

1) CIL ITEM : B400-11
 2) FMEA CODE : B400
 3) COMPONENT : NPOTP
 4) PART NUMBER : R5007701
 5) SYSTEM/SUBSYSTEM : PUMPS/BANK
 6) FAILURE MODE : INADEQUATE PREBURNER PUMP HEAD RISE

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) CCRD # : ME3-01-3275

PHASE	FAILURE DESCRIPTION/EFFECT	CRITICALITY
N	<p>REDUCED PREBURNER PUMP OUTPUT RESULTS IN COMMANDING THE PREBURNER OXIDIZER VALVES FURTHER OPEN. DPOV COMMAND LIMIT PREVENTS REACHING DESIRED THRUST. ENGINE OPERATION CONTINUES AT REDUCED POWER LEVEL AND OFF-NOMINAL MIXTURE RATIO. MISSION ABORT MAY RESULT IF OFF-NOMINAL PROPELLANT CONSUMPTION LEADS TO A SLE ENGINE SHUTDOWN ON PREMATURE PROPELLANT DEPLETION.</p> <p>REUNDANCY SCREENS: TURBOPUMP SYSTEM - SENSOR SYSTEM: UNLIKE REDUNDANCY</p> <p>A: PASS. REDUNDANT HARDWARE ITEMS ARE CAPABLE OF CHECKOUT DURING NORMAL GROUND TURNAROUND. B: PASS. LOSS OF A REDUNDANT HARDWARE ITEM IS DETECTABLE DURING FLIGHT. C: PASS. LOSS OF REDUNDANT HARDWARE ITEMS COULD NOT RESULT FROM A SINGLE CREDIBLE EVENT.</p>	<p>1R HAZARD REF: HE-04N.</p>

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CIL ITEM: B400-11		DESIGN	DOCUMENT REF.
<p>FAILURE CAUSE A: IMPELLER BLADE DISTORTION/DAMAGE FAILURE CAUSE B: HOUSING DIFFUSER VANE DISTORTION/DAMAGE</p> <p>THE PREBURNER PUMP INCREASES THE LIQUID OXYGEN PRESSURE REQUIRED FOR THE OXIDIZER AND FUEL PREBURNERS. THE PREBURNER IMPELLER IS A SHROUDED CENTRIFUGAL DESIGN UTILIZING FOUR FULL AND FOUR PARTIAL BLADES (1). THE PREBURNER PUMP HOUSING INCORPORATES ELEVEN DIFFUSER VANES FOR DYNAMIC HEAD RECOVERY AND GUIDANCE OF THE IMPELLER FLOW TO THE VOLUTE DISCHARGE SCROLL (2). BOTH COMPONENTS ARE INVESTMENT CASTINGS UTILIZING INCONEL 718, WHICH WAS SELECTED FOR ITS STRENGTH WHILE RETAINING DUCTILITY AT CRYOGENIC TEMPERATURES (3). THE ALLOY IS RESISTANT TO CORROSION AND STRESS CORROSION CRACKING, AND IS LOX COMPATIBLE (3). THE IMPELLER AND VOLUTE CASTINGS ARE SUBJECTED TO THE HOT ISOSTATIC PRESSING PROCESS FOR IMPROVED MECHANICAL PROPERTIES AND DENSIFICATION (1) (2). THE ALLOY IS SOLUTION HEAT TREATED AND AGE-HARDENED (1) (2). SYSTEM CONTAMINATION IS CONTROLLED BY THE VEHICLE CLEANLINESS REQUIREMENTS (4) WHICH MINIMIZES POTENTIAL DAMAGE FROM CONTAMINATION IMPACT. THE BLADE AND VANE SURFACE FINISH AND CONTOURS ARE CONTROLLED TO MINIMIZE SURFACE DISCONTINUITIES WHICH REDUCES LOCAL SURFACE STRESS CONCENTRATION (1) (2). THE PREBURNER PUMP IMPELLER AND VOLUTE PARENT MATERIAL WAS CLEARED FOR FRACTURE MECHANICS/NOE FLAW GROWTH BY RISK ASSESSMENT (5). THESE PARTS MEET CEI REQUIREMENTS FOR HIGH CYCLE AND LOW CYCLE FATIGUE LIFE (6). THE MINIMUM FACTORS OF SAFETY FOR THESE PARTS MEET CEI REQUIREMENTS (7). THE PREBURNER PUMP HOUSING HAS COMPLETED DESIGN VERIFICATION TESTING FOR PROOF PRESSURE-STRESS DISTRIBUTION (8). THE CONTROLLER SOFTWARE IS CONFIGURED TO DETECT AND RESPOND TO THE FAILURES IDENTIFIED AND COMMAND A SAFE ENGINE STATE (9). WEAR OF PARTS DURING OVERHAUL ARE CONTROLLED BY THE REQUIREMENTS OF THE OVERHAUL SPECIFICATION (10).</p>			<p>(1) RS007723 (2) RS007739 (3) RSS-8578-11 (4) ICD 13M15000 (5) NASA TASK 117 (6) RL00532, CP320R0003B (7) RSS-8546-16, CP120R0003B (8) RSS-403-59A (9) CP406R0000 3.2.3:5.2 (10) RL00874</p>
CIL ITEM: B400-11		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
FAILURE CAUSE A, B:	<p>RS007723 - IMPELLER RS007739 - VOLUTE</p> <p>MATERIAL INTEGRITY</p>	<p>MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS.</p> <p>IMPELLER AND VOLUTE HOT ISOSTATIC PRESS IS VERIFIED PER SPECIFICATION REQUIREMENTS.</p> <p>IMPELLER AND VOLUTE ARE RADIOGRAPHIC AND PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS.</p>	<p>RS007723 RS007739 RB0170-155 RL00368 RAD115-006 RAD115-116</p>

C/L ITEM: B400-11		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
B - 260 ALL CAUSES:		VOLUTE IS PROOF PRESSURE TESTED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007739 RL00018
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RB0170-155
	ASSEMBLY INTEGRITY	IMPELLER AND VOLUTE ARE HIDDEN SURFACE INSPECTED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007723 RS007739 RL00314
		VOLUTE IS PENETRANT INSPECTED BEFORE AND AFTER PROOF PRESSURE TESTING PER SPECIFICATION REQUIREMENTS.	RA0115-116
		IMPELLER AND VOLUTE INTERNAL CAST SURFACE FINISH IS INSPECTED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007723 RS007739 RA0115-007
	CLEANLINESS OF COMPONENTS	IMPELLER AND VOLUTE ARE VERIFIED CLEANED PER SPECIFICATION REQUIREMENTS.	RL10001
	RS007701 - HPDTP		RS007701
	ASSEMBLY INTEGRITY	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 & H INSPECTIONS.	RL00050-04 RL00056-06 RL00056-07 RL00461
		DATA FROM PREVIOUS FLIGHT OR HOT FIRE IS REVIEWED FOR PROPER TURBOPUMP OPERATION/PERFORMANCE (LAST TEST).	MSFC PLN 1228
FAILURE HISTORY: COMPREHENSIVE FAILURE HISTORY DATA IS MAINTAINED IN THE PROBLEM REPORTING DATABASE (PRANS/PACA). REFERENCE: NASA LETTER 8421/88/308 AND ROCKETDOME LETTER 88RC09761.			

OPERATIONAL USE: N/A. 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	FLAN 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 DEFECTABLE REF	NOT 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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