATP VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PACKAGING FOR SHIPPING IS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY

GENERAL SYSTEM CONTAMINATION

THIS FAILURE MODE HAS NOT OCCURRED ON THIS COMPONENT DUE CONTAMINATION. HOWEVER, GENERAL MPS SYSTEM CONTAMINATION HAS OCCURR WHICH MAY LODGE ANYWHERE IN THE SYSTEM CAUSING THIS FAILURE MO (REFERENCE THE FOLLOWING PARAGRAPHS).

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

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

METAL SHAVINGS HAVE BEEN DISCOVERED IN LINES AND COMPONENTS, WHICH W MOST LIKELY GENERATED WHEN THEY WERE CUT OUT AND/OR REPLACED (REFEREN CARs AC9868, A9654, AC2210, AB1706; DR AD2226). METHODS ARE BEI REVISED TO MINIMIZE PARTICLE GENERATION WHEN INSTALLING/REPLACI COMPONENTS, LINES, AND FITTINGS REQUIRING WELDED OR BRAZED JOIN (PRODUCT QUALITY IMPROVEMENT COUNCIL). PERSONNEL HAVE BEEN CAUTIONE ROCKWELL PROBLEM ACTION CENTER WILL CONTINUE TO MONITOR BRAZING/WELDI REWORK CONTAMINATION. PROCEDURES ARE BEING REVISED TO IMPRO CLEANLINESS MAINTENANCE DURING COMPONENT BUILD UP AND REWORK (REFEREN MCR 12512). SUPPLIER DOCUMENTS/PROCEDURES HAVE BEEN REVIEWED A CLEANLINESS MAINTENENCE PROCEDURES HAVE BEEN IMPROVED.

A PIECE OF A BRAZING PREFORM LODGED IN A 2-WAY SOLENOID VALVE ON OV-0 AT PALMDALE CAUSING A LEAKAGE FAILURE (REFERENCE CARs AC2111, AB2538) STEEL AND ALUMINUM PARTICLES CAUSED EXCESSIVE LEAKAGE ON THE 850 PS HELIUM RELIEF VALVE (REF CAR AC2239). FOR BOTH FAILURES CORRECTI ACTION WAS TO ADD SPECIAL PURGE PORTS TO THE MPS HELIUM PANEL ASSEMBLI 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 ARE BEING REVISED TO IMPROVE CLEANLINESS MAINTENANCE DURING COMPONENT BUILD UP AND REWORK (REFERENCE MCR 12512). SUPPLIER DOCUMENTS/PROCEDURES HAVE BEEN REVIEWED AND CLEANLINESS MAINTENENCE 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.

(E) OPERATIONAL USE

NO CREW ACTION CAN BE TAKEN.