1) CIL ITEM : B400-23
2) FMEA CODE : B400
3) COMPONENT : HPOTP
4) PART NUMBER : RS007701
5) SYSTEM/SUBSYSTEM : PUMPS/XXXX
6) FAILURE MODE : TURBINE PIECE PART STRUCTURAL FAILURE

7) PREPARED : SSME RELIABILITY
8) APPROVED :
9) DATE : 06-01-95
10) REVISION/CHANGE : -002/D
11) EFFECTIVITY : -761
12) HAZARD REFERENCE : SEE LISTINGS BELOW
13) CCBD # : ME3-01-3075

PHASE	FAILURE DESCRIPTION/EFFECT	CRITICALITY
SHC	MIGRATION DOWNSTREAM OF PART FRAGMENT RESULTS IN PUNCTURE OF HEAT EXCHANGER TUBE. LOSS OF VEHICLE. REDUNDANCY SCREENS: SINGLE POINT FAILURE: N/A	1 HAZARD REF: ME-B3S, ME-C1S,H, ME-C1A,C, ME-B3A,H,C

CIL ITEM: B400-23	DESIGN	DOCUMENT REF.
	FAILURE CAUSE A: INTERNAL STRUCTURAL FAILURE OF:	
	(1) FIRST-STAGE TURBINE BLADE (2) SECOND-STAGE TURBINE BLADE (3) FIRST-STAGE NOZZLE	(1) RS007707 (2) RS007710 (3) RS007750 (4) RSS-8578-11
	THE PARTS LISTED ABOVE ARE MANUFACTURED UTILIZING MAR-M-246 WITH HAFNIUM ADDITION TO THE BASIC ALLOY. THE ALLOY WAS SELECTED FOR ITS OPTIMUN COMBINATION OF RUPTURE STRENGTH, RESISTANCE TO CREEP, AND HIGHEST STATIC MECHANICAL PROPERTIES OF NICKEL BASE ALLOYS FROM ROOM-TO-ELEVATED TEMPERATURES (4). THE BLADES ARE CAST USING THE DIRECTIONAL SOLIDIFICATION PROCESS THAT IMPARTS INCREASED DUCTILITY RESULTING IN IMPROVED RUPTURE (4), AND HIGH CYCLE AND LOW CYCLE FATIGUE LIFE (5). THE STRUCTURAL ANALYSIS FOR DESIGN OF THE TURBINE NOZZLES AND BLADES USED MATERIAL PROPERTIES APPROPRIATE FOR THE OPERATING ENVIRONMENT (HYDROGEN RICH STEAM) AND TEMPERATURE. THE RESULTS OF THE ANALYSIS SHOWED ADEQUATE MARGIN ON STRUCTURAL INTEGRITY BUT LESS THAN CEI LIFE FOR LOW CYCLE FATIGUE OF THE NOZZLE. THE FIRST-STAGE NOZZLE IS NOT ISOSTATIC PRESSED TO FURTHER IMPROVE MATERIAL PROPERTIES (3). THE BLADES ARE SOLUTION HEAT TREATED AND AGE-HARDENED. THE FIRST-STAGE NOZZLE MEETS CEI REQUIREMENTS FOR HIGH CYCLE FATIGUE LIFE (5), BUT IS LOW CYCLE FATIGUE LIFE LIMITED BY MAJOR WAIVER (6). THE FIRST-STAGE TURBINE BLADES ARE HIGH CYCLE AND LOW CYCLE FATIGUE LIFE LIMITED BY MAJOR WAIVER (8). THE SECOND-STAGE TURBINE BLADES ARE HIGH CYCLE AND LOW CYCLE FATIGUE LIFE LIMITED BY MAJOR WAIVER (9). CONTINUED USE WITH ALLOWABLE DISCREPANCIES RESULTING FROM OPERATION IS EVALUATED AND CONTROLLED PER THE REQUIREMENTS OF THE MAINTENANCE CONTROL DOCUMENT (7).	(5) RL00532, CP320R00038 (6) DAR 2148 (7) RSS-8793 (8) DAR 2272 (9) DAR 2275
	(1) SHAFT (2) DISC	(1) RS007703 (2) RS007705 (3) RSS-8578-11
	THE PARTS LISTED ABOVE ARE MANUFACTURED UTILIZING WASPALOY, WHICH WAS SELECTED FOR ITS STRENGTH AND DUCTILITY AT CRYOGENIC AND ELEVATED TEMPERATURES, STRENGTH-TO-WEIGHT RATIO AND CORROSION RESISTANCE. THE ALLOY IS VACUUM MELTED TO MINIMIZE IMPURITY FORMATION AND THERMO-MECHANICALLY PROCESSED TO IMPROVE HIGH TEMPERATURE STRESS RUPTURE DUCTILITY (3). FORGING GRAIN FLOW IS SPECIFIED TO MAXIMIZE MATERIAL PROPERTIES IN THE DIRECTION OF STRESS INTENSITY (1) (2). THE PARTS ARE SOLUTION HEAT TREATED, STABILIZED, AND AGE-HARDENED. THE FORGING EXHIBITS A RECRYSTALIZED STRUCTURE WHICH REQUIRES THE USE OF A HYDROGEN BARRIER TO PREVENT EMBRITTLEMENT. THIS IS PROVIDED BY GOLD PLATING OF THE CRITICAL SURFACES. THE GOLD PLATING AT THE FIR TREES IS BROACHED TO PROVIDE A CLOSE TOLERANCE FIT WITH THE TURBINE BLADES. THE SHAFT MEETS CEI REQUIRMENTS FOR HIGH CYCLE FATIGUE LIFE (4), BUT IS LOW CYCLE FATIGUE LIFE LIMITED BY MAJOR WAIVER (5) (7). THE DISC MEETS CEI REQUIREMENTS FOR HIGH CYCLE FATIGUE LIFE (4), BUT IS LOW CYCLE FATIGUE LIFE LIMITED BY MAJOR WAIVER (6) (8).	(4) RL00532, CP320R00038 (5) DAR 2024 (6) DAR 2023 (7) DAR 2432 (8) DAR 2474

