

June 01, 1995

CRITICAL ITEMS LIST

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1) CIL ITEM : B400-15  
2) FMEA CODE : B400  
3) COMPONENT : HPOTFP  
4) PART NUMBER : R9007701  
5) SYSTEM/SUBSYSTEM : PUMP/OXYN  
6) FAILURE MODE : LOSS OF PURGE PRESSURE BARRIER

7) PREPARED : SSNE RELIABILITY  
8) APPROVED :  
9) DATE : 06-01-95  
10) REVISION/CHANGE : -002/0  
11) EFFECTIVITY : -761  
12) HAZARD REFERENCE : SEE LISTINGS BELOW  
13) CCBB # : MB-D-3275

PHASE	FAILURE DESCRIPTION/EFFECT	CRITICALITY
SHC	<p>LOSS OF HELIUM PURGE PRESSURE BARRIER PERMITS LIQUID OXIDIZER LEAKAGE OR HOT TURBINE GAS LEAKAGE IN THE INTERMEDIATE SEAL, RESULTING IN POSSIBLE CONTACT BETWEEN THE TWO FLUIDS AND POSSIBLE DISINTEGRATION OF PUMP COMPONENTS. MIXING OF OXIDIZER AND HOT-GAS WILL CAUSE DISINTEGRATION OF ROTATING ASSEMBLY, RESULTING IN AN OXIDIZER FIRE OR EXPLOSION. LOSS OF VEHICLE.</p> <p>REDUNDANCY SCREENS: SINGLE POINT FAILURE: N/A</p>	<p>↑ HAZARD REF: ME-C18,H, ME-C1A,C</p>

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CIL ITEM: B400-15	DESIGN	DOCUMENT REF.
<p>FAILURE CAUSE A: SEAL FAILURE OR DAMAGE</p> <p>THE INTERMEDIATE SEAL (1) ESTABLISHES A HELIUM PURGE PRESSURE BARRIER TO MAINTAIN INTERNAL SEPARATION OF HYDROGEN-RICH STEAM WITH GASEOUS OXYGEN. THE SEAL HOUSING ASSEMBLY IS FABRICATED IN TWO HALVES WHICH LOCK TOGETHER WITH INTERLOCKING TANGS. GASEOUS HELIUM IS SUPPLIED FROM THE MAIN PUMP HOUSING TO THE SEAL HOUSING MANIFOLD AND IS INTRODUCED BETWEEN THE SEAL RING ELEMENTS. THE CLEARANCE BETWEEN THE SEAL AND MATING RING CONTROLS THE BACKPRESSURE OF THE PURGE BARRIER AND IS SPECIFIED BY DRAWING REQUIREMENTS (1)(2). THE SEAL ELEMENTS ARE RADially FREE-FLOATING TO ACCOMMODATE SHAFT DYNAMIC DEFLECTIONS AND UTILIZE A BUSH NOSE PAD DESIGN WITH A MICROFINISH SURFACE ON THE DOWNSTREAM FACE FOR BYPASS LEAKAGE PREVENTION (1). THE SEALS ARE AXIALLY PRELOADED AGAINST THE HOUSING BY A SPRING BETWEEN THE SEALS FOR PROPER POSITIONING DURING NON-OPERATIONAL PHASES (1). PRESSURE LOADING DURING OPERATION ENHANCES THE NOSE PAD SEALING. THE HOUSING IS MANUFACTURED UTILIZING INCONEL 718, AND WAS SELECTED FOR ITS STRENGTH AND DUCTILITY OVER A WIDE TEMPERATURE RANGE (3). THE ALLOY IS RESISTANT TO CORROSION AND STRESS CORROSION CRACKING AND IS LOX COMPATIBLE (3). THE HOUSING IS SOLUTION HEAT TREATED AND AGE-HARDENED (1). SILVER PLATING IS UTILIZED AT THE OUTER FLANGE RIM TO PREVENT HELIUM LEAKAGE (1). HYDROGEN ENVIRONMENT PROTECTION IS NOT REQUIRED DUE TO THE LOW STRAIN APPLICATION OF THE HOUSING. THE SEAL ELEMENTS CONTAIN AN OUTER ADAPTER RING MANUFACTURED UTILIZING INCONEL X-750 AND AN INNER RING OF CARBON G64. THE ADAPTER RING PROVIDES AN INTERFERENCE FIT TO COMPRESS THE CARBON RING AND HAS ANTI-ROTATION TANGS ON THE OUTER DIAMETER TO LIMIT TANGENTIAL MOVEMENT (1). THE ALLOY IS SOLUTION HEAT TREATED AND AGE-HARDENED (1), AND EXHIBITS RESISTANCE TO CORROSION AND STRESS CORROSION CRACKING (3). THE ADAPTER RINGS ARE CONTINUOUSLY EXPOSED TO GASEOUS NITROGEN OR HELIUM DURING ALL PHASES OF OPERATION. THE CARBON RINGS ARE MANUFACTURED UTILIZING CARBON GRAPHITE, WHICH IS SINTERED IN A PREFORM SHAPE (3). THE MATERIAL IS RESISTANT TO DETERIORATION IN A HIGH TEMPERATURE EXHAUST GAS ENVIRONMENT (3). ITS WEAR RESISTANCE, COEFFICIENT OF FRICTION, AND LIGHTWEIGHT RESPONSE ABILITY TO SHAFT MOVEMENT ARE SUITED FOR THIS APPLICATION (3). THE SPRING IS MANUFACTURED UTILIZING INCONEL X-750, WHICH HAS HIGH TEMPERATURE STRENGTH AND IS ANNEALED FOR THIS DUCTILE APPLICATION (1). THE MATING RING IS MANUFACTURED UTILIZING INCONEL 718, AND IS SOLUTION HEAT TREATED AND AGE-HARDENED (2). THE JOURNAL FOR THE SEAL RINGS IS CHROMIUM PLATED AND GROUND TO ACHIEVE A MICROFINISH SURFACE TO ENHANCE THE SEALING CHARACTERISTICS (2). THE AXIAL FACES OF THE MATING RING, THE INNER HEAT SHIELD, AND THE SHAFT SHOULDER HAVE STRINGENT PERPENDICULARITY REQUIREMENTS TO PRODUCE A TIGHT AXIAL STACK (1)(2)(4). THE AXIAL STACKUP, PLUS SILVER PLATING OF THE HEAT SHIELD FACES, CREATES A SEAL AND PREVENTS HOT-GAS BYPASS LEAKAGE UNDER THE MATING RING. A FLOW DIVERTER IS INCORPORATED INTO THE MATING RING DESIGN TO PREVENT DIRECT IMPINGEMENT OF OXIDIZER TO THE SEAL ELEMENT (2). THE HEAT SHIELD FUNCTIONS IN A SIMILAR MANNER FOR THE HOT-GAS FLOW (4). THE INTERMEDIATE SEAL AND MATING RING PARENT MATERIALS WERE CHOS FOR FRACTURE MECHANICS/WIDE FLOW GROWTH SINCE THEY CONTAIN NO FRACTURE CRITICAL PARTS (5). THE HIGH CYCLE AND LOW CYCLE FATIGUE LIFE OF THE INTERMEDIATE SEAL AND MATING RING MEET CEI REQUIREMENTS (6). THE MINIMUM FACTORS OF SAFETY FOR THESE PARTS MEET CEI REQUIREMENTS (7). REUSE OF PARTS DURING OVERHAUL ARE CONTROLLED BY THE REQUIREMENTS OF THE OVERHAUL SPECIFICATION (8).</p>	<p>(1) NS007930  (2) NS007940  (3) RSS-8578-11  (4) NS007941  (5) NASA TASK 117  (6) RL00532,  CP320R0003B  (7) RSS-8546-16,  CP320R0003B  (8) RL80874</p>	

