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PRINT DATE: 05/11/95

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL HARDWARE
NUMBER: 03-1-0431 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 1 09/23/94

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: VALVE, BALL (TYPE 3) EATON CONSOLIDATED CONTROLS	MC284-0395-0053 1440-511

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
VALVE, LH2 HIGH POINT BLEED 1.5 INCH. NORMALLY CLOSED, PNEUMATICALLY
ACTUATED OPEN. INCORPORATES RELIEF VALVE.

REFERENCE DESIGNATORS: PV22

QUANTITY OF LIKE ITEMS: 1
ONE

FUNCTION:

THIS VALVE CONTROLS THE FLOW OF GH2 BLEED FROM THE LH2 17-INCH
DISCONNECT (WHICH IS THE HIGH POINT IN THE ENGINE FEED SYSTEM) OVERBOARD
THROUGH THE HIGH POINT BLEED DISCONNECT (PD17) INTO THE GROUND VENT
SYSTEM. THE VALVE IS ACTUATED OPEN AT THE START OF SLOW FILL TO BLEED OFF
ANY GH2 ACCUMULATED IN THE FEEDLINE DURING LOADING OPERATIONS. VALVE IS
CLOSED APPROXIMATELY TWENTY SIX SECONDS PRIOR TO LIFTOFF. THE VALVE
INCORPORATES A RELIEF FEATURE WHICH RELIEVES THE LINE BETWEEN THE HIGH
POINT BLEED DISCONNECT AND THE BLEED VALVE BACK INTO THE FEEDLINE. THE
BLEED DISCONNECT ACTS AS A REDUNDANT INHIBIT AGAINST OVERBOARD FLOW
AFTER LH2 TSM UMBILICAL SEPARATION.

SHUTTLE CRITICAL ITEMS LIST - ORBITER

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ASSEMBLY : EATON CONSOL. CNTLS	CRIT. FUNC:	1
P/N RI : MC284-0395-0053	CRIT. HDW:	1
P/N VENDOR:	VEHICLE	102 103 104
QUANTITY : 1	EFFECTIVITY:	X X X
: ONE	PHASE(S):	PL X LO X OO DO LS

PREPARED BY:	DES	J E OSLUND	APPROVED BY:	DES	<u>H. Bafford</u>	REDUNDANCY SCREEN:	A-	B-	C-
REL	L H FINEBERG	REL	<u>L. Ascoe</u>	APPROVED BY (NASA):	SSM	<u>Chell J. Eddy</u>			
QE	E M GUTIERREZ	QE	<u>B. Williams</u>	REL	<u>Th. J. B...</u>	QE	<u>...</u>		

ITEM:
 VALVE, GH2 HIGH PT BLEED 1.5 INCH. NORMALLY CLOSED, PNEUMATICALLY ACTUATED OPEN. INCORPORATES RELIEF VALVE. (PV22)

FUNCTION:
 THIS VALVE CONTROLS THE FLOW OF GH2 BLEED FROM THE LH2 17-INCH DISCONNECT (WHICH IS THE HIGH POINT IN THE ENGINE FEED SYSTEM) OVERBOARD THROUGH THE HIGH POINT BLEED DISCONNECT (PD17) INTO THE GROUND VENT SYSTEM. THE VALVE IS ACTUATED OPEN AT THE START OF FAST FILL TO BLEED OFF ANY GH2 ACCUMULATED IN THE FEEDLINE DURING LOADING OPERATIONS. VALVE IS CLOSED APPROXIMATELY TWENTY SECONDS PRIOR TO LIFTOFF. THE VALVE IS MANUALLY OPENED FOR FIRST VACUUM INERT (WIRED TO THE LH2 INBOARD FILL & DRA [PV12] COCKPIT SWITCH). THE VALVE INCORPORATES A RELIEF FEATURE WHICH RELIEVES THE LINE BETWEEN THE HIGH POINT BLEED DISCONNECT AND THE BLEED VALVE BACK INTO THE FEEDLINE. THE BLEED DISCONNECT ACTS AS A REDUNDANT INHIBIT AGAINST OVERBOARD FLOW AFTER LH2 TSM UMBILICAL SEPARATION.