CIL ITEM: B400-23	DESIGN	DOCUMENT REF.
	(1) INTERSTAGE SEAL THE INTERSTAGE SEAL IS MANUFACTURED UTILIZING INCOLOY 903. INCOLOY 903 IS AN IRON BASE ALLOY WHICH WAS SELECTED FOR ITS TENSILE STRENGTH, RESISTANCE TO STRESS CORROSION CRACKING, AND HYDROGEN ENVIRONMENT EMBRITTLEMENT (2). THE ALLOY IS THERMO-MECHANICALLY PROCESSED FOR IMPROVED HIGH TEMPERATURE STRESS RUPTURE DUCTILITY AND IS SOLUTION HEAT TREATED AND AGE-HARDENED. THE SEAL IS PILOTED BY THE SHAFT AND DISC. FOUR VENT HOLES ARE INCORPORATED AT THE SEAL UPSTREAM LOCATION AND ARE USED TO PRESSURIZE THE INTERNAL CAVITY FORMED BETWEEN THE SEAL, SHAFT, AND DISC. THIS FEATURE REDUCES THE PRESSURE DIFFERENTIAL ACROSS THE SEAL WHILE ENHANCING THE DOWNSTREAM RADIAL PILOT FIT. THE SEAL MEETS CEI REQUIREMENTS FOR HIGH CYCLE AND LOW CYCLE FATIGUE LIFE (3).	(1) RS007957 (2) RSS-8578-11 (3) RL00532, CP320R0003B
	(1) SECOND-STAGE TURBINE BLADE DAMPER (2) TURBINE BLADE LOCK (3) BELLOWS SHIELD (4) TURBINE SEAL COOLANT SHIELD (5) TURBINE SEAL RETAINER BOLT LOCK (6) DISCHARGE STRUT RETAINER SEGMENT (7) FIRST-STAGE TIP SEAL RETAINER (8) FIRST-STAGE TURBINE BLADE DAMPER (9) FIRST-STAGE TURBINE BLADE DAMPER CENTERPLATE (10) FIRST-STAGE NOZZLE PLUG THE PARTS LISTED ABOVE ARE MANUFACTURED UTILIZING HAYNES 188, WHICH WAS SELECTED FOR ITS STRENGTH AT ELEVATED TEMPERATURES, CORROSION RESISTANCE, AND RESISTANCE TO DEGRADATION IN HIGH PRESSURE GASEOUS HYDROGEN (11). THE ALLOY IS ANNEALED FOR THIS BENDING APPLICATION. THE PARTS MEET CEI REQUIREMENTS FOR HIGH CYCLE AND LOW CYCLE FATIGUE LIFE (12).	(1) RS007711 (2) RS007712 (3) RS007781 (4) RS007881 (5) RS007882 (6) RS007875 (7) RS007915 (8) RS007980 (9) RS007981 (10) RS007891 (11) RSS-8578-11 (12) RL00532, CP320R0003B

CIL ITEM: 8400-23	DESIGN	DOCUMENT REF.
	(1) DISCHARGE STRUT RETAINER BOLT (2) DISC BOLT AND WASHER (3) FIRST-STAGE NOZZLE RETAINER BOLT (4) DISC BOLT (5) FIRST-STAGE NOZZLE RETAINER BOLT AND WASHER (6) TURBINE SEAL RETAINER BOLT (7) JET RING RETAINER BOLT (8) DISCHARGE STRUT RETAINER BOLT AND WASHER THE PARTS LISTED ABOVE ARE MANUFACTURED UTILIZING A-286 CRES, WHICH WAS SELECTED FOR ITS TENSILE STRENGTH, DUCTILITY, ELASTIC MODULUS, AND RESISTANCE TO CORROSION AND STRESS CORROSION CRACKING (9). THE WASHERS ARE SOLUTION HEAT TREATED AND AGE-HARDENED. THE BOLTS ARE SOLUTION HEAT TREATED AND AGE-HARDENED. FOR ADDITIONAL STRENGTH, THE JET RING BOLTS ARE COLD WORKED AFTER AGING, WHILE THE DISC, FIRST-STAGE NOZZLE, AND TURBINE SEAL BOLTS ARE COLD WORKED PRIOR TO AND AFTER AGE-HARDENING. HYDROGEN ENVIRONMENT, AT ANY TEMPERATURE, DOES NOT HAVE ANY SIGNIFICANT EFFECT ON THE PROPERTIES (9). ALL BOLT TORQUES AND ELONGATIONS ARE SPECIFIED PER DRAWING REQUIREMENTS. DRY-FILM LUBRICATION OR SILVER PLATING IS USED ON THE BOLT THREADS TO MINIMIZE FRICTION AND ALLOWS EQUAL PRELOAD DISTRIBUTION TO THE THREADED SURFACES. THE PARTS MEET CEI REQUIREMENTS FOR HIGH CYCLE AND LOW CYCLE FATIGUE LIFE (10).	(1) RS007792 (2) RS007797 (3) RS007870 (4) RS007871 (5) RS007872 (6) RS007889 (7) RS007890 (8) RS007894 (9) RSS-8578-11 (10) RLO0532, CP320R0005B
	(1) JET RING RETAINER BOLT AND WASHER THE CUPWASHER (1) IS MANUFACTURED UTILIZING 321 CRES, WHICH WAS SELECTED FOR ITS REQUIRED STRENGTH, DUCTILITY, AND RESISTANCE TO CORROSION AND STRESS CORROSION CRACKING (2). THE ALLOY IS ANNEALED FOR THIS BENDING APPLICATION. HYDROGEN ENVIRONMENT DOES NOT HAVE ANY SIGNIFICANT EFFECT ON THE PROPERTIES AT OPERATING TEMPERATURES (2). THE WASHER MEETS CEI REQUIREMENTS FOR LOW CYCLE FATIGUE LIFE (3). JET RING CUPWASHERS ARE TO BE REMOVED AND REPLACED AT INTERVALS SPECIFIED BY MAJOR WAIVER (4).	(1) MS9860 (2) RSS-8578-11 (3) RLO0532, CP320R0003B (4) DAR 2631
	(1) TURBINE HOUSING ASSEMBLY THE TURBINE HOUSING (1) IS A WELDED ASSEMBLY WHICH CONSISTS OF A BELLOWS SUBASSEMBLY, STRUT SUBASSEMBLY, AND FAIRING SUBASSEMBLY. THE BELLOWS SUBASSEMBLY HAS A UPSTREAM FLANGE AND A DOWNSTREAM SHELL WHICH ARE CONNECTED BY AN OUTER AND INNER BELLOWS. BOTH BELLOWS ARE WELDED TO THE INLET FLANGE WHICH IS RETAINED IN THE OXIDIZER PREBURNER BY ECCENTRIC RINGS (2) (3) AT THE FLANGE INLET LIP. THE ECCENTRIC RINGS PROVIDE RADIAL POSITIONING OF THE FLANGE, WHILE COMPRESSION SUPPLIED BY THE BELLOWS AND PRESSURE LOADING DURING OPERATION SEATS THE ASSEMBLY AXIALLY AGAINST THE PREBURNER. A SINGLE ECCENTRIC RING (4) MAY BE USED AS AN ALLOWABLE ALTERNATE TO THE TWO ECCENTRIC RING DESIGN. BECAUSE THE FLANGE INLET LIP IS PILOTED BY A CORRESPONDING GROOVE IN THE PREBURNER, MOVEMENT OF THE BELLOWS IS NOT POSSIBLE TO AFFECT THE SEALING FUNCTION AT THE INTERFACE. THE FLANGE AND SHELL ARE MANUFACTURED UTILIZING INCOLOY 903. INCOLOY 903 IS AN IRON BASED ALLOY WHICH WAS SELECTED FOR ITS STRENGTH, RESISTANCE TO HYDROGEN ENVIRONMENT EMBRITTLEMENT, CORROSION RESISTANCE AND RESISTANCE TO STRESS CORROSION CRACKING (5). THE ALLOY IS SOLUTION TREATED AND	(1) RS007746 (2) RS007879 (3) RS007880 (4) R055017 (5) RSS-8578-11 (6) RL00703 (7) RL00532, CP320R0003B (8) RSS-8793 (9) DAR 2141

