

June 01, 1995

CRITICAL ITEMS LIST

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1) CIL ITEM : B400-14  
2) FMEA CODE : B400  
3) COMPONENT : HPOTP  
4) PART NUMBER : RS007701  
5) SYSTEM/SUBSYSTEM : PUMPS/BXIX  
6) FAILURE MODE : LOSS OF AXIAL BALANCING FORCE

7) PREPARED : SSME RELIABILITY  
8) APPROVED :  
9) DATE : 06-01-95  
10) REVISION/CHANGE : -0B2/O  
11) EFFECTIVITY : -761  
12) HAZARD REDUNDANCY : SEE LISTINGS BELOW  
13) CCBD # : ME3-01-3215

PHASE	FAILURE DESCRIPTION/EFFECT	CRITICALITY
SHC	EXCESSIVE SHAFT AXIAL DISPLACEMENT, RESULTING IN INTERNAL RUBBING OF ROTATING COMPONENTS. DISINTEGRATION OF ROTATING PARTS OCCURS AT HIGH SPEED. LOSS OF VEHICLE.  REDUNDANCY SCREENS: SINGLE POINT FAILURE: N/A	HAZARD REF: ME-C15,M, ME-C1A,C

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CIL ITEM: 8400-14	DESIGN	DOCUMENT REF.
<b>FAILURE CAUSE A: DAMAGE TO BALANCE PISTON ORIFICES FROM CONTAMINATION</b>		
<p>THE ROTOR RESIDUAL THRUST FORCES ARE COUNTERACTED AND BALANCED DURING MAINSTAGE BY A BALANCE PISTON DESIGN. THE BALANCE PISTON IS A SELF-COMPENSATING, NON-RUBBING DESIGN WHICH UTILIZES LEAKAGE FLOWS ACROSS OVERLAPPING ORIFICES TO ATTAIN THE DESIRED PRESSURE GRADIENTS IN THE BALANCE CAVITIES. THE LEAKAGE FLOWS, WHICH ARE ROUTED FROM THE MAIN IMPELLER DISCHARGE, ARE CONTROLLED BY THE ORIFICE DIMENSIONS BETWEEN THE MAIN IMPELLER (1) AND THE LEFT AND RIGHT BALANCE PISTON SEALS (2) (3). ASSEMBLY PROCEDURES ESTABLISH PROPER SHIMMING OF THE IMPELLER AND SEAL TO PROVIDE OPTIMUM BALANCE PISTON RESPONSE (4). SHARP EDGE ORIFICE LIPS ARE MACHINED ONTO THE MAIN IMPELLER OUTER SHROUDS. THE MAIN IMPELLER IS MANUFACTURED UTILIZING AN INCONEL 718 FORGING AND IS SOLUTION HEAT TREATED AND AGE-HARDENED (1). THE ALLOY IS RESISTANT TO CORROSION AND STRESS CORROSION CRACKING (5). ITS STRENGTH PROVIDES WEIGHT SAVINGS WHILE RETAINING DUCTILITY AT CRYOGENIC TEMPERATURES (5). THE LEFT AND RIGHT BALANCE PISTON SEALS ARE MANUFACTURED UTILIZING SILVER AND CONTAIN THE STATIONARY SHARP EDGE ORIFICES (2) (3). SILVER WAS SELECTED FOR ITS HIGH IGNITION TEMPERATURE AND THERMAL CONDUCTIVITY CHARACTERISTICS FOR THIS