1) CIL ITEM : B400-07
2) FMEA CODE : B400
3) COMPONENT : HPOTP
4) PART NUMBER : RS007701
5) SYSTEM/SUBSYSTEM : PUMPS/BXXX
6) FAILURE MODE : FAILURE TO TRANSMIT TORQUE

7) PREPARED : SSME RELIABILITY
8) APPROVED :
9) DATE : 06-01-95
10) REVISION/CHANGE : -002/0
11) EFFECTIVITY : -751
12) HAZARD REFERENCE : SEE LISTINGS BELOW
11) CCBD # : ME3-01-3275

PHASE	FAILURE DESCRIPTION/EFFECT	CRITICALITY
SMC	TURBINE UNLOADS AND OVERSPEEDS WITH PROBABLE BLADE FAILURE AND/OR DISK BURST, RUBBING, AND ROTOR UNBALANCE. TURBINE BURST MAY CAUSE SHRAPNEL DAMAGE TO OTHER PARTS OF THE ENGINE, RESULTING IN ULTIMATE ROTATING ASSEMBLY DISINTEGRATION, FIRE, OR EXPLOSION. LOSS OF VEHICLE. REDUNDANCY SCREENS: SINGLE POINT FAILURE: N/A	1 HAZARD REF: ME-C1S,A,M,C