CIL ITEM: 8400-23	DESIGN	DOCUMENT REF.
	AGE-HARDENED (3). THE OUTER BELLOWS IS MANUFACTURED UTILIZING INCONEL 718, WHICH WAS SELECTED FOR ITS STRENGTH, MODULUS OF ELASTICITY, RESISTANCE TO STRESS CORROSION CRACKING, AND EASE OF FABRICATION (5). THE ALLOY IS SOLUTION HEAT TREATED AND AGE-HARDENED. HYDROGEN PROTECTION IS PROVIDED BY COPPER PLATING AT THE INNER AND OUTER PLYS OF THE STRUCTURE WHICH ARE EXPOSED TO HYDROGEN (1). THE INNER BELLOWS IS MANUFACTURED UTILIZING ANNEALED HAYNES 188. THE STRUT SUBASSEMBLY IS MANUFACTURED UTILIZING INCOLOY 903. THE DOME, RING, AND HOUSING DETAILS ARE SOLUTION HEAT TREATED AND AGE-HARDENED. IN ADDITION, THE RING AND HOUSING FORGINGS ARE THERMO-MECHANICALLY PROCESSED. THE FAIRING SUBASSEMBLY PROTECTS THE FLANGE, INNER BELLOWS, AND STRUTS FROM DIRECT IMPINGEMENT OF HOT-GAS, AND IS MANUFACTURED UTILIZING ANNEALED HAYNES 188. THE OUTER SHELL IS A WELDED STRUCTURE WHICH UTILIZES A CIRCUMFERENTIAL STIFFENER RING AT THE DISCHARGE SHROUD AND A BACKUP LINER AT THE INLET FOR ADDITIONAL RIGIDITY. THE INLET OF THE SHELL AND THE LINER HAS OFFSET AXIAL SLOTS TO ACCOMMODATE THERMAL MOVEMENT. EIGHT RADIAL HOLES AT THE INLET PROVIDE HOT-GAS TO THE BELLOWS CAVITY FOR PROPER CONDITIONING OF THE HYDROGEN COOLANT. THE INNER CONE IS A WELDED STRUCTURE WHICH INCORPORATES A CIRCUMFERENTIAL STIFFENER RING AT THE DISCHARGE. THE OUTER SHELL AND THE INNER CONE ARE CONNECTED BY TWELVE STRUT SHIELDS AND FLANGES. THE INLET OF THE OUTER SHELL IS PILOTED BY THE HOUSING FLANGE LIP FOR RADIAL POSITIONING. DURING OPERATION, THE SHEET METAL ASSEMBLY TRANSMITS AXIAL LOADS TO THE STRUTS BY SIX BRACKETS AND PADS WHICH ARE WELDED TO THE BACKSIDE OF THE CONE. THE STRUT HAS CORRESPONDING CHANNELS TO ACCEPT THE PADS AND PROVIDE AN ANTI-ROTATION FEATURE FOR THE ASSEMBLY. AXIAL RETENTION IN THE UNLOADED DIRECTION IS PROVIDED BY THE STRUT SHIELDS WHICH ARE FAIRED TOGETHER AND WELDED AT THE TRAILING EDGE. THE FAIRING SUBASSEMBLY IS A VENTED DESIGN WHICH MINIMIZES PRESSURE DIFFERENTIALS ACROSS THE SHEET METAL. THE NON-RESTRICTIVE SYSTEM OF RETENTION ALLOWS FREE THERMAL EXPANSION AND CONTRACTION. SHEET METAL CRACKS ARE CONTROLLED PER THE REQUIREMENTS OF THE SHEET METAL INSPECTION SPECIFICATION (6). THE SPECIFICATION LIMITS THE CRACK LENGTH, SPACING, AND SHAPE, AND IS BASED ON GROWTH RATES FROM ENGINE TEST EXPERIENCE. THE TURBINE HOUSING MEETS CEI REQUIREMENTS FOR HIGH CYCLE FATIGUE LIFE (7) BUT IS LOW CYCLE FATIGUE LIFE LIMITED BY MAJOR WAIVER (9), AND IS SUBJECT TO MAINTENANCE AND REPAIR OF THE SHEET METAL. CONTINUED USE WITH ALLOWABLE DISCREPANCIES RESULTING FROM OPERATION IS EVALUATED AND CONTROLLED PER THE REQUIREMENTS OF THE MAINTENANCE CONTROL DOCUMENT (8).	