CONTROLLED TOLERANCE APPLICATION (5). IN ADDITION, IT EXHIBITS ANTI-GALLING CHARACTERISTICS AND WEAR RESISTANCE (5). THE SEALS ARE SECURED TO THE TURNING VANES, WHICH ARE SECURED TO THE MAIN HOUSING. THE COMPRESSIVE LOAD SUPPLIED BY THE SEAL BOLTS AGAINST THE TURNING VANES, TOGETHER WITH THE INTERFERENCE FIT BETWEEN THE SEAL AND MAIN HOUSING, MINIMIZES BYPASS LEAKAGE POTENTIALS. DAMAGE DUE TO CONTAMINATION IS MINIMIZED BY THE VEHICLE PROPELLANT CLEANLINESS REQUIREMENTS (6). THE MAIN IMPELLER HAS COMPLETED DESIGN VERIFICATION TESTING FOR NATURAL FREQUENCY (7) AND STRESS DISTRIBUTION (8). THE ROTATING ASSEMBLY HAS COMPLETED DESIGN VERIFICATION TESTING FOR STRUCTURAL DEFLECTIONS (9). THE BALANCE PISTON SEALS ARE ASSESSED TO HAVE INFINITE LIFE (10) AND ARE NOT TRACKED BY SERIALIZATION.</p>	<p>(1) RS007718  (2) RS007727  (3) RS007773  (4) RL00814  (5) RSS-8578-11  (6) JCD 13415000  (7) RSS-403-4B  (8) RSS-403-57A  (9) RSS-403-50  (10) RL00532,  CP320R0003B</p>	
<b>FAILURE CAUSE B: LOSS OF BOLT PRELOAD CAUSING RUBBING IN THE BALANCE PISTON REGION</b>		
<p>THE LEFT AND RIGHT BALANCE PISTON SEALS ARE RETAINED AXIALLY AGAINST THE TURNING VANES BY BOLTS WHICH ARE LOCKED WITH CUPWASHERS. THE CUPWASHERS ARE YIELDED AGAINST A NOTCH IN THE BOLT HEAD AND TO THE BALANCE PISTON RINGS, TO PREVENT DISENGAGEMENT DURING OPERATION. RADIAL PILOTING FOR THE SEALS ARE PROVIDED BY THE INTERFERENCE FIT FROM THE HOUSING ASSEMBLY. EACH SEAL UTILIZES ELEVEN BOLTS AND CUPWASHERS THAT ARE MANUFACTURED UTILIZING A-286 CRES (1) (2). THE ALLOY IS RESISTANT TO CORROSION AND STRESS CORROSION CRACKING (3). THE ALLOY IS SOLUTION HEAT TREATED AND AGE-HARDENED (1) (2). DRY-FILM LUBRICATION IS APPLIED TO BOTH PARTS TO MINIMIZE FRETTING, WHILE ALLOWING EQUAL LOAD DISTRIBUTION FOR THE THREADED SURFACES (1) (2). THE CUPWASHERS ARE ANNEALED FOR THIS BENDING APPLICATION (2). ASSEMBLY PROCEDURE FOR LOCKING DEVICES ENSURE DEFECT-FREE INSTALLATION (4). THE BOLTS AND CUPWASHERS ARE ASSESSED TO HAVE INFINITE LIFE (5) AND ARE NOT TRACKED BY SERIALIZATION.</p>	<p>(1) RS007792  (2) RS007794  (3) RSS-8578-11  (4) RL00814  (5) RL00532,  CP320R0003B</p>	