CIL ITEM: 8400-07	DESIGN	DOCUMENT REF.
	FAILURE CAUSE A: FAILURE OF SHAFT OR IMPELLER SPLINES	
	TORQUE FROM THE SHAFT IS TRANSMITTED TO THE MAIN IMPELLER AND PREBURNER IMPELLER BY A SET OF INVOLUTE EXTERNAL FILLET ROOT SIDE FIT SPLINES. THE SIDE FIT DESIGN AFFORDS AN INCREASE IN THE SPLINE FILLET RADII FOR GREATER LOAD CAPACITY. THE SHAFT IS MACHINED FROM A WASPALOY FORGING, WHICH IS VACUUM MELTED TO MINIMIZE IMPURITY FORMATION AND IS THERMO-MECHANICALLY PROCESSED TO IMPROVE HIGH TEMPERATURE STRESS RUPTURE DUCTILITY (1). THE ALLOY IS SOLUTION HEAT TREATED, STABILIZED, AND AGE-HARDENED TO PRODUCE HIGH STRENGTH AND DUCTILITY AT CRYOGENIC AND ELEVATED TEMPERATURES (1). DRY-FILM LUBRICATION (1) IS APPLIED TO MINIMIZE FRETTING WHILE REDUCING FRICTION. THE MAIN IMPELLER ENGAGES THE SHAFT WITH A CORRESPONDING INTERNAL FILLET ROOT SIDE FIT SPLINE. THE MAIN IMPELLER IS MACHINED FROM AN INCONEL 718 FORGING, WHICH IS SOLUTION HEAT TREATED, AND AGE-HARDENED (2). THE ALLOY'S STRENGTH PROVIDES WEIGHT SAVINGS WHILE RETAINING DUCTILITY AT CRYOGENIC TEMPERATURES (3). THE PREBURNER IMPELLER RECEIVES TORQUE BY AN INTERNAL SPLINE DESIGN SIMILAR TO THE MAIN IMPELLER. THE PREBURNER IMPELLER IS CAST FROM INCONEL 718 AND IS SUBJECTED TO THE HOT ISOSTATIC PRESSING PROCESS FOR IMPROVED MECHANICAL PROPERTIES AND DENSIFICATION (4). THE ALLOY IS SOLUTION HEAT TREATED AND AGE-HARDENED (4). INCONEL 718 IS RESISTANT TO CORROSION AND STRESS CORROSION CRACKING (3). THESE PARTS MEET CEI REQUIREMENTS FOR HIGH CYCLE AND LOW CYCLE FATIGUE LIFE (5). THE MAIN IMPELLER HAS COMPLETED DESIGN VERIFICATION TESTING FOR NATURAL FREQUENCY (6) AND STRESS DISTRIBUTION (7).	(1) RS007703 (2) RS007718 (3) RSS-8578-11 (4) RS007721 (5) RL00532, CP320R00038 (6) RSS-403-48 (7) RSS-403-57A
	FAILURE CAUSE F: TURBINE DISC FAILURE FAILURE CAUSE G: SHAFT FAILURE	
	TORQUE FROM THE DISC (1) IS TRANSMITTED TO THE SHAFT (2) BY TWO SETS OF CURVIC COUPLINGS. THE DISC AND SHAFT ARE MACHINED FROM WASPALOY DIE FORGINGS, WHICH ARE VACUUM MELTED TO MINIMIZE IMPURITY FORMATION. THE FORGINGS ARE THERMO-MECHANICALLY PROCESSED TO IMPROVE HIGH TEMPERATURE STRESS RUPTURE DUCTILITY, SOLUTION HEAT TREATED, STABILIZED, AND AGE-HARDENED (1) (2). THE ALLOY WAS SELECTED FOR ITS STRENGTH AND DUCTILITY AT CRYOGENIC AND ELEVATED TEMPERATURES AND CORROSION RESISTANCE (3). THE FORGING EXHIBITS A RECRYSTALIZED STRUCTURE WHICH DOES REQUIRE THE USE OF A HYDROGEN BARRIER TO PREVENT EMBRITTLEMENT. THIS IS PROVIDED BY GOLD PLATING OF THE CRITICAL SURFACES (1) (2). THE GOLD PLATING AT THE FIR TREES IS BROACHED TO PROVIDE A CLOSE TOLERANCE FIT WITH THE TURBINE BLADES (4). THERE ARE NO WELDS USED ON THE DISC OR SHAFT. FORGING GRAIN FLOW IS SPECIFIED TO MAXIMIZE MATERIAL PROPERTIES IN THE DIRECTION OF STRESS INTENSITY (1) (2). THE THREADS ON THE SHAFT FOR THE MAIN IMPELLER RETENTION NUT AND TURBINE BEARING PACKAGE ARE ROLLED TO DRAWING REQUIREMENTS FOR INCREASED STRENGTH (2). DRY-FILM LUBRICATION IS SPRAYED AND BAKED ONTO ALL MATING COMPONENT SURFACES ALONG THE SHAFT TO REDUCE FRICTION AND MINIMIZE FRETTING (2). THE SHAFT MEETS CEI REQUIREMENTS FOR HIGH CYCLE FATIGUE LIFE (4), BUT IS LOW CYCLE FATIGUE LIFE LIMITED BY MAJOR WAIVER (5) (9). THE DISC MEETS CEI REQUIREMENTS FOR HIGH CYCLE FATIGUE LIFE (4), BUT IS LOW CYCLE FATIGUE LIFE LIMITED BY MAJOR WAIVER (6) (10). THE DISC AND SHAFT HAVE COMPLETED DESIGN VERIFICATION TESTING FOR NATURAL FREQUENCY (7) AND STRESS DISTRIBUTION (8).	(1) RS007705 (2) RS007703 (3) RSS-8578-11 (4) RL00532, CP320R00038 (5) BAR 2024 (6) BAR 2023 (7) RSS-403-10A, RSS-403-11 (8) RSS-403-52 (9) BAR 2432 (10) BAR 2676