CIL ITEM: 8400-23	DESIGN	DOCUMENT REF.
	(1) JET RING ASSEMBLY THE TUBE STIFFENING DOUBLERS, THE DISTRIBUTION MANIFOLD, AND THE 19 EQUALLY SPACED COOLANT JETS ARE MANUFACTURED USING 347 CRES, WHICH WAS SELECTED FOR ITS TENSILE STRENGTH, DUCTILITY, AND RESISTANCE TO CORROSION CRACKING (2). THE COOLANT INLET "S" TUBES, THE DOUBLERS, JET BUSHINGS, AND MANIFOLD ARE ANNEALED. THE COOLANT INLET "S" TUBES, THE MANIFOLD SHROUD, SHROUD STIFFENING COLLAR, AND THE BASE RING ARE MANUFACTURED UTILIZING A-286 CRES. THE ALLOY IS SOLUTION HEAT TREATED AND AGE-HARDENED. BOTH MATERIALS ARE RESISTANT TO HYDROGEN ENVIRONMENT EFFECTS AND DO NOT REQUIRE EMBRITTLEMENT PROTECTION (2). THE JET RING CONSISTS ENTIRELY OF A FURNACE BRAZED ASSEMBLY, WITH NICKEL PLATING ON THE A-286 COMPONENTS TO IMPROVE BRAZEABILITY (1). THE JET RING EXPERIENCES A THERMAL GRADIENT DUE TO THE LOWER COOLANT TEMPERATURES WITHIN THE JET RING PASSAGES. THE SHROUDED ATTACHMENT DESIGN FOR THE DISTRIBUTION MANIFOLD AND THE "S" SHAPE OF THE COOLANT INLET TUBES ALLOW FOR RELATIVE MOTION BETWEEN THE "S" TUBES AND DISTRIBUTION MANIFOLD RELATIVE TO THE BASE RING WITHOUT DEVELOPING THERMAL STRESSES. BRAZE FOIL IS INSERTED IN THE JET BUSHING-TO-MANIFOLD JOINTS PRIOR TO FURNACE BRAZING TO INSURE ADEQUATE BRAZE PENETRATION.	(1) RS007757 (2) RB0-8578-11
	(1) DISCHARGE STRUT ASSEMBLY THE DISCHARGE STRUT ASSEMBLY CONSISTS OF A FLANGE AND SHEET METAL SUBASSEMBLY. THE FLANGE IS MANUFACTURED UTILIZING FORGED INCOLOY 903. INCOLOY 903 IS AN IRON BASE ALLOY WHICH IS THERMO-MECHANICALLY PROCESSED, SOLUTION HEAT TREATED AND AGE-HARDENED. THE SHEET METAL SUBASSEMBLY DETAILS INCLUDE THE -033, -035, -037 VANES, THE -025 SHIELDS, THE -039 PLATES, THE -043 REFLECTOR, THE -053 RING, AND THE -019 SLEEVES. THE SHEET METAL IS MANUFACTURED UTILIZING ANNEALED HAYNES 188. A MIXED COOLANT OF HYDROGEN AND HOT-GAS IS USED TO COOL THE UPSTREAM PORTION OF THE FLANGE, THE -033 VANE AND THE -025 SHIELDS. THE VANE IS SLOTTED WHILE THE SHIELDS ARE SEGMENTED TO ALLOW FOR THERMAL EXPANSION AND CONTRACTION (1). THE VANE IS WELDED TO THE -019 SLEEVES AND IS CRIMPED AT THE UPSTREAM LOCATION TO THE FLANGE LIP. THE CRIMP IS RESTRAINED FROM MOVEMENT BY THE SECOND-STAGE LIP SEAL (2) AND NOZZLE FLANGE (3) DURING OPERATION. THE SHIELDS ARE BUTT-WELDED TO THE FLANGE AND ARE ENCLOSED BY THE VANE. THE MIXED COOLANT IS SUBSEQUENTLY DISCHARGED INTO THE HOT-GAS EXHAUST STREAM VIA VENT HOLES ON THE VANE (1). SINCE THE COOLANT IS METERED BY THE FLOW PASSAGES IN THE STRUT FLANGE, THE RESULTANT PRESSURE DIFFERENTIAL ACROSS THE VANE AND SHIELDS ARE MINIMIZED. THE -019 SLEEVES COVER THE 22 STRUTS TO FORM A PROTECTIVE COOLANT JACKET BETWEEN THE STRUTS AND THE EXHAUST GAS. THE SLEEVES ARE CRIMPED CIRCUMFERENTIALLY TO THE STRUTS IN THE ENCLOSED CAVITY OF THE VANE AND SHIELDS. HYDROGEN COOLANT IS METERED BY INDIVIDUAL LEE JET PLUGS (4) TO COOL THE STRUT AND SLEEVE, AND IS DISCHARGED AT THE MAIN HOUSING (5) INTERFACE. THE SEGMENTED -035 VANES, THE -043 REFLECTOR, AND THE -053 RING ARE WELDED TO THE SLEEVE FOR RETENTION. THE REFLECTOR AND RING FORM A SHIELD FOR THE MAIN HOUSING AGAINST THE EXHAUST GAS AND UTILIZES THE COOLANT FROM THE SLEEVE DISCHARGE. THE REMAINING -037 VANE IS SECURED AT THE UPSTREAM LOCATION TO THE MAIN HOUSING BY RETAINER SEGMENTS (6), BOLTS (7), AND LOCKWASHERS (8). THIS AREA IS COOLED BY THE REFLECTOR DISCHARGE. THE DOWNSTREAM SECTION OF THE VANE IS POSITIONED BY THE -039 PLATES, WHICH ARE WELDED TO THE SLEEVES. THE PLATES PROVIDE REACTION SUPPORT FOR THE VANE AGAINST MOMENTUM AND PRESSURE LOADING WHILE ALLOWING FREE THERMAL MOVEMENT OF THE VANE. THE STRUT MEETS CEI REQUIREMENTS FOR HIGH CYCLE AND LOW CYCLE FATIGUE LIFE (9).	(1) RS007779 (2) RS007915 (3) RS007910 (4) JEPA1253022A (5) RS007729 (6) RS007875 (7) RS007792 (8) RS007894 (9) RL00532, CP320R00058

