1) CIL ITEM	: B400-03	7) PREPARED	: SSME RELIABILITY
2) FMEA CODE	: B400	8) APPROVED	:
3) COMPONENT	: HPOTP	9) DATE	: 06-01-95
4) PART NUMBER	: RS007701	10) REVISION/CHANGE	: -002/0
5) SYSTEM/SUBSYSTEM	: PUMPS/HKXX	11) EFFECTIVITY	: -761
6) FAILURE MODE	: TURBINE BLADE STRUCTURAL FAILURE	12) HAZARD REFERENCE	: SEE LISTINGS BELOW
		13) CCBD #	: ME3-01-3215

PHASE	FAILURE DESCRIPTION/EFFECT	CRITICALITY
SMC	LOSS OF TURBINE BLADE, LEADING TO MULTIPLE BLADE FAILURE AND ROTOR UNBALANCE. ROTOR UNBALANCE RESULTS IN RUBBING AND ULTIMATE ROTATING ASSEMBLY DISINTEGRATION. LOSS OF VEHICLE. REDUNDANCY SCREENS: SINGLE POINT FAILURE: N/A	1 HAZARD REF: ME-C1S,M ME-C1A,C.

CIL ITEM: B400-03	DESIGN	DOCUMENT REF.
	FAILURE CAUSE A: BLADE CRACKS FAILURE CAUSE D: IMPACT THE TURBINE IS A TWO-STAGE REACTION DESIGN WHICH UTILIZES 78 FIRST-STAGE BLADES (1) AND 73 SECOND-STAGE BLADES (2). THE TURBINE BLADES INCORPORATE TIP SHROUDS FOR IMPROVED SEALING AND ARE ATTACHED TO THE DISCS BY FIR TREES. COULOMB DAMPING BETWEEN BLADES IS ACHIEVED BY TWO-PIECE DAMPERS (3) (4) FOR THE FIRST-STAGE AND SINGLE-PIECE DAMPERS (5) FOR THE SECOND-STAGE. THE BLADES ARE MACHINED FROM INVESTMENT SHELL CASTINGS UTILIZING DIRECTIONALLY SOLIDIFIED MAR-M-246 WITH HAFNIUM ADDITION TO THE BASIC ALLOY. THE HAFNIUM ADDITION IMPROVES DUCTILITY AND CASTABILITY IN THIN WALLED HOLLOW SECTIONS (6). THE DIRECTIONAL SOLIDIFICATION PROCESS IMPARTS INCREASED DUCTILITY RESULTING IN IMPROVED RUPTURE, HIGH CYCLE AND LOW CYCLE FATIGUE LIFE (6). THE MATERIAL IS A NICKEL BASE ALLOY WHICH WAS SELECTED FOR ITS COMBINATION OF RUPTURE STRENGTH, RESISTANCE TO CREEP, AND REQUIRED STATIC MECHANICAL PROPERTIES FROM ROOM TO ELEVATED TEMPERATURES (6). STRUCTURAL ANALYSIS FOR THE DESIGN OF THE TURBINE BLADES SHOW ADEQUATE STRUCTURAL MARGIN WITHOUT PROTECTION IN A HYDROGEN STEAM ENVIRONMENT. THE ALLOY IS SOLUTION HEAT TREATED AND AGE-HARDENED (1) (2). ENGINE TEST EXPERIENCE WITH THIS ALLOY FROM CONTAMINATION IMPACT AND INGESTION IN THE HPFTP TURBINE HAVE NOT RESULTED IN BLADE FAILURE. THE FIRST-STAGE TURBINE BLADES ARE HIGH CYCLE AND LOW CYCLE FATIGUE LIFE LIMITED BY MAJOR WAIVER (11). THE SECOND-STAGE TURBINE BLADES ARE HIGH CYCLE AND LOW CYCLE FATIGUE LIFE LIMITED BY MAJOR WAIVER (12). THE FIRST-STAGE AND SECOND-STAGE TURBINE BLADES HAVE COMPLETED DESIGN VERIFICATION TESTING FOR NATURAL FREQUENCY, MODE SHAPE (8), AND STRESS DISTRIBUTION AT THE FIR TREES (9). CONTINUED USE WITH ALLOWABLE DISCREPANCIES RESULTING FROM OPERATION IS EVALUATED AND CONTROLLED PER THE REQUIREMENTS OF THE MAINTENANCE CONTROL DOCUMENT (10).	(1) RS007707 (2) RS007710 (3) RS007980 (4) RS007981 (5) RS007711 (6) RSS-8578-11 (7) RL00532, CP320R0003B (8) RSS-403-15, RSS-403-30 (9) RSS-403-29 (10) RSS-8793 (11) DAR 2272 (12) DAR 2275

CIL ITEM: B400-03	DESIGN	DOCUMENT REF.