CIL ITEM: 8402-07	DESIGN	DOCUMENT REF.
	FAILURE CAUSE C: LOSS OF TURBINE TIE-BOLT PRELOAD	
	THE TURBINE DISC IS SECURED TO THE SHAFT ASSEMBLY BY TWELVE BOLTS (1) WHICH ARE STRETCHED AND PRELOADED DURING INSTALLATION. THE BOLTS ARE INSERTED THROUGH THE DISC AND CURVIC COUPLING AND ENGAGE WITH FOUR NUT PLATES (2) ATTACHED TO THE SHAFT. THE LOCKWASHERS (3), WHICH ARE DESIGNED TO ACCEPT TWO BOLTS EACH FOR ANTI-ROTATION, ARE SECURED TO PREVENT BOLT DISENGAGEMENT FROM THE NUT PLATES. THE BOLTS, NUT PLATES, AND WASHERS ARE MANUFACTURED UTILIZING A-286 CRES, WHICH WAS SELECTED FOR ITS TENSILE STRENGTH AND RESISTANCE TO CORROSION AND STRESS CORROSION CRACKING (4). HYDROGEN ENVIRONMENT EMBRITTLEMENT, AT ANY TEMPERATURE, DOES NOT HAVE A SIGNIFICANT EFFECT ON THE PROPERTIES OF THIS ALLOY (4). THE BOLTS ARE SOLUTION HEAT TREATED, COLD WORKED, AGED, AND COLD WORKED AGAIN TO ACHIEVE ADDITIONAL STRENGTH (1). THE SHANK PORTION OF THE BOLTS ARE FLASH SILVER PLATED (1) AND DRY-FILM LUBRICATED (5) FOR LUBRICITY AND EQUAL LOAD DISTRIBUTION OF THE THREADED SURFACES DURING TORQUE APPLICATION. THE NUT PLATE AND WASHER ALLOYS ARE SOLUTION HEAT TREATED AND AGE-HARDENED (2) (3). ASSEMBLY PROCEDURES FOR LOCKING DEVICES ENSURE DEFECT-FREE INSTALLATION (5). THE BOLTS DO NOT TRANSMIT ANY TORSIONAL LOAD, BUT FUNCTION ONLY TO MAINTAIN ENGAGEMENT OF THE CURVIC LOAD SURFACES. THE BOLTS, NUT PLATES, AND LOCKWASHERS ARE ASSESSED TO HAVE INFINITE LIFE (6) AND ARE NOT TRACKED BY SERIALIZATION.	(1) RS007871 (2) RS007887 (3) RS007797 (4) RSS-8578-11 (5) RL00814 (6) RL00532, CP320R00038
	FAILURE CAUSE D: LOSS OF PREBURNER TIE-BOLT PRELOAD	
	THE PREBURNER IMPELLER TIE BOLT (1) IS STRETCHED AND PRELOADED AT ASSEMBLY TO AXIALLY POSITION THE PREBURNER IMPELLER AGAINST THE MAIN IMPELLER RETENTION NUT. A LOCKWASHER (2) IS YIELDED TO PREVENT BOLT DISENGAGEMENT DURING OPERATION. THE BOLT IS MANUFACTURED UTILIZING A-286 CRES, WHICH WAS SELECTED FOR ITS TENSILE STRENGTH AND RESISTANCE TO CORROSION AND STRESS CORROSION CRACKING (5). THE ALLOY IS SOLUTION HEAT TREATED, COLD WORKED, AGED, AND COLD WORKED AGAIN TO ACHIEVE ADDITIONAL STRENGTH (1). THE LOCKWASHER IS MANUFACTURED UTILIZING HASTELLOY B-2 AND WAS SELECTED FOR ITS STRENGTH, CORROSION AND STRESS CORROSION CRACKING RESISTANCE, AND EASE OF FABRICATION (3). THE ALLOY IS ANNEALED FOR THIS BENDING APPLICATION (2). DRY-FILM LUBRICATION IS APPLIED TO THE BOLT AND LOCKWASHER TO RELIEVE FRICTION AND ALLOW EQUAL LOAD DISTRIBUTION OF THE THREADED SURFACES (1) (2). ASSEMBLY PROCEDURES FOR LOCKING DEVICES ENSURE DEFECT-FREE INSTALLATION (4). THE BOLT SERVES TO POSITION THE PREBURNER IMPELLER DURING NON-OPERATIONAL PHASES ONLY. DURING OPERATION, THE PREBURNER IMPELLER IS AXIALLY LOADED BY THE FLUID PRESSURE DISTRIBUTION. ONLY CLOCKWISE ROTATION OF THE BOLT IS ALLOWED DURING HARDWARE INSPECTIONS TO PRECLUDE ACCIDENTIAL LOSS OF PRELOAD (5). THE BOLT AND LOCKWASHER ARE ASSESSED TO HAVE INFINITE LIFE (6) AND ARE NOT TRACKED BY SERIALIZATION.	(1) RS007726 (2) RS007728 (3) RSS-8578-11 (4) RL00814 (5) RL00461 (6) RL00532, CP320R00038