CIL ITEM: 9400-23	DESIGN	DOCUMENT REF.
	(1) FIRST-STAGE TIP SEAL ASSEMBLY (2) SECOND-STAGE TIP SEAL ASSEMBLY THE FIRST- AND SECOND-STAGE TIP SEALS CONSIST OF A CONTINUOUS LINER THAT IS RETAINED ON THE OUTER DIAMETER BY A BACKUP BAND. THE LINER IS MANUFACTURED UTILIZING HASTELLOY X, WHICH WAS SELECTED FOR ITS FORMING CHARACTERISTICS, STRENGTH, AND OXIDIZATION RESISTANCE AT ELEVATED TEMPERATURES (3). THE MATERIAL IS ANNEALED AND FORMED INTO HONEYCOMB CELLS FOR WEAR AND ABRASION RESISTANCE DURING CONTACT WITH THE TURBINE BLADES (3). THE BACKUP BANDS ARE MANUFACTURED UTILIZING RENE 41, WHICH WAS SELECTED FOR ITS STRENGTH AT ELEVATED TEMPERATURES AND CORROSION RESISTANCE (3). THE BANDS OPERATE WITHIN THE ELASTIC RANGE AND DO NOT REQUIRE PROTECTION IN AN HYDROGEN ENVIRONMENT (3). THE BANDS ARE SOLUTION HEAT TREATED, AGE- HARDENED AND NICKEL PLATED PRIOR TO BRAZING ONTO THE LINER (1) (2). THE BANDS ARE SEGMENTED TO ALLOW UNRESTRICTED HOOP MOVEMENT DUE TO THERMAL LOADING (1) (2). TANGENTIAL MOVEMENT OF THE TIP SEALS ARE PREVENTED BY THE USE OF ANTI-ROTATION SLOTS IN THE BACKUP BANDS (1) (2). THE HONEYCOMB CELLS ARE DESIGNED TO ACCEPT RUBBING FROM THE TURBINE BLADE RAILS FOR MAXIMUM SEALING EFFECTIVENESS. THE FIRST-STAGE TIP SEALS MEET CEI REQUIREMENTS FOR HIGH CYCLE AND LOW CYCLE FATIGUE LIFE (4). THE SECOND-STAGE TIP SEALS ARE LOW CYCLE FATIGUE LIFE LIMITED BY MAJOR WAIVER (5). (1) SECOND-STAGE NOZZLE ASSEMBLY THE SECOND-STAGE NOZZLE ASSEMBLY (1) CONSISTS OF AN AIRFOIL AND BOX STRUCTURE. THE AIRFOIL IS MANUFACTURED UTILIZING MAR-M-246 WITH HAFNIUM ADDITION. THE STRUCTURAL ANALYSIS FOR DESIGN OF THE TURBINE NOZZLES USED MATERIAL PROPERTIES APPROPRIATE FOR THE OPERATING ENVIRONMENT (HYDROGEN RICH STEAM) AND TEMPERATURE. THE RESULTS OF THE ANALYSIS SHOWED ADEQUATE MARGIN ON STRUCTURAL INTEGRITY BUT LESS THAN CEI LIFE FOR LOW CYCLE FATIGUE. THE BOX STRUCTURE IS MANUFACTURED UTILIZING FORGED UNSPALOY. THE ALLOY IS SOLUTION HEAT TREATED, STABILIZED AND AGE-HARDENED. HYDROGEN PROTECTION FOR THE BOX STRUCTURE IS NOT REQUIRED DUE TO THE LOW OPERATIONAL STRAINS. THE AIRFOIL AND BOX STRUCTURE ARE AXIALLY PRELOADED AGAINST EACH OTHER AND ARE RETAINED BY RADIAL TUBES WHICH TRANSFER COOLANT FROM THE TURBINE HOUSING TO THE INTERNAL CAVITY OF THE BOX STRUCTURE. THE TUBES ARE MANUFACTURED UTILIZING A-286 CRES. THE ALLOY IS SOLUTION TREATED AND AGE-HARDENED. THE INTERSTAGE SEAL CONTAINS THE SEAL AND RETAINER ELEMENT. THE SEAL IS MANUFACTURED UTILIZING INCONEL 625, WHICH WAS SELECTED FOR ITS STRENGTH AT ELEVATED TEMPERATURES, FABRICABILITY, AND BRAZEABILITY (2). THE ALLOY IS ANNEALED, FORMED INTO HONEYCOMB CELLS, AND BRAZED (3) ONTO THE RETAINER. ALTHOUGH INCONEL 625 IS AFFECTED BY HIGH PRESSURE HYDROGEN, PROTECTION IS NOT REQUIRED DUE TO THE LOW OPERATIONAL STRAINS (2). THE RETAINER IS MANUFACTURED UTILIZING ANNEALED HAYNES 188. THE RETAINER, WITH THE ATTACHED SEAL, IS SECURED TO THE BOX STRUCTURE BY 8 RIVETS. THE NOZZLE IS PILOTED TO THE TURBINE HOUSING (4), AND THE SECOND-STAGE NOZZLE FLANGE (5). TANGENTIAL ROTATION IS PREVENTED BY SCALLOPS IN THE NOZZLE FLANGE WHICH ENGAGES WITH THE RADIAL COOLANT TUBE PASSAGES AT THE OUTER DIAMETER (1). THE BOX STRUCTURE, TUBES AND OUTER SHROUD OF THE AIRFOIL STRUCTURE ARE COOLED BY MIXED COOLANT, WHILE THE AIRFOIL VANES ARE HOLLOW CAST TO REDUCE THERMAL STRESSES DURING OPERATION. THE NOZZLE MEETS CEI REQUIREMENTS FOR HIGH CYCLE FATIGUE LIFE (6), BUT IS LOW CYCLE FATIGUE LIMITED BY MAJOR WAIVER (7). CONTINUED USE WITH ALLOWABLE DISCREPANCIES RESULTING FROM OPERATION IS EVALUATED AND CONTROLLED PER THE REQUIREMENTS OF THE MAINTENANCE CONTROL DOCUMENT (8).	(1) RS007914 (2) RS007915 (3) RSS-8578-11 (4) RL00532, CP32DR00038 (5) DAR 2603 (1) RD016027 (2) RSS-8578-11 (3) RS007752 (4) RS007746 (5) RS007910 (6) RL00532, CP32DR00038 (7) DAR 2147 (8) RSS-8793