FAILURE MODE:
 FAILS TO REMAIN CLOSED (INCLUDES BUILT-IN RELIEF VALVE) DURING TERMINAL COUNT.

CAUSE(S):
 PIECE-PART STRUCTURAL FAILURE.

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EFFECT(S) ON:

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

(A,B) LCC REQUIRES VALVE TO BE CLOSED AT T-10 SECONDS (ONE TIME VERIFICATION). AFTER T-10 SECONDS FAILURE WILL RESULT IN CONTINUED BLEED FLOW. BLEED DISCONNECT (PD17) IS NOT CERTIFIED FOR CLOSURE UNDER FLOW CONDITIONS AND CANNOT BE CONSIDERED AS A REDUNDANCY AGAINST OVERBOARD LEAKAGE. POSSIBLE RUPTURE OF DISCONNECT HOUSING AND/OR DOWNSTREAM BLEED SYSTEM DUE TO WATER HAMMER.

LH2 WILL DUMP OVERBOARD RESULTING IN LOSS OF 230 POUNDS OF PROPELLANT. THIS WILL NOT EFFECT ENGINE INLET CONDITIONS OR CAUSE A LOW LEVEL CUTOFF. POSSIBLE AFT COMPARTMENT OVERPRESS. FIRE/EXPLOSIVE HAZARD BOTH INTERIOR AND EXTERIOR TO THE VEHICLE.

RESULTS IN LOSS OF HELIUM SUPPLY DURING MANIFOLD REPRESSURIZATION CAUSING LOSS OF AFT COMPARTMENT PURGE (RTLS AND TAL ABORT CRITICAL).

(C,D) POSSIBLE LOSS OF CREW/VEHICLE.

(E) FUNCTIONAL CRITICALITY EFFECTS

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

- 1) HIGH POINT BLEED VALVE (PV22) FAILS TO REMAIN CLOSED.
- 2) BLEED DISCONNECT (PD17) FAILS TO CLOSE/REMAIN CLOSED.

LH2 WILL DUMP OVERBOARD RESULTING IN LOSS OF 230 POUNDS OF PROPELLANT. THIS WILL NOT EFFECT ENGINE INLET CONDITIONS OR CAUSE A LOW LEVEL CUTOFF. FIRE/EXPLOSIVE HAZARD EXTERIOR TO THE VEHICLE. RESULTS IN LOSS OF HELIUM SUPPLY DURING MANIFOLD REPRESSURIZATION CAUSING LOSS OF AFT COMPARTMENT PURGE (RTLS AND TAL ABORT CRITICAL). POSSIBLE LOSS OF CREW/VEHICLE.

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

- 1) HIGH POINT BLEED VALVE (PV22) FAILS TO REMAIN CLOSED.
- 2) LH2 BLEED LINE BETWEEN PV22 AND PD17 RUPTURE/LEAKAGE.

LH2 WILL LEAK INTO THE AFT FUSELAGE CAUSING LOSS OF 230 POUNDS OF PROPELLANT, POSSIBLE AFT COMPARTMENT OVERPRESS, AND FIRE/EXPLOSION HAZARD. THIS WILL NOT AFFECT ENGINE INLET CONDITIONS OR CAUSE A LOW LEVEL CUTOFF. POSSIBLE LOSS OF CRITICAL ADJACENT COMPONENTS DUE TO CRYO EXPOSURE. RESULTS IN LOSS OF HELIUM SUPPLY DURING MANIFOLD REPRESSURIZATION CAUSING LOSS OF AFT COMPARTMENT PURGE (RTLS AND TAL ABORT CRITICAL). POSSIBLE LOSS OF CREW/VEHICLE.

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SUBSYSTEM :MAIN PROPULSION

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DISPOSITION & RATIONALE:

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

(A) DESIGN

VALVE

FAILURE OF THE VALVE TO REMAIN CLOSED CAN OCCUR DUE TO ACTUATOR SPRING FAILURE OR A STRUCTURAL FAILURE AT THE BALL CLOSURE TO SHAFT ATTACH INTERFACE.