CIL ITEM: B400-07	DESIGN	DOCUMENT REF.
	FAILURE CAUSE E: MAIN IMPELLER RETAINER NUT/LOCK FAILURE THE RETENTION NUT (1) SECURES THE MAIN IMPELLER AXIALLY ON THE SHAFT WITH A PRELOAD AT ASSEMBLY. A CUPWASHER (2) IS YIELDED AGAINST THE NUT AND IMPELLER TO PREVENT NUT DISENGAGEMENT. THE NUT IS MANUFACTURED UTILIZING INCONEL 718 AND IS SOLUTION HEAT TREATED AND AGE-HARDENED (1). THE ALLOY WAS SELECTED FOR ITS STRENGTH AND DUCTILITY AT ROOM AND CRYOGENIC TEMPERATURES (3). THE CUPWASHER IS MANUFACTURED UTILIZING ANNEALED 302 CRES, WHICH IS DUCTILE AND SUITED FOR THIS BENDING APPLICATION (3). BOTH ALLOYS ARE RESISTANT TO CORROSION AND STRESS CORROSION CRACKING (3). DRY-FILM LUBRICANT IS APPLIED TO THE NUT AND WASHER TO MINIMIZE FRICTION AND ALLOWS EQUAL LOAD DISTRIBUTION OF THE THREADED SURFACES (1) (2). THE NUT IS FURTHER PREVENTED FROM DISENGAGEMENT BY THE PREBURNER IMPELLER SHOULDER, WHICH SUPPLIES A COMPRESSIVE FORCE DURING ASSEMBLY (4) AND INCREASES DURING OPERATION DUE TO THE PRESSURE LOADS OF THE PREBURNER IMPELLER. THE NUT THREADS ARE ROLLED TO DRAWING REQUIREMENTS FOR INCREASED CLAMPING FORCE (1). ASSEMBLY PROCEDURES FOR LOCKING DEVICES ENSURE DEFECT-FREE INSTALLATION (4). THE NUT AND CUPWASHER ARE ASSESSED TO HAVE INFINITE LIFE (5) AND ARE NOT TRACKED BY SERIALIZATION. ALL CAUSES: WASPALOY, INCONEL 718, A-286 CRES, 302 CRES, AND HASTELLOY B-2 SATISFY LOX COMPATIBILITY REQUIREMENTS (1). THE HIGH CYCLE AND LOW CYCLE FATIGUE LIFE OF THE MAIN IMPELLER, PREBURNER IMPELLER, TURBINE TIE-BOLT, NUT PLATES AND WASHERS, PREBURNER TIE-BOLT AND LOCKWASHER, AND MAIN IMPELLER RETAINER NUT AND CUPWASHER MEET CEI REQUIREMENTS (2). THE MINIMUM FACTORS OF SAFETY FOR THESE PARTS, ALONG WITH THE DISC, MEET CEI REQUIREMENTS (3). THE HARDWARE PARENT MATERIALS WERE CLEARED FOR FRACTURE MECHANICS/HCF FLAW GROWTH SINCE THEY ARE NOT FRACTURE CRITICAL PARTS, EXCEPT FOR THE HPOTP SHAFT AND MAIN IMPELLER WHICH WERE CLEARED BY CRITICAL INITIAL FLAW SIZE DETECTABILITY, THE PREBURNER IMPELLER AND FIRST-STAGE DISK WERE CLEARED BY RISK ASSESSMENT (4). THE ROTATING ASSEMBLY HAS COMPLETED DESIGN VERIFICATION TESTING FOR NATURAL FREQUENCY (5) AND STRUCTURAL DEFLECTION (6). REUSE OF PARTS DURING OVERHAUL ARE CONTROLLED BY THE REQUIREMENTS OF THE OVERHAUL SPECIFICATION (7).	(1) RI0017249 (2) RS007789 (3) RSS-8578-11 (4) RL00814 (5) RL00532, CP320R00038 (1) RSS-8578-11 (2) RL00532, CP320R00038 (3) RSS-8546-16, CP320R00038 (4) NASA TASK 317 (5) RSS-403-49, RSS-403-44R1 (6) RSS-403-50 (7) RL00874