CIL ITEM: B400-23	DESIGN	DOCUMENT REF.
	CLEANLINESS REQUIREMENTS DURING HANDLING AND ASSEMBLY (1) MINIMIZES CONTAMINATION INTRODUCTION INTO THE TURBINE. ASSEMBLY PROCEDURES FOR LOCKING DEVICES ENSURE DEFECT-FREE INSTALLATION (2). THE MINIMUM FACTORS OF SAFETY FOR THESE PARTS MEET CEI REQUIREMENTS (3). THE HARDWARE PARENT MATERIALS WERE CLEARED FOR FRACTURE MECHANICS/HDE FLAW GROWTH SINCE THEY ARE NOT FRACTURE CRITICAL PARTS, EXCEPT FOR THE ROTOR SHAFT WHICH WAS CLEARED BY CRITICAL INITIAL FLAW SIZE DETECTABILITY, THE FIRST-STAGE TURBINE BLADES, NOZZLE AND DISK, THE SECOND STAGE TURBINE BLADES AND NOZZLE, HATH HOUSING, AND TURBINE INLET HOUSING WERE CLEARED BY RISK ASSESSMENT (4). THE FMEA/CIL WELDS ARE CLEARED FOR FRACTURE MECHANICS/HDE FLAW GROWTH BY THE WELD ASSESSMENT (5). TABLE B400 LISTS ALL FMEA/CIL WELDS AND IDENTIFIES THOSE WELDS IN WHICH THE CRITICAL INITIAL FLAW SIZE IS NOT DETECTABLE AND THOSE WELDS IN WHICH THE ROOT SIDE IS NOT ACCESSIBLE FOR INSPECTION. THOSE WELDS IN WHICH THE CRITICAL INITIAL FLAW SIZE IS NOT DETECTABLE ARE ACCEPTABLE FOR FLIGHT BY RISK ASSESSMENT (5). REUSE OF PARTS DURING OVERHAUL ARE CONTROLLED BY THE REQUIREMENTS OF THE OVERHAUL SPECIFICATION (6).	(1) RL10001 (2) RL00814 (3) RSS-8546-16, CP320B0003B (4) NASA TASK 117 (5) RSS-8756 (6) RL00074

CIL ITEM: B400-23	INSPECTION AND TEST		
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
FAILURE CAUSE A:	RS007746 - TURBINE HOUSING		RS007746
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007746 RB0170-153 RB0170-186 RB0170-154 RB0170-197
		THE INNER, OUTER, AND FLANGE BELLOW RINGS FORGING ARE PENETRANT AND ULTRASONIC INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116 RA0115-012
		STRUT FORGING IS PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116
		SHELL FORGING IS PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116
	BELLOW INTEGRITY	BELLOWS SURFACE IRREGULARITY IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RL00078

CIL ITEM: 8400-23		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
		BELLOWS BUTT-WELD LOCATION, GRAIN DIRECTION, AND CONVOLUTION HEIGHT IS VERIFIED PER DRAWING REQUIREMENTS.	RS007740 RS007749
		OUTER BELLOW IS LEAK TESTED PRIOR TO CONVOLUTING PER SPECIFICATION REQUIREMENTS.	RL00315
	STRUT DETAIL SURFACE INTEGRITY	ALL STRUT DETAIL PARTS ARE VERIFIED BY PENETRANT INSPECTION PER SPECIFICATION REQUIREMENTS PRIOR TO WELDING.	RA0115-116
	ACCEPTANCE TESTING	INNER AND OUTER BELLOWS ACCEPTANCE TESTING IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RL00147 RL00146
	HEAT TREAT	HEAT TREAT IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007746 RA0611-020
	WELD INTEGRITY	ALL WELDS ARE INSPECTED TO DRAWING AND SPECIFICATION REQUIREMENTS PER WELD CLASS. INSPECTIONS INCLUDE: VISUAL, DIMENSIONAL, PENETRANT, RADIOGRAPHIC, ULTRASONIC, AND FILLER MATERIAL, AS APPLICABLE.	RL70011 RA0607-004 RA0115-116 RA0115-006 RA1115-001 RA0115-127
		SPECIAL WELD JOINT 4 INSPECTION OF THE STRUT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RL00258
		SPECIAL WELD JOINT 1 INSPECTION OF THE HOUSING IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RL00259
	BRAZE INTEGRITY	ALL BRAZE ARE INSPECTED TO DRAWING AND SPECIFICATION REQUIREMENTS.	RA0107-010
	SURFACE FINISH	HOUSING NICKEL PLATING IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA1109-005
		OUTER BELLOWS COPPER PLATING IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA1109-002
	HOUSING INTEGRITY	HOUSING PROOF TEST IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RL00019
	SURFACE INTEGRITY	HOUSING PENETRANT INSPECTION IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0115-116

CIL ITEM: B400-23	INSPECTION AND TEST		
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
	RS007779 - STRUT		RS007779
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007779 RBD170-196 RBD170-197
		STRUT IS PENETRANT AND MAGNETIC PARTICLE INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116 RA0115-115
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0111-018 RA0611-020
	ASSEMBLY INTEGRITY	STRUT SHEET METAL IS INSPECTED WITH A GO, NO-GO GAUGE FOR CLEARANCE INTO POWERHEAD PER SPECIFICATION REQUIREMENTS.	RL00814 RL00874
		UPSTREAM COMPONENTS ARE BORESCOPE INSPECTED AFTER EACH ENGINE HOT FIRE AND PRIOR TO EACH FLIGHT.	RF0001-053 RL00461 OMRSD V41BQQ.065
	WELD INTEGRITY	ALL WELDS ARE INSPECTED TO DRAWING AND SPECIFICATION REQUIREMENTS PER WELD CLASS. INSPECTIONS INCLUDE: VISUAL, DIMENSIONAL, PENETRANT, RADIOGRAPHIC, ULTRASONIC, AND FILLER MATERIAL, AS APPLICABLE.	RL10011 RA0607-094 RA0115-116 RA0115-006 RA0115-001 RA0115-127
	RS007875 - DISCHARGE STRUT RETAINER SEGMENT		RS007875
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007875
		RETAINER FORGING IS VERIFIED BY PENETRANT AND ULTRASONIC INSPECTION PER SPECIFICATION REQUIREMENTS.	RA0115-116 RA0115-012