THE VALVE ACTUATOR IS SPRING LOADED TO THE CLOSED POSITION. THE ACTUATOR PISTON DRIVES A SPRING LOADED RACK WHICH, IN TURN, DRIVES A PINION GEAR, THE SHAFT OF WHICH ROTATES THE VALVE BALL (CLOSURE). THE SPRING IS MANUFACTURED FROM 0.177 INCH DIAMETER ELGILOY WIRE AND HAS A SPRING RATE OF 96 POUNDS PER INCH. IN THE INSTALLED POSITION, WITH THE ACTUATOR VENTED, THE SPRING EXERTS A FORCE OF 275 POUNDS. IF THE SPRING SHOULD BREAK WITH THE VALVE CLOSED, THE INTERNAL FRICTION OF THE ACTUATOR AND VALVE WOULD PREVENT THE VALVE FROM LEAVING THE CLOSED POSITION. PRESSURE LOADS ON THE VALVE BALL, FROM EITHER DIRECTION, ARE EVENLY DISTRIBUTED AND WOULD NOT TEND TO OPEN THE VALVE. THE RACK AND PINION ARE OF INCONEL 718 AND THE PINION GEAR/SHAFT IS MACHINED FROM A SINGLE PIECE OF STOCK. STRUCTURAL ANALYSIS INDICATES POSITIVE MARGINS OF SAFETY FOR ALL CONDITIONS OF VALVE OPERATIONS; FRACTURE/FATIGUE ANALYSES SHOW THAT ALL CRITICAL PARTS ARE SATISFACTORY FOR FOUR TIMES EXPECTED LIFE.

INTERNAL LEAKAGE CAN OCCUR DUE TO ENTRAPMENT OF CONTAMINANT PARTICLES BETWEEN THE BALL SEAL AND THE BALL CLOSURE OR THE RELIEF VALVE POPPET AND SEAT. HOWEVER, SYSTEM CONTAMINATION IS MINIMIZED DUE TO THE PRESENCE OF AN ET SCREEN, A GSE DEBRIS PLATE, AND A GSE FILTER.

INTERNAL LEAKAGE THROUGH THE VALVE IS CONTROLLED BY A FLUOROGOLD BALL SEAL WHICH IS LOADED BY A BELLEVILLE SPRING.

THE RELIEF VALVE WILL RELIEVE AND RESEAT IN THE RANGE OF 15 TO 40 PSID WITH A MAXIMUM FLOWRATE OF 1 POUND PER SECOND. THE RELIEF VALVE'S SIMPLE DESIGN EMPLOYS A SPHERICAL KEL-F POPPET ATTACHED TO A 6061-T651 PISTON WHICH IS LOADED BY AN ELGILOY SPRING, HOLDING THE POPPET ONTO ITS SEAT. THE PISTON IS GUIDED BY A 6061-T651 CAP AND, TO PREVENT BINDING, THE TOLERANCES BETWEEN PISTON AND CAP ARE CLOSELY CONTROLLED (0.002 TO 0.009 ON THE DIAMETER). ADDITIONALLY, THE PISTON IS HARD ANODIZED.

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SYSTEM

IF THE LH2 BLEED VALVE FAILS TO REMAIN CLOSED BEFORE T-0 THE LH2 BLEED DISCONNECT WOULD BE CLOSING WITH A HYDROGEN FLOW OF 0.9 POUNDS/SECOND. THE LH2 BLEED DISCONNECT IS NOT CERTIFIED FOR CLOSURE UNDER FLOW. THE CLOSURE IS AT A ONE "G" ACCELERATION RATE (T-0 UMBILICAL SEPARATION RATE). THE WATER HAMMER EFFECT GENERATED DURING THIS CLOSURE HAS BEEN ANALYZED TO BE LESS THAN 60 PSIG. SYSTEM PROOF PRESSURE LEVEL IS 66 PSIG.