CIL ITEM: B400-07	INSPECTION AND TEST		
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
FAILURE CAUSE A:	RS007703 - SHAFT RS007718 - MAIN IMPELLER RS007723 - PREBURNER IMPELLER		RS007703 RS007718 RS007723
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RI0170-162 RI0170-153

CIL ITEM: B400-07		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
		PREBURNER IMPELLER ISOSTATIC PRESS IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RL00368
		SHAFT IS PENETRANT AND ULTRASONIC INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116 RA0115-012
		MAIN IMPELLER IS PENETRANT AND ULTRASONIC INPSECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116 RA0115-012
		PREBURNER IMPELLER IS PENETRANT AND RADIOGRAPHICALLY INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116 RA0115-006
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS FOR THE MAIN AND PREBURNER IMPELLERS.	RA0611-020 RB0170-155
	ASSEMBLY INTEGRITY	MAXIMUM GROWTH IS VERIFIED BY THE SHAFT AND MAIN IMPELLER HIGH SPEED SPIN PER DRAWING REQUIREMENTS.	RS007703 RS007718
		SPLINES ARE INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-143
		SHAFT AND MAIN IMPELLERS SPLINE ECCENTRICITIES ARE INSPECTED AND OFFSET PER SPECIFICATION REQUIREMENTS.	RL00816
		SHAFT AND PREBURNER IMPELLER DRY-FILM LUBRICATION IS VERIFIED PER SPECIFICATION AND DRAWING REQUIREMENTS.	RA0112-003 RS007703 RS007723
		MAIN IMPELLER INLET AND TURNING VANES ARE BORESCOPE INSPECTED PRIOR TO EACH FLIGHT.	OMRSD V41BUU.065
FAILURE CAUSES B,F,O:	RS007703 - SHAFT RS007705 - DISC		RS007703 RS007705
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RB0170-102

CIL ITEM: 0400-07		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
		DISC AND SHAFT ARE PENETRANT INSPECTED BEFORE AND AFTER SPIN TEST PER SPECIFICATION REQUIREMENTS.	RA0115-116
		SHAFT IS ULTRASONICALLY INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-012
	ASSEMBLY INTEGRITY	MAXIMUM GROWTH IS VERIFIED BY THE HIGH SPEED SPIN PER DRAWING REQUIREMENTS.	RS007705 RS007703
		THE GOLD PLATING IN THE HOT-GAS AREA OF THE SHAFT AND DISC IS VERIFIED PER SPECIFICATION AND DRAWING REQUIREMENTS.	RA1109-009 RS007703 RS007705
		TURBINE END COMPONENTS ARE BORESCOPE INSPECTED FOR EVIDENCE OF LOSS OF GOLD PLATING PRIOR TO EACH FLIGHT.	CMRSD V418U0.065
		SHAFT AND DISC CURVIC COUPLING DIMENSIONS ARE INSPECTED PER DRAWING REQUIREMENTS.	RS007703 RS007705
		THE SHAFT AND DISC CONCENTRICITIES ARE INSPECTED AND CONTROLLED THROUGH THEIR CURVICS PER DRAWING REQUIREMENTS.	RS007703 RS007705
FAILURE CAUSE C:	RS007871 - TURBINE BOLTS RS007887 - NUT PLATE RS007797 - WASHER		RS007871 RS007887 RS007797
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION AND DRAWING REQUIREMENTS.	RB0160-014 RS007871 RS007887 RS007797
		BOLTS ARE PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116
	HEAT TREAT	HEAT TREAT AND ANNEALING ARE VERIFIED PER SPECIFICATION AND DRAWING REQUIREMENTS.	RB0160-014 RS007871 RS007887 RS007797
	ASSEMBLY INTEGRITY	BOLT PILOTING SHOULDERS ARE INSPECTED FOR TRUE POSITION TO THE THREADS PER DRAWING REQUIREMENTS.	RS007871