CIL ITEM: B400-23		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
	RS007703 - SHAFT		RS007703
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RB0170-182
	HEAT TREAT	FORGING IS HEAT TREAT PER SPECIFICATION REQUIREMENTS.	RB017D-182
		FORGING IS PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116
		TENSILE STRENGTH OF SPECIMENS IS VERIFIED PER DRAWING REQUIREMENTS.	RS007703
	SURFACE FINISH	SHAFT IS PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116
		SHAFT DRY-FILM LUBRICATION AND BURNISH IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0112-003 RA0112-007
		SHAFT GOLD-PLATING IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007703 RA1109-009
		TURBINE END COMPONENTS ARE BORESCOPE INSPECTED FOR EVIDENCE OF LOSS OF GOLD PLATING PRIOR TO EACH FLIGHT.	OMRSD V410U0.065
	ASSEMBLY INTEGRITY	SHAFT DIMENSION AND CONCENTRICITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007703
		SHAFT IS SPIN-TESTED PER DRAWING REQUIREMENTS.	RS007703
	RS007705 - DISC		RS007705
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RB0170-182
		DISC TENSILE SPECIMENS ARE VERIFIED TO COMPLY WITH DRAWING REQUIREMENTS.	RS007706
		DISC FORGING IS VERIFIED BY PENETRANT INSPECTION PER SPECIFICATION REQUIREMENTS.	RA0115-116
	SURFACE FINISH	DISC IS VERIFIED BY PENETRANT INSPECTION BEFORE AND AFTER SPIN-TEST.	RA0115-116

CIL ITEM: 8400-25		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
		DISC GOLD-PLATING IS VERIFIED PER SPECIFICATION AND DRAWING REQUIREMENTS.	RA1109-009 RS007705
	ASSEMBLY INTEGRITY	DISC SPIN-TEST IS VERIFIED PER DRAWING REQUIREMENTS.	RS007705
	RS007707 - FIRST-STAGE TURBINE BLADE		RS007707
	RS007980 - FIRST-STAGE DAMPER		RS007980
	RS007981 - CENTERPLATE		RS007981
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RB0170-157 RS007980 RS007981
		BLADE CASTING SURFACE ROUGHNESS IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0115-007
	ASSEMBLY INTEGRITY	BLADE DIMENSIONAL REQUIREMENTS ARE VERIFIED PER SPECIFICATION REQUIREMENTS.	RF0004-006 RL00445
	SURFACE FINISH	BLADE SURFACE WAVINESS IS VERIFIED PER DRAWING REQUIREMENTS.	RS007707
		DAMPER SURFACE FINISH IS VERIFIED PER DRAWING REQUIREMENTS.	RS007980
		BLADE FINAL SURFACE IS PENETRANT AND RADIOGRAPHIC INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116 RA0115-006
		BLADE BLENDING IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA1603-005
	RS007914 - FIRST-STAGE TIP SEAL		RS007914
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007914
	BRAZE INTEGRITY	SEAL BRAZING IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RB0170-159

CIL ITEM: B400-23		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
	WELD INTEGRITY	ALL WELDS ARE INSPECTED TO DRAWING AND SPECIFICATION REQUIREMENTS PER WELD CLASS. INSPECTIONS INCLUDE: VISUAL, DIMENSIONAL, PENETRANT, RADIOGRAPHIC, ULTRASONIC, AND FILLER MATERIAL, AS APPLICABLE.	RL10D11 RA0607-096 RA0115-116 RA0115-006 RA1115-001 RA0115-127
	SURFACE FINISH	SEAL NICKEL PLATING IS VERIFIED PER DRAWING REQUIREMENTS.	RS007914
	HEAT TREAT	HEAT TREAT IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007913 RA0611-020
	RS007913 - FIRST-STAGE TIP SEAL RETAINER		RS007913
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007913
	RS007750 - FIRST-STAGE NOZZLE		RS007750
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RB0170-166
		NOZZLE IS NOT ISOSTATIC PRESSED PER SPECIFICATION REQUIREMENTS.	RL00368
	ASSEMBLY INTEGRITY	NOZZLE SPECIAL INSPECTION IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RL00314
		NOZZLE FINAL SURFACE PENETRANT INSPECTION IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0115-116
	RS007710 - SECOND-STAGE TURBINE BLADE		RS007710
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RB0170-157
		BLADE CASTING SURFACE IS VERIFIED TO CONFORM TO SPECIFICATION REQUIREMENTS.	RA0115-007
	ASSEMBLY INTEGRITY	BLADE FINAL SURFACE PENETRANT AND RADIOGRAPHIC INSPECTION IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0115-116 RA0115-006
		BLADE DIMENSIONAL AND VISUAL INSPECTION IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RF0004-086 RF0004-066

CIL ITEM: B400-23	INSPECTION AND TEST		
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
	RS007711 - SECOND-STAGE BLADE DAMPER		RS007711
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007711
	RS007915 - SECOND-STAGE TIP SEAL		RS007915
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007915
		TIP SEAL FORGING IS VERIFIED PENETRANT OR ULTRASONIC INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116 RA0115-012
	WELD INTEGRITY	ALL WELDS ARE INSPECTED TO DRAWING AND SPECIFICATION REQUIREMENTS PER WELD CLASS. INSPECTIONS INCLUDE: VISUAL, DIMENSIONAL, PENETRANT, RADIOGRAPHIC, ULTRASONIC, AND FILLER MATERIAL, AS APPLICABLE.	RL10011 RA0607-094 RA0115-116 RA0115-086 RA1115-001 RA0115-127
	BRAZE INTEGRITY	TIP SEAL BRAZING IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0107-010
	SURFACE FINISH	TIP SEAL NICKEL PLATING IS VERIFIED PER DRAWING REQUIREMENTS.	RS007915
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0611-020
	RS007752 - SECOND-STAGE NOZZLE RD016027 - NOZZLE ASSEMBLY		RS007752 RD016027
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007752
		NOZZLE FORGING PENETRANT AND ULTRASONIC INSPECTION IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0115-116 RA0115-012

CIL ITEM: 8400-23		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
		NOZZLE FORGING IS VERIFIED FURNISHED IN THE SOLUTION-TREATED CONDITION PER DRAWING REQUIREMENTS.	RS007752
		NOZZLE IS HOT ISOSTATIC PRESSED PER SPECIFICATION REQUIREMENTS.	RL00368
		NOZZLE DETAIL PARTS ARE PENETRANT INSPECTED AFTER FINAL MACHINING PER SPECIFICATION REQUIREMENTS.	RA0115-116
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0611-020
	BRAZE INTEGRITY	BRAZING IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0107-010
	WELD INTEGRITY	ALL WELDS ARE INSPECTED TO DRAWING AND SPECIFICATION REQUIREMENTS PER WELD CLASS. INSPECTIONS INCLUDE: VISUAL, DIMENSIONAL, PENETRANT, RADIOGRAPHIC, ULTRASONIC, AND FILLER MATERIAL, AS APPLICABLE.	RL10011 RA0607-094 RA0115-116 RA0115-006 RA1115-001 RA0115-127
	RS007957 - INTERSTAGE SEAL		RS007957
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RB0170-197
		SEAL FORGING PENETRANT INSPECTION IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0115-116
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0611-020
	ASSEMBLY INTEGRITY	SEAL PENETRANT INSPECTION IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0115-116
	RS007757 - JET RING		RS007757
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007757
	WELD INTEGRITY	ALL WELDS ARE INSPECTED TO DRAWING AND SPECIFICATION REQUIREMENTS PER WELD CLASS. INSPECTIONS INCLUDE: VISUAL, DIMENSIONAL, PENETRANT, RADIOGRAPHIC, ULTRASONIC, AND FILLER MATERIAL, AS APPLICABLE.	RL10011 RA0607-094 RA0115-116 RA0115-006 RA1115-001 RA0115-127