CIL ITEM: B400-14		DESIGN	DOCUMENT REF.
ALL CAUSES:			
<p>INCONEL 718, SILVER, AND A-286 CRES SATISFY LOX COMPATIBILITY REQUIREMENTS (1). THE HIGH CYCLE AND LOW CYCLE FATIGUE LIFE OF THE MAIN IMPELLER, BALANCE PISTON SEALS, BALANCE PISTON BOLTS, AND CUPWASHERS MEET CET REQUIREMENTS (2). THE MINIMUM FACTORS OF SAFETY FOR THESE PARTS MEET CET REQUIREMENTS (3). THE HARDWARE PARENT MATERIALS WERE CLEARED FOR FRACTURE MECHANICS/IDE FLAW GROWTH SINCE THEY ARE NOT FRACTURE CRITICAL PARTS, EXCEPT FOR THE RIGHT AND LEFT-TURNING VANES WHICH WERE CLEARED BY CRITICAL INITIAL FLAW SIZE DETECTABILITY, THE MAIN HOUSING WAS CLEARED BY RISK ASSESSMENT (4). REUSE OF PARTS DURING OVERHAUL ARE CONTROLLED BY THE REQUIREMENTS OF THE OVERHAUL SPECIFICATION (5).</p>			<p>(1) RSS-B576-11                  (2) RL00532,                  CP320R0003B                  (3) RSS-B546-16,                  CP320R0003B                  (4) NASA TASK 117                  (5) RL00874</p>
CIL ITEM: B400-14		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
FAILURE CAUSE A:	<p>RS007727 - SEAL RING                  RS007729 - MAIN HOUSING                  (RS007732 - VOLUTE)                  (RS007729 - FLANGES)                  RS007773 - SEAL RING</p>		<p>RS007727                  RS007729                  RS007732                  RS007729                  RS007773</p>
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION AND DRAWING REQUIREMENTS.	<p>RA0170-153                  RS007727                  RS007773</p>
	ASSEMBLY INTEGRITY	<p>ALL INSTRUMENTATION, BLEED AND FLOW PASSAGES ARE INSPECTED FOR CONTAMINATION PER SPECIFICATION REQUIREMENTS.</p> <p>MAIN HOUSING WELDS 22 &amp; 24 ARE MASS SPECTROMETER LEAK CHECKED PER SPECIFICATION REQUIREMENTS.</p> <p>TURNING VANES, SEAL RETAINING RINGS AND SEAL RINGS ARE VERIFIED AS BOTTOMED PER SPECIFICATION REQUIREMENTS.</p>	<p>RL00814                  RA0115-116                  RL00814</p>

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CIL ITEM: B400-14		INSPECTION AND TEST		
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.	
FAILURE CAUSE B:  B - 294		THE OXIDIZER SYSTEM IS PURGED PER SPECIFICATION REQUIREMENTS.	OMRSD 800FBO.300 OMRSD 800FMO.250 OMRSD V41C80.080 OMRSD V41C80.081	
		HEAT TREAT	MAIN HOUSING HEAT TREAT IS VERIFIED BY SPECIFICATION REQUIREMENTS.	RA0611-020
		RS007792 - SCREW RS007794 - CLIPWASHER RS007741 - TURNING VANE RS007743 - TURNING VANE		RS007792 RS007794 RS007741 RS007743
		MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007792 RS007794 RS007741 RS007743
		HEAT TREAT	HEAT TREAT AND ANNEALING ARE VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0611-020
		SURFACE FINISH	THE SCREW AND CLIPWASHER DRY-FILM LUBRICATION IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0112-003
		ASSEMBLY INTEGRITY	SCREW TORQUE IS VERIFIED PER DRAWING REQUIREMENTS.	RS007701
			LOCKWASHER DEFORMATION IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007701 RLOC814
		RS007701 - HP01P		RS007701
	ALL CAUSES:	CLEANLINESS OF COMPONENTS	COMPONENTS ARE VERIFIED CLEANED PER SPECIFICATION REQUIREMENTS.	RL10001

CIL ITEM: B400-14		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
	ASSEMBLY INTEGRITY	<p>THE PUMP SUBASSEMBLIES ARE INSPECTED DURING OVERHAUL PER SPECIFICATION REQUIREMENTS. INSPECTIONS INCLUDE: VISUAL, DIMENSIONAL, PENETRANT, AND REPLACEMENT OF USAGE ITEMS AS APPLICABLE, PER OVERHAUL CLASSIFICATION.</p> <p>OPERATION/PERFORMANCE IS VERIFIED BY ENGINE HOT FIRE TESTING AND 2ND E &amp; W INSPECTIONS.</p> <p>TORQUE CHECKS ARE PERFORMED PRIOR TO EACH FLIGHT.</p> <p>HPOTP MICROSHAFT TRAVEL MEASUREMENTS ARE PERFORMED PRIOR TO EACH FLIGHT PER SPECIFICATION REQUIREMENTS.</p> <p>DATA FROM PREVIOUS FLIGHT OR HOT FIRE IS REVIEWED FOR PROPER TURBOPUMP OPERATION/PERFORMANCE. (LAST TEST)</p>	<p>RL00874 RA0115-114</p> <p>RL00050-04 RL00056-06 RL00056-07 RL00461</p> <p>DMRSD V41850.04D</p> <p>RLD1034 RL00050-04 DMRSD V41850.04S</p> <p>NSFC PLN 1228</p>
<p>FAILURE HISTORY: COMPREHENSIVE FAILURE HISTORY DATA IS MAINTAINED IN THE PROBLEM REPORTING DATABASE (PRANS/PRACA). REFERENCE: NASA LETTER 8A29/88/308 AND ROCKETDYNE LETTER 88RC09761.</p>			

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OPERATIONAL USE: NOT APPLICABLE.