(B) TEST

ATP

EXAMINATION OF PRODUCT

AMBIENT PROOF:

VALVE BODY - 195 PSIG, VALVE OPEN AND CLOSED
ACTUATOR - 1700 PSIG

VALVE RESPONSE TIMES - AMBIENT AND CRYO (-300 DEG F AND -423 DEG F):

VALVE: 55 PSIG
ACTUATOR: 500 AND 740 PSIG

EXTERNAL LEAKAGE - AMBIENT AND CRYO (-300 DEG F AND -423 DEG F):

VALVE BODY: 130 PSIG
ACTUATOR: 740 PSIG

INTERNAL LEAKAGE - AMBIENT AND CRYO (-300 DEG F AND -423 DEG F):

INLET-TO-OUTLET @ 55 PSIG
ACTUATOR: 740 PSIG

POSITION INDICATION: VERIFICATION OF OPERATION

ELECTRICAL CHARACTERISTICS - CONTACT RESISTANCE; INSULATION RESISTANCE; AND DIELECTRIC STRENGTH.

RELIEF VALVE CRACK AND RESEAT - AMBIENT AND CRYO(-300 DEG F): 15-40 PSID

CERTIFICATION

LIFE -

CRYO - 500 CYCLES AT -400 DEG F
AMBIENT - 1500 CYCLES

RANDOM VIBRATION TESTS - IN ALL THREE AXES

13.3 HOURS IN EACH AXIS WHILE PRESSURIZED TO 105 PSIG AND AT -300 DEG F.

DESIGN SHOCK (ALL THREE AXES) - 18 SHOCKS OF 15G EACH, THREE IN EACH DIRECTION.

SHUTTLE CRITICAL ITEMS LIST - ORBITER

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THERMAL CYCLE TESTS - PERFORMED THREE TIMES

70 DEG F TO -400 DEG F TO 70 DEG F TO 275 DEG F TO 150 DEG F

VALVE RESPONSE TIMES - AMBIENT AND CRYO (-300 DEG F AND -423 DEG F):

VALVE: 55 PSIG

ACTUATOR: 500 AND 740 PSIG

EXTERNAL LEAKAGE - AMBIENT AND CRYO (-300 DEG F AND -423 DEG F):

VALVE BODY: 130 PSIG

ACTUATOR: 740 PSIG

INTERNAL LEAKAGE - AMBIENT AND CRYO (-300 DEG F AND -423 DEG F):

INLET-TO-OUTLET @ 55 PSIG

ACTUATOR: 740 PSIG

ELECTRICAL CHARACTERISTICS - CONTACT RESISTANCE; INSULATION RESISTANCE;
AND DIELECTRIC STRENGTH.

ELECTRICAL BONDING - LESS THAN 100 MILLIOHMS

BURST - BY SIMILARITY TO THE TYPE V VALVE. 800 PSIG VALVE BODY, 1400
PSIG ACTUATOR

OMRSD

V41AYO.020 LH2 PROPELLANT SYSTEM SHAFT SEAL AND EXTERNAL LEAK TEST (I5)

V41AYO.140 LH2 PROPELLANT SYSTEM DECAY (EVERY FLT)

V41AYO.221 HELIUM SIGNATURE LEAK CHECK (EVERY FLT)

V41BFO.090 LH2 HI PT BLEED VALVE (PV22) SEAT LEAK TEST (EVERY FLT)

V41BHO.090 LH2 HI PT BLEED VALVE (PV22) RELIEF VALVE FUNCTIONAL (I10)

V41BIO.200 LH2 HI PT BLEED VALVE (PV22) RESPONSE (EVERY FLT)

V41BIO.230 INFLIGHT VALVE RESPONSE (POST FLIGHT DATA ANALYSIS)

(C) INSPECTION

RECEIVING INSPECTION

RAW MATERIAL VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS
CERTIFICATION. TEST REPORTS REQUIRED ON CAST MATERIAL. COMPLETION OF
HOT ISOSTATIC PRESSING (HIP) PROCESS IS VERIFIED. CAST HOUSING (ROUGH
MACHINED) IS INSPECTED FOR POROSITY.

CONTAMINATION CONTROL

CONTAMINATION CONTROL PROCESS AND CORROSION PROTECTION PROVISIONS ARE
VERIFIED. THE INTERNAL WETTED SURFACES ARE CLEANED TO LEVEL 400A AND
VERIFIED BY INSPECTION.