FAILURE CAUSE B: ROTOR BLADE TIP RUBBING
FAILURE CAUSE C: HONEYCOMB RETAINER FAILURE

THE TURBINE BLADES (1) (2) INCORPORATE TIP SHROUDS AND UTILIZES TIP SEALS (3) (4) FOR IMPROVED SEALING. THE TIP SHROUDS CONTAIN TWO CIRCUMFERENTIAL RAILS AT THE OUTER DIAMETER WHICH ARE DESIGNED TO GROOVE INTO THE HONEYCOMB TIP SEALS FOR LEAKAGE CONTROL. THE BLADES ARE MACHINED FROM INVESTMENT SHELL CASTINGS UTILIZING DIRECTIONALLY SOLIDIFIED MAR-M-246 WITH HAFNIUM ADDITION. THE TIP SEALS CONSIST OF A CONTINUOUS LINER THAT IS BRAZED ON THE OUTER DIAMETER TO A BACKUP BAND. THE LINER IN MANUFACTURED UTILIZING HASTELLOY X, WHICH WAS SELECTED FOR ITS FORMING CHARACTERISTICS, STRENGTH, AND OXIDIZATION RESISTANCE AT ELEVATED TEMPERATURES (5). THE MATERIAL IS ANNEALED (3) (4) AND FORMED INTO HONEYCOMB CELLS FOR WEAR AND ABRASION RESISTANCE DURING CONTACT WITH THE TURBINE BLADES. THE BACK-UP BANDS ARE MANUFACTURED UTILIZING RENE 41, WHICH WAS SELECTED FOR ITS STRENGTH AT ELEVATED TEMPERATURES AND CORROSION RESISTANCE (5). THE BANDS OPERATE WITHIN THE ELASTIC RANGE AND DO NOT REQUIRE PROTECTION IN A HYDROGEN ENVIRONMENT (5). THE BANDS ARE SOLUTION HEAT TREATED, AGE-HARDENED, AND NICKEL PLATED PRIOR TO BRAZING ONTO THE LINER, AND ARE SEGMENTED TO ALLOW UNRESTRICTED HOOP MOVEMENT FROM THERMAL LOADING (3) (4). THE FIRST-STAGE TIP SEAL IS SECURED TO THE SECOND-STAGE NOZZLE ASSEMBLY (6) BY TEN SEGMENTED RETAINERS (7) WHICH OVERLAP ADJACENT SEGMENTS TO FORM A CONTINUOUS HOOP. THE RETAINERS PROVIDES RADIAL AND AXIAL SUPPORT, AND ARE SEGMENTED TO ALLOW FREE EXPANSION AND CONTRACTION IN THE HOT-GAS TURBINE ENVIRONMENT. THE RETAINERS ARE MANUFACTURED UTILIZING ANNEALED HAYNES 188, WHICH WAS SELECTED FOR ITS TENSILE STRENGTH AT ELEVATED TEMPERATURES, CORROSION RESISTANCE, AND RESISTANCE TO DEGRADATION IN HIGH PRESSURE GASEOUS HYDROGEN (5). TEN RETAINER SCREWS (8) ARE STAKED AT ASSEMBLY TO SECURE THE RETAINERS TO THE NOZZLE. ASSEMBLY PROCEDURES FOR LOCKING DEVICES ENSURE DEFECT-FREE INSTALLATION (9). THE SCREWS ARE MANUFACTURED UTILIZING A-286 CRES, WHICH WAS SELECTED FOR ITS TENSILE STRENGTH AND RESISTANCE TO CORROSION AND STRESS CORROSION CRACKING (5). HYDROGEN ENVIRONMENT EMBRITTLEMENT, AT ANY TEMPERATURE, DOES NOT HAVE A SIGNIFICANT EFFECT ON THE PROPERTIES OF THIS ALLOY (5). THE SCREW ALLOY IS SOLUTION HEAT TREATED, COLD WORKED, AGED, AND COLD WORKED AGAIN (8). THE SECOND-STAGE TIP SEAL IS PILOTED BY THE DISCHARGE STRUT (10), SECOND-STAGE NOZZLE FLANGE (11), AND THE SECOND-STAGE NOZZLE ASSEMBLY (6). TANGENTIAL MOVEMENT OF THE TIP SEALS IS PREVENTED BY THE USE OF ANTI-ROTATION TANGS, WHICH ENGAGE INTO SLOTS IN THE BACKUP BANDS (3) (4). THE HONEYCOMB CELLS ARE DESIGNED TO ACCEPT RUBBING FROM THE TURBINE BLADE RAILS FOR MAXIMUM SEALING EFFECTIVENESS. THE COMPONENT DYNAMIC BALANCE REQUIREMENTS MINIMIZES SYNCHRONOUS BLADE TIP DEFLECTIONS WHICH ENHANCES TIP SEALING (12). THE FIRST-STAGE TURBINE BLADES ARE HIGH CYCLE AND LOW CYCLE FATIGUE LIFE LIMITED BY MAJOR WAIVER (16). THE SECOND-STAGE TURBINE BLADES ARE HIGH CYCLE AND LOW CYCLE FATIGUE LIFE LIMITED BY MAJOR WAIVER (17). THE FIRST-STAGE AND SECOND-STAGE TURBINE BLADES HAVE COMPLETED DESIGN VERIFICATION TESTING FOR NATURAL FREQUENCY, MODE SHAPE (14), AND STRESS DISTRIBUTION AT THE FIR TREES (15). THE FIRST-STAGE TIP SEAL RETAINERS ARE ASSESSED TO HAVE INFINITE LIFE (13) AND ARE NOT TRACKED BY SERIALIZATION. THE SECOND-STAGE TIP SEALS ARE LOW CYCLE FATIGUE LIFE