TABLE 8400. HIGH PRESSURE OXIDIZER TURBOPUMP  
FREA/CIL WELD JOINTS

COMPONENT	BASIC PART NO.	WELD NO.	WELD TYPE	CLASS	ROOT SIDE NOT ACCESS	CRITICAL INITIAL		COMMENTS
						FLAW SIZE NOT HCF	DETECTABLE LCF	
MAIN HOUSING	RS007729	1,2	EBW	I	X	X		
MAIN HOUSING	RS007729	3	EBW	I		X		
MAIN HOUSING	RS007729	9,10	GTAW	II	X	X	X	
MAIN HOUSING	RS007729	11,12	GTAW	I		X		
MAIN HOUSING	RS007729	13	EBW	I	X	X		
MAIN HOUSING	RS007729	14-17,16	GTAW	II	X			
MAIN HOUSING	RS007729	18,19	GTAW	II	X	I	X	
MAIN HOUSING	RS007729	21,23	GTAW	II	X			
MAIN HOUSING	RS007729	22,24	GTAW	II	X			
MAIN HOUSING	RS007729	44,53-59	GTAW	I	X			
MAIN HOUSING	RS007729	45	GTAW	I	X			
MAIN HOUSING	RS007729	48	GTAW	I	X	X		X
MAIN HOUSING	RS007729	49	GTAW	I	X			
MAIN HOUSING	RS007729	50	GTAW	I				
MAIN HOUSING	RS007729	51,52	GTAW	I	X			
MAIN HOUSING	RS007729	54	GTAW	I	X			
MAIN HOUSING	RS007729	55,56	GTAW	I	X			
MAIN HOUSING	RS007729	61	GTAW	I				
MAIN HOUSING	RS007729	62	GTAW	I	X			
MAIN HOUSING	RS007729	63	GTAW	I				
MAIN HOUSING	RS007729	64	GTAW	I	X	X		
MAIN HOUSING	RS007729	65	GTAW	I	X			
MAIN HOUSING	RS007729	66-70	GTAW	II	X			
INLET HOUSING	RS007732	4	GTAW	I			I	
INLET HOUSING	RS007732	8,9	GTAW	I			I	
VOLUTE	RS007732	10,15	GTAW	I	X	I		
VOLUTE	RS007732	20,21	GTAW	I				
VOLUTE	RS007732	22,23	GTAW	I				
VOLUTE	RS007732	24,27	GTAW	I		X		X
VOLUTE	RS007732	25,26	GTAW	I				
FLANGE	RS007736	1,2	GTAW	II	X			
FLANGE	RS007736	3,26	GTAW	II	X			