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ASSEMBLY/INSTALLATION

ALL DETAIL PARTS ARE INSPECTED FOR CRITICAL DIMENSIONS, SURFACE FINISH, BURRS, DAMAGE, AND CORROSION. CRITICAL POPPET AND SLEEVE SURFACES ARE LAPPED AND INSPECTED WITH 40X MAGNIFICATION. TORQUES ARE VERIFIED TO BE IN ACCORDANCE WITH DRAWING REQUIREMENTS. PRIOR TO INSTALLATION, SEALS ARE VISUALLY EXAMINED WITH 10X MAGNIFICATION FOR DAMAGE AND CLEANLINESS. ALL SPRINGS ARE LOT TRACEABLE AND LOAD TESTED AT THE PIECE PART LEVEL. MANDATORY INSPECTION POINTS ARE INCLUDED IN THE ASSEMBLY PROCEDURE.

CRITICAL PROCESSES

HEAT TREATMENT OF THE VALVE BALL AFTER MACHINING IS VERIFIED. PART PASSIVATION AND HARD ANODIZING ARE VERIFIED. CERTIFICATION OF WELDING, POTTING, AND SOLDERING IS VERIFIED. PAINTING (ON BODY), ELECTRICAL BONDING, AND DRY FILM LUBRICANT ARE VERIFIED BY INSPECTION. ALL CASTINGS ARE SUBJECTED TO A HIP PROCESS.

NONDESTRUCTIVE EVALUATION

PRIOR TO FINAL MACHINING, THE HOUSING IS X-RAYED, ETCH AND DYE PENETRANT INSPECTED, AND LEAK CHECKED AT PROOF PRESSURE. ALL WELDS ON THE ELECTRICAL CONNECTOR ARE DYE PENETRANT INSPECTED AND VERIFIED BY INSPECTION.

TESTING

ATP VERIFIED BY INSPECTION.

PACKAGING/HANDLING

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

(D) FAILURE HISTORY

INTERNAL LEAKAGE:

MINOR INTERNAL LEAKAGES HAVE OCCURRED AT THE SUPPLIER DURING ATP. CORRECTIVE ACTIONS WERE DESIGN CHANGES TO THE BALL SEAL AND RETAINER. DISCREPANT PARTS WERE REPLACED, MANUFACTURING ASSEMBLY PROCEDURES WERE CHANGED, AND ALLOWABLE ACTUATOR AND SHAFT SEAL LEAKAGE RATE REQUIREMENTS WERE RELAXED (REFERENCE CARs AC5714, AC6963, AB3341).

INTERNAL LEAKAGE DURING ATP WAS CAUSED BY BURRS AT THE SEALING CONTACT AREA OF THE BALL SEAL (REFERENCE CAR AB9088). SUPPLIER INITIATED A DEBURRING OPERATION UNDER 30X MAGNIFICATION. CORRECTIVE ACTION IS EFFECTIVE FOR TYPE I THRU TYPE V VALVES.

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INTERNAL LEAKAGE DURING ATP WAS DETERMINED TO BE CAUSED BY INSUFFICIENT SEALING PRESSURE BETWEEN THE BALL SEAL AND THE BALL (REFERENCE CAR AC5985). THE SEAL RETAINER WAS FOUND TO BE DIMENSIONALLY DISCREPANT, CAUSING THE LACK OF SEALING PRESSURE. ALL EXISTING SEAL RETAINERS (P/N 80692) HAVE BEEN INSPECTED AND REWORKED TO THE CORRECT ANGLE OF 26 DEGREES.

DURING ATP AT ROCKWELL-DOWNEY, THE TYPE IV BALL VALVE EXHIBITED EXCESSIVE OUTLET-TO-INLET LEAKAGE AT LH2 TEMPERATURES (REFERENCE CAR AD1422). THE LEAKAGE WAS DUE TO HIGH POROSITY OF THE VALVE BODY (A356 ALUMINUM) AT THE BALL SEAL BODY CONTACT AREA. CORRECTIVE ACTION WAS TO IMPLEMENT A HOT ISOSTATIC PRESSING (HIP) PROCESS WHICH REDUCES THE POROSITY OF THE PARENT METAL. THE PROBLEM IS ATP SCREENABLE DURING THE HYDROGEN ATP. OV103 AND OV104 BALL VALVES (LH2 ATPped BUT NOT HIPped) HAVE EXHIBITED NO LEAKAGE. THE OV102 VALVES WERE NOT ACCEPTANCE TESTED WITH LH2. THE OV102 LH2 VALVES ARE SCHEDULED FOR REMOVAL AND REWORK FOR OTHER DESIGN CHANGES.