CIL ITEM: B400-15		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
FAILURE CAUSE A1	RS007930 - INTERMEDIATE SEAL RS007940 - MATING RING		RS007930 RS007940
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION AND DRAWING REQUIREMENTS.	RB0170-153 RS007930
		RING IS PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0611-020
	SURFACE FINISH	THE SEALING SURFACES ARE INSPECTED FOR NICKS AND SCRATCHES PRIOR TO INSTALLATION PER SPECIFICATION REQUIREMENTS.	RL00814
		CHROME AND SILVER PLATING IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA1109-002 RA1609-001
	CLEANLINESS OF COMPONENTS	COMPONENTS ARE VERIFIED CLEANED PER SPECIFICATION REQUIREMENTS.	RL10001
	ASSEMBLY INTEGRITY	SEAL AND RING SEALING DIAMETERS ARE INSPECTED PER DRAWING REQUIREMENTS.	RS007930 RS007940
		CLEARANCE BETWEEN THE SEAL AND THE RING IS INSPECTED PER DRAWING REQUIREMENTS.	RS007930 RS007940
		INTERMEDIATE SEAL IS LEAK TESTED AT ASSEMBLY PER SPECIFICATION REQUIREMENTS.	RL00814
		ROTATING ASSEMBLY BALANCE IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RL00816
		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.	RL00874 RAD115-116
		OPERATION/PERFORMANCE IS VERIFIED BY ENGINE HOT FIRE TESTING AND 2ND E & M INSPECTIONS.	RL00050-06 RL00056-06 RL00056-07 RL00461

CIL ITEM: #400-15		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
		OXIDIZER SYSTEM IS PUNGED PER SPECIFICATION REQUIREMENTS.	OMRSD 800F80.300 OMRSD 800F80.250 OMRSD V41C80.080 OMRSD V41C80.081
		ENGINE SYSTEM IS VERIFIED TO BE DRY PER OMRSD REQUIREMENTS: - POST LANDING AT LAUNCH SITE - ADDITIONAL DRYNESS VERIFICATION AS REQUIRED	OMRSD V41C80.080 OMRSD V41C80.081
		TORQUE CHECKS ARE PERFORMED PRIOR TO EACH FLIGHT.	OMRSD V41B50.040
		MPDP MICROSHAFT TRAVEL IS PERFORMED PRIOR TO EACH FLIGHT PER SPECIFICATION REQUIREMENTS.	RL01034 OMRSD V41B50.045 RL00050-04
		DATA FROM PREVIOUS FLIGHT OR HOT FIRE IS REVIEWED FOR PROPER TURBOPUMP OPERATION/PERFORMANCE. (LAST TEST)	MSFC PLM 1228
<p>FAILURE HISTORY: COMPREHENSIVE FAILURE HISTORY DATA IS MAINTAINED IN THE PROBLEM REPORTING DATABASE (PRMS/PRCA). REFERENCE: NASA LETTER SA21/88/308 AND ROCKETDYNE LETTER BRRC09761.</p>			

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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	CRITICAL INITIAL		COMMENTS
					SIDE NOT ACCESS	FLAW SIZE NOT DEFECTABLE	NOT DEFECTABLE	
					KEF	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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