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TABLE 1400. HIGH PRESSURE OXIDIZER TURBOPUMP  
FREA/CIL WELD JOINTS

COMPONENT	BASIC PART NO.	WELD NO.	WELD TYPE	CLASS	ROOT	CRITICAL INITIAL		COMMENTS
					SIDE NOT ACCESS	FLAW SIZE NOT HCF	DETECTABLE LCF	
FLANGE	RS007736	6,7	GTAW	II	X			
FLANGE	RS007736	9-12,17	GTAW	II	X			
FLANGE	RS007736	13-16	GTAW	II	X			
FLANGE	RS007736	18,20	GTAW	I	X			
FLANGE	RS007736	19,21	GTAW	II	X			
FLANGE	RS007736	22	EBW	I	X			
FLANGE	RS007736	23	GTAW	II				
FLANGE	RS007736	24	GTAW	II	X			
FLANGE	RS007736	26	GTAW	II	X			
BELLOWS	RS007740	1,2,5,9	GTAW	I		X		
BELLOWS	RS007740	3,4	EBW	I				
HOUSING	RS007746	1,2	GTAW	I	X		X	
HOUSING	RS007746	3	GTAW	I	X			
HOUSING	RS007746	4	GTAW	II	X			
HOUSING	RS007746	5	GTAW	II	X		X	
HOUSING	RS007746	6-17	GTAW	II	X		X	
HOUSING	RS007746	18-29	GTAW	II	X		X	
HOUSING	RS007746	30-41	GTAW	II		X		X
BELLOWS	RS007748	1	EBW	I				
BELLOWS	RS007748	2	GTAW	I	X			
BELLOWS	RS007749	1-4	GTAW	I				
BELLOWS	RS007749	5,6	EBW	I				
BELLOWS	RS007749	11	EBW	I				
BELLOWS	RS007749	12	EBW	I				
BELLOWS	RS007751	3	EBW	I	X			
BELLOWS	RS007751	4	EBW	I	X	X		X
BELLOWS	RS007751	8	GTAW	I	X	X		
SECOND STAGE NOZZLE	RS007752	1,2	EBW	I	X			
SECOND STAGE NOZZLE	RS007752	1	GTAW	I	X	X		X
JET RING	RS007757	1	GTAW	I	X	X		X
FAIRING	RS007774	1-12	GTAW	I		X		
FAIRING	RS007774	13-24	GTAW	I		X		

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TABLE B100. HIGH PRESSURE OXIDIZER TURBOPUMP  
FMEAS/CIL WELD JOINTS

COMPONENT	BASIC PART NO.	WELD NO.	WELD TYPE	CLASS	ROOT SIDE NOT ACCESS	CRITICAL INITIAL		COMMENTS
						FLAW SIZE NOT REF	DEFECTABLE LCF	
FAIRING	RS007774	25-36	BTAW	I		X		
FAIRING	RS007774	74	BTAW	I				
FAIRING	RS007774	75,76	BTAW	II	X			
STRUT	RS007779	23-44, 143-164	BTAW	II	X			
STRUT	RS007779	45-66, 165-186	BTAW	II	X			
STRUT	RS007779	67	BTAW	II	X			
STRUT	RS007779	69,70	EDW	II	X			
STRUT	RS007779	71	EDW	II				
STRUT	RS007779	72	EDW	II				
STRUT	RS007779	73-94	EDW	II				
STRUT	RS007779	95,96	EDW	II	X			
SHIELD	RS007781	1,11	BTAW	II				
SHIELD	RS007781	2,3,4	BTAW	II				
SEAL	RS006848	1 PLC	BTAW	I				
SEAL	RS006857	1 PLC	BTAW	I		X	X	