DURING ATP, THE INLET TO OUTLET LEAKAGE AT CRYO TEMPERATURES EXCEEDED THE LEAKAGE REQUIREMENT (REFERENCE CAR A6441). DURING DISASSEMBLY, IT WAS NOTED THAT THE TORQUE ON THE BALL SEAL ASSEMBLY RETAINER WAS LOW. THE RETAINER WAS RETORQUED AND THE VALVE WAS RETESTED AT CRYO TEMPERATURES AND LEAKAGE REQUIREMENTS WERE MET. ASSEMBLY PROCEDURES WERE CHANGED TO INCORPORATE AN INSPECTION POINT TO VERIFY PROPER RETAINER TORQUE.

DURING ATP CRYO TESTS, LEAKAGE PAST THE BALL SEAL WAS NOT WITHIN THE LEAKAGE REQUIREMENTS (REF CAR A5402). DIS-ASSEMBLY OF THE VALVE SHOWED NO OBVIOUS LEAK PATHS. THE ATP WAS REVISED TO ESTABLISH A ONE HOUR COLD SOAK STABILIZATION TIME PRIOR TO FUNCTIONAL TESTING. ALSO, THE PROCEDURES WERE ESTABLISHED TO OBTAIN CORRECT SEAL LOADING DURING ASSEMBLY. THE VALVE HAS BEEN REDESIGNED AND THIS SEAL CONFIGURATION IS NO LONGER IN USE.

DURING ATP, THE INLET-TO-OUTLET LEAKAGE (125 AND 162 SCIM - MAX ALLOWABLE 100 SCIM) EXCEEDED THE REQUIREMENT ON TWO VALVES (REF CAR A9672). DUE TO MPTA TEST SCHEDULE DEMANDS, BOTH VALVES WERE WAIVED AND APPROVED FOR MPTA TESTING. NO FAILURE ANALYSIS WAS PERFORMED ON EITHER VALVE.

DURING ATP, THE INLET-TO-OUTLET LEAKAGE (820 SCIM - MAX ALLOWABLE 400 SCIM) EXCEEDED THE REQUIREMENT (REF CAR A8502). ALSO, THE RELIEF VALVE FLOW REQUIREMENTS WERE NOT MET. DUE TO MPTA TEST SCHEDULE DEMANDS, THE VALVE WAS WAIVED AND APPROVED FOR MPTA TESTING. NO FAILURE ANALYSIS WAS PERFORMED.

DURING ATP, EXCESSIVE INLET-TO-OUTLET LEAKAGE ON TWO VALVES OCCURRED AT CRYO TEMPERATURES (REF CARS AC6753 AND AC5201). THE VALVES WERE DISASSEMBLED AND THE BALL SEAL REVEALED HAIRLINE CRACKS AT SEVERAL POINTS ON THE INNER DIAMETER. TESTING INDICATED THAT THE CRACKS WERE CAUSED BY THE GEOMETRY OF THE BALL SEAL. THE BALL SEAL WAS REDESIGNED TO INCORPORATE A LARGER INNER DIAMETER; THE VALVE PASSED SUBSEQUENT LEAKAGE TESTS. THIS DESIGN CHANGE WAS INCORPORATED ON ALL FIVE BALL VALVE CONFIGURATIONS.

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DURING LEAK TEST AT KSC, THE RTLS INBOARD DUMP VALVE LEAKED INTERNALLY (REFERENCE CAR AB5689). LEAKAGE WAS DUE TO CONTAMINATION ON THE RELIEF VALVE POPPET. THE VALVE WAS REPLACED AND SUBSEQUENTLY PASSED THE VEHICLE LEAK CHECK REQUIREMENTS.

FAILS TO REMAIN CLOSED:

THERE HAVE BEEN NO FAILURES OF THE VALVE TO REMAIN CLOSED.

(E) OPERATIONAL USE
NO ACTION CAN BE TAKEN.