CIL ITEM: B400-07		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
		SILVER PLATING OF THE BOLTS IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007871 RL00814
		DRY-FILM LUBRICATION IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007871 RL00814
		BOLT STRETCHING IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007871 RL00814
		NUT LOCK DEFORMATION IS INSPECTED AFTER INSTALLATION OR PRIOR TO DISASSEMBLY.	RS007701 RL00814
FAILURE CAUSE D:	RS007726 - PREBURNER TIE-BOLT RS007728 - LOCK		RS007726 RS007728
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED BY DRAWING REQUIREMENTS.	RS007726 RS007728
	HEAT TREAT	HEAT TREAT AND ANNEALING IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007728 RB0160-014
	ASSEMBLY INTEGRITY	THE BOLT PILOTING SHOULDER IS INSPECTED FOR TRUE POSITION TO THE THREADS PER DRAWING REQUIREMENTS.	RS007726
		BOLT DRY-FILM LUBRICATION IS VERIFIED PER DRAWING REQUIREMENTS.	RS007726
		BOLT STRETCH IS INSPECTED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007701 RL00814
		NUT LOCK DEFORMATION IS INSPECTED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007701 RL00814
FAILURE CAUSE E:	R0017249 - NUT RS007789 - LOCK		R0017249 RS007789
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007789 RB0170-153

CIL ITEM: 6400-07		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
	HEAT TREAT	HEAT TREAT AND ANNEALING ARE VERIFIED PER SPECIFICATION AND DRAWING REQUIREMENTS.	RA0611-020 RSD07789
	ASSEMBLY INTEGRITY	PENETRANT INSPECTION IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RB017249 RAD115-116
		NUT AND LOCK DRY-FILM LUBRICATION IS VERIFIED PER DRAWING REQUIREMENTS.	RSD07789 RB017249
		NUT TORQUE IS VERIFIED PER ASSEMBLY DRAWING REQUIREMENTS.	RSD07701
		LOCK DEFORMATION IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RSD07701 RL00814
ALL CAUSES:	RSD07701 - HPOTP		RSD07701
	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 & M INSPECTIONS.	RL00050-04 RL00056-06 RL00056-07 RL00461
		TORQUE CHECKS ARE PERFORMED EACH FLIGHT FLOW TO VERIFY ASSEMBLY INTEGRITY.	OMRSD V41BSO.040
		HPOTP MICROSHAFT TRAVEL IS PERFORMED PRIOR TO EACH FLIGHT PER SPECIFICATION REQUIREMENTS.	RL01036 RL00050-04 OMRSD V41BSO.045

CIL ITEM: 0400-07		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
		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 (PRAMS/PRACA).
REFERENCE: NASA LETTER SA21/88/308 AND ROCKETDYNE LETTER 88RC09761.

OPERATIONAL USE: NOT APPLICABLE.