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FIELD CONFIGURATION VARIANCES FROM CIL RATIONALE

CIL ITEMS: B400-XN	HPOIP		P/N RS007791
BASE LINE RATIONALE	VARIANCE	CHANGE RATIONALE	VARIANT DASH NUMBER
<p>1. B400-02, B400-03 SECOND STAGE NOZZLE CASTING IS NOT ISOSTATIC PRESSED PER DRAWING REQUIREMENTS. (ECP 1A-2949)</p>	<p>SECOND STAGE NOZZLE CASTINGS HAVE NOT BEEN HOT ISOSTATIC PRESSED</p>	<p>NOT ISOSTATIC PRESS INCREASES STRUCTURAL INTEGRITY BY REDUCING CASTING MICROPOROSITY.</p> <p>USE AS IS RATIONALE:</p> <ol style="list-style-type: none"> <li>1. LIFE LIMIT ON NON HOT ISOSTATIC PRESSED 2ND STAGE NOZZLES REDUCES PROBABILITY OF LOW CYCLE FATIGUE CRACKING RESULTING FROM EXCESSIVE MICROPOROSITY. (DAR 2147)</li> <li>2. A PENETRANT INSPECTION INTERVAL HAS BEEN IMPOSED ON NON HOT ISOSTATIC PRESSED 2ND STAGE NOZZLES TO VERIFY NO CRACKING IN EXCESS OF ALLOWABLE LIMITS. (DAR 2147)</li> </ol>	<p>-121, -131, -141, -151, -161, -171, -181, -191, -201, -211, -221, -231, -241, -251, -261, -271, -291, -301, -311, -351, -351, -371, -401</p>
<p>2. B400-13, B400-22 PROCESSED AND INSPECTED PER SPECIFICATION REQUIREMENTS (RL00916). (ECP 909)</p>	<p>BEARINGS ARE PROCESSED AND INSPECTED PER SPECIFICATION REQUIREMENTS (RL00558).</p>	<p>LONG TERM FATIGUE LIFE OF BEARING IS EXTENDED BY REDUCING THE ALLOWABLE SIZE AND QUANTITY OF ALLOWABLE DEFECTS.</p> <p>USE AS IS RATIONALE:</p> <ol style="list-style-type: none"> <li>1. WEAR LIFE LIMIT ON BEARINGS PREVENTS WEAR FROM EXCEEDING ALLOWABLE LIMITS. (DAR 2054, DAR 2082)</li> <li>2. CONTINUED USE WITH ALLOWABLE DISCREPANCIES IS CONTROLLED PER THE MAINTENANCE CONTROL DOCUMENT REQUIREMENTS (RSS-8793).</li> </ol>	<p>-121, -131, -141, -151, -161, -171, -181, -191, -201, -211, -221, -231, -241, -251, -261, -271, -291, -301, -311, -331, -351, -371, -401, -411, -421, -431, -441, -451, -461</p>

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FIELD CONFIGURATION VARIANCES FROM CIL RATIONALE

CIL ITEMS: B400-NK		HPOTP	P/W RS007701
BASE LINE RATIONALE	VARIANCE	CHANGE RATIONALE	VARIANT DASH NUMBER
3. B400-21 HOUSING DETAILS ARE ULTRASONIC INSPECTED PER DRAWING AND SPECIFICATION REQUIREMENTS. (ECP 680)	HOUSING DETAILS HAVE NOT BEEN ULTRASONIC INSPECTED PER DRAWING AND SPECIFICATION REQUIREMENTS.	<p>THE ADDED NDI PROVIDES ADDED CONFIDENCE THAT THE CRITICAL FLAW SIZE IS DETECTED IN THE PARENT MATERIAL OF THE HOUSING DETAILS.</p> <p>USE AS IS RATIONALE:</p> <ol style="list-style-type: none"> <li>HOUSING DETAILS ARE ACCEPTABLE WITHOUT ULTRASONIC INSPECTION DUE TO A PENETRANT INSPECTION OF THE HOUSING DETAILS. THE PENETRANT INSPECTION IS ADEQUATE TO DETECT CRITICAL INITIAL FLAWS WHICH ARE THROUGH CRACKS.</li> </ol>	-121, -131, -141, -151, -161, -171, -181, -191, -201, -211, -221, -231, -241, -251, -261, -271, -291, -301, -311, -331, -351, -371, -401, -411, -421, -431, -441, -451, -461, -471, -481, -491, -501
4. B400-21 FITTING MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS (INCONEL 718, 880170-153).	RS007729-059 TEE-FITTING IS MANUFACTURED FROM AIR MELT 321 CRES BAR (00-S-763 CL321 COND A).	<p>INCONEL 718 MATERIAL DOES NOT EXHIBIT INCLUSION STRINGERS WHICH ARE SUSCEPTABLE TO CHEMICAL ATTACK AND MAY RESULT IN LEAKAGE.</p> <p>USE AS IS RATIONALE:</p> <ol style="list-style-type: none"> <li>FITTINGS ARE LEAK CHECKED FOLLOWING PROOF PRESSURE TEST PER RL00387.</li> <li>LOADS INDUCED BY FABRICATION (WELDING AND PROOF PRESSURE TESTING) ARE HIGHER THAN OPERATIONAL LOADS AND SUFFICIENT TO SCREEN -059 FITTINGS FOR LEAKAGE.</li> </ol>	-171, -181

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