CIL ITEM: B400-23		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
	BRAZE INTEGRITY	BRAZING IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007757 RA0107-010 RL10011
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0611-020
	SURFACE FINISH	NICKEL PLATING IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA1100-005
	RS007781 - BELLOWS SHIELD		RS007781
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007781
	WELD INTEGRITY	ALL WELDS ARE INSPECTED TO DRAWING AND SPECIFICATION REQUIREMENTS PER WELD CLASS. INSPECTIONS INCLUDE: VISUAL, DIMENSIONAL, PENETRANT, RADIOGRAPHIC, ULTRASONIC, AND FILLER MATERIAL, AS APPLICABLE.	RL10011 RA0607-094 RA0115-116 RA0115-006 RA0115-001 RA0115-127
		BELLOWS SHIELD RESISTANCE WELD IS VERIFIED PER SPECIFICATION REQUIREMENTS.	S10107RA0046
	RS007881 - TURBINE SEAL COOLANT SHIELD		RS007881
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007881
	ASSEMBLY INTEGRITY	SHIELD SEALING SURFACE IS VERIFIED FREE OF IMPERFECTIONS OR COPPER PLATING AS REQUIRED PER DRAWING REQUIREMENTS.	RS007881
	RS007792 - DISCHARGE STRUT RETAINER BOLTS		RS007792
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007792
	SURFACE FINISH	BOLT FLASH SILVER-PLATE IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA1689-011
		BOLT DRY-FILM LUBRICATION IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0112-003

CIL ITEM: B400-23	INSPECTION AND TEST		
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
	RS007894 - DISCHARGE STRUT WASHER		RS007894
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007894
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0611-020
	SURFACE FINISH	DRY-FILM LUBRICATION IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0112-003
	RS007871 - DISC BOLT		RS007871
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RB0160-014
	SURFACE INTEGRITY	BOLT PENETRANT INSPECTION IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0115-116
	SURFACE FINISH	BOLT FLASH SILVER-PLATING IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA1699-011
	RS007797 - WASHER		RS007797
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007797
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0611-020
	SURFACE FINISH	WASHER DRY-FILM LUBRICATION IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0112-003
	RS007982 - FIRST-TURBINE BLADE LOCK		RS007982
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007982
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0111-010
	RS007712 - SECOND-TURBINE BLADE LOCK		RS007712

CIL ITEM: B400-23		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RB0170-179
	RS007870 - FIRST-STAGE NOZZLE RETAINER BOLTS		RS007870
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007870
		BOLT IS VERIFIED BY ULTRASONIC INSPECTION PER SPECIFICATION REQUIREMENTS.	RL00125
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RB0168-014
	ASSEMBLY INTEGRITY	BOLT PENETRANT INSPECTION IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0115-116
	SURFACE FINISH	SILVER-PLATING IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA1609-011
	RS007872 - FIRST-STAGE NOZZLE RETAINER WASHER		RS007872
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007872
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0611-020
	SURFACE FINISH	WASHER DRY-FILM LUBRICATION IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0112-003
	RS007890 - JET RING RETAINER BOLT		RS007890
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007890
	SURFACE INTEGRITY	BOLT PENETRANT INSPECTION IS VERIFIED PER DRAWING REQUIREMENTS.	RS007890
	MS9880 - JET RING RETAINER WASHER		MS9880
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	MS9880

CIL ITEM: B40D-23	INSPECTION AND TEST		
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
	HEAT TREAT	HEAT TREAT IS VERIFIED PER DRAWING REQUIREMENTS.	MS9880
	RS007889 - TURBINE SEAL RETAINER BOLTS		RS007889
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007889
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0160-014
	ASSEMBLY INTEGRITY	BOLT PENETRANT INSPECTION IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0115-116
	SURFACE FINISH	BOLT FLASH SILVER-PLATING IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA1609-011
	RS007882 - TURBINE SEAL RETAINER BOLTS AND LOCKS		RS007882
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007882
	RS007891 - FIRST-STAGE NOZZLE PLUG		RS007891
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007891
	BRAZE INTEGRITY	BRAZE IS INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0107-010
	RS007701 - HPOTP		RS007701
	CLEANLINESS OF COMPONENTS	THE HPOTP AND SUBASSEMBLIES ARE VERIFIED CLEANED PER SPECIFICATION REQUIREMENTS.	RL10001
	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.	RL00374 RA0115-116
		FASTENER INSTALLATION, TORQUE, AND ELONGATION ARE VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007701 RL00814

CIL ITEM: B400-23		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
		LOCK AND LOCKWASHER DEFORMATION IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007701 RL00B14
		OPERATION/PERFORMANCE IS VERIFIED BY ENGINE HOT FIRE TESTING AND 2ND E & M INSPECTION.	RL00050-04 RL00056-06 RL00056-07 RL00461
		THE RETAINER TO SECOND-STAGE NOZZLE ASSEMBLY GAP AND SCREW STACKING ARE INSPECTED PER SPECIFICATION REQUIREMENTS AND DAR.	OMRSD V41BU0.066 RL00B14 DAR 2696
		TORQUE CHECKS ARE PERFORMED PRIOR TO EACH FLIGHT.	OMRSD V41B50.040
		RPOTP MICROSHAFT TRAVEL MEASUREMENTS ARE PERFORMED PRIOR TO EACH FLIGHT PER SPECIFICATION REQUIREMENTS.	RL01034 RL00050-04 OMRSD V41B50.045
		AN INTERNAL BORESCOPE INSPECTION IS PERFORMED PRIOR TO EACH FLIGHT.	OMRSD V41BU0.065
		DATA FROM THE 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/PRACA).
REFERENCE: NASA LETTER SR21/88/308 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