TABLE B400. HIGH PRESSURE OXIDIZER TURBOPUMP
FMEA/CIL WELD JOINTS

COMPONENT	BASIC PART NO.	WELD NO.	WELD TYPE	CLASS	ROOT SIDE NOT ACCESS	CRITICAL INITIAL FLAW SIZE NOT DETECTABLE HCF	LCF	COMMENTS
MAIN HOUSING	RS007729	1,2	EBW	1	X	X		
MAIN HOUSING	RS007729	3	EBW	1		X		
MAIN HOUSING	RS007729	9,10	GTAW	II	X	X	X	
MAIN HOUSING	RS007729	11,12	GTAW	I		X		
MAIN HOUSING	RS007729	13	EBW	1	X	X		
MAIN HOUSING	RS007729	14-17,46	GTAW	II	X			
MAIN HOUSING	RS007729	18,19	GTAW	II	X	X	X	
MAIN HOUSING	RS007729	21,23	GTAW	II	X			
MAIN HOUSING	RS007729	22,24	GTAW	II	X			
MAIN HOUSING	RS007729	44,55-59	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	1	X			
MAIN HOUSING	RS007729	66-70	GTAW	II	X			
INLET HOUSING	RS007732	4	GTAW	I		X		
INLET HOUSING	RS007732	8,9	GTAW	I		X		
VOLUTE	RS007732	10,15	GTAW	I	X	X		
VOLUTE	RS007732	20,21	GTAW	I				
VOLUTE	RS007732	22,23	GTAW	1				
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			

TABLE B400. HIGH PRESSURE OXIDIZER TURBOPUMP
FMEA/CIL WELD JOINTS

COMPONENT	BASIC PART NO.	WELD NO.	WELD TYPE	CLASS	ROOT SIDE NOT ACCESS	CRITICAL INITIAL FLAW SIZE NOT DETECTABLE HCF	LCF	COMMENTS
FLANGE	R0007736	6,7	GTAW	II	X			
FLANGE	R0007736	9-12,17	GTAW	II	X			
FLANGE	R0007736	13-16	GTAW	II	X			
FLANGE	R0007736	18,20	GTAW	I	X			
FLANGE	R0007736	19,21	GTAW	II	X			
FLANGE	R0007736	22	EBW	I	X			
FLANGE	R0007736	23	GTAW	II				
FLANGE	R0007736	24	GTAW	II	X			
FLANGE	R0007736	26	GTAW	II	X			
BELLOWS	R0007740	1,2,5,9	GTAW	I		X		
BELLOWS	R0007740	3,4	EBW	I				
HOUSING	R0007746	1,2	GTAW	I	X	X	X	
HOUSING	R0007746	3	GTAW	I	X			
HOUSING	R0007746	4	GTAW	II	X			
HOUSING	R0007746	5	GTAW	II	X	X		
HOUSING	R0007746	6-17	GTAW	II	X	X		
HOUSING	R0007746	18-29	GTAW	II	X	X	X	
HOUSING	R0007746	30-41	GTAW	II		X	X	
BELLOWS	R0007748	1	EBW	I				
BELLOWS	R0007749	2	GTAW	I	X			
BELLOWS	R0007749	1-4	GTAW	I				
BELLOWS	R0007749	5,6	EBW	I				
BELLOWS	R0007749	11	EBW	I				
BELLOWS	R0007749	12	EBW	I				
BELLOWS	R0007751	3	EBW	I	X			
BELLOWS	R0007751	4	EBW	I	X	X	X	
BELLOWS	R0007751	8	GTAW	I	X	X		
SECOND STAGE NOZZLE	R0007752	1,2	EBW	I	X			
SECOND STAGE NOZZLE	R0007752	1	GTAW	I	X	X	X	
JET RING	R0007757	1	GTAW	I	X	X	X	
FAIRING	R0007774	1-12	GTAW	I		X		
FAIRING	R0007774	13-24	GTAW	I		X		

TABLE B400. HIGH PRESSURE OXIDIZER TURBOPUMP
PREA/CIL WELD JOINTS

COMPONENT	BASIC PART NO.	WELD NO.	WELD TYPE	CLASS	ROOT SIDE NOT ACCESS	CRITICAL INITIAL FLAW SIZE NOT DETECTABLE REF	LCF	COMMENTS
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	EBW	II	X			
STRUT	RS007779	71	EBW	II				
STRUT	RS007779	72	EBW	II				
STRUT	RS007779	73-94	EBW	II				
STRUT	RS007779	95,96	EBW	II	X			
SHIELD	RS007781	1,11	BTAW	II				
SHIELD	RS007781	2,3,4	BTAW	II				
SEAL	RS008848	1 PLC	BTAW	I				
SEAL	RS008857	1 PLC	BTAW	I		X	X	

FIELD CONFIGURATION VARIANCES FROM CIL RATIONALE

CIL ITEMS: B400-XX		HPOTP	P/N RS007791
BASE LINE RATIONALE	VARIANCE	CHANGE RATIONALE	VARIANT DASH NUMBER
1. B400-02, B400-03 SECOND STAGE NOZZLE CASTING IS HOT ISOSTATIC PRESSED PER DRAWING REQUIREMENTS. (ECP 1A-2949)	SECOND STAGE NOZZLE CASTINGS HAVE NOT BEEN HOT ISOSTATIC PRESSED	HOT ISOSTATIC PRESS INCREASES STRUCTURAL INTEGRITY BY REDUCING CASTING MICROPOROSITY. USE AS IS RATIONALE: 1. LIFE LIMIT ON NON HOT ISOSTATIC PRESSED 2ND STAGE NOZZLES REDUCES PROBABILITY OF LOW CYCLE FATIGUE CRACKING RESULTING FROM EXCESSIVE MICROPOROSITY. (DAR 2147) 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)	-121, -131, -141, -151, -161, -171, -181, -191, -201, -211, -221, -231, -241, -251, -261, -271, -291, -301, -311, -331, -351, -371, -401
2. B400-13, B400-22 PROCESSED AND INSPECTED PER SPECIFICATION REQUIREMENTS (RL00916). (ECP 909)	BEARINGS ARE PROCESSED AND INSPECTED PER SPECIFICATION REQUIREMENTS (RL00558).	LONG TERM FATIGUE LIFE OF BEARING IS ENHANCED BY REDUCING THE ALLOWABLE SIZE AND QUANTITY OF ALLOWABLE DEFECTS. USE AS IS RATIONALE: 1. WEAR LIFE LIMIT ON BEARINGS PREVENTS WEAR FROM EXCEEDING ALLOWABLE LIMITS. (DAR 2054, DAR 2082) 2. CONTINUED USE WITH ALLOWABLE DISCREPANCIES IS CONTROLLED PER THE MAINTENANCE CONTROL DOCUMENT REQUIREMENTS (RSS-8795).	-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

FIELD CONFIGURATION VARIANCES FROM CIL RATIONALE

CIL ITEMS: 8400-RK		HPOTP	P/N RS007701
BASE LINE RATIONALE	VARIANCE	CHANGE RATIONALE	VARIANT DASH NUMBER
3. 8400-21 HOUSING DETAILS ARE ULTRASONIC INSPECTED PER DRAWING AND SPECIFICATION REQUIREMENTS. (ECP 680)	HOUSING DETAILS HAVE NOT BEEN ULTRASONIC INSPECTED PER DRAWING AND SPECIFICATION REQUIREMENTS.	THE ADDED NDI PROVIDES ADDED CONFIDENCE THAT THE CRITICAL FLAW SIZE IS DETECTED IN THE PARENT MATERIAL OF THE HOUSING DETAILS. USE AS IS RATIONALE: 1. 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.	-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. 8400-21 FITTING MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS (INCONEL 718, #80170-153).	RS007729-059 TEE-FITTING IS MANUFACTURED FROM AIR MELT 321 CRES BAR (QQ-S-763 CL321 COND A).	INCONEL 718 MATERIAL DOES NOT EXHIBIT INCLUSION STRINGERS WHICH ARE SUSCEPTABLE TO CHEMICAL ATTACK AND MAY RESULT IN LEAKAGE. USE AS IS RATIONALE: 1. FITTINGS ARE LEAK CHECKED FOLLOWING PROOF PRESSURE TEST PER RL00587. 2. LOADS INDUCED BY FABRICATION (WELDING AND PROOF PRESSURE TESTING) ARE HIGHER THAN OPERATIONAL LOADS AND SUFFICIENT TO SCREEN -059 FITTINGS FOR LEAKAGE.	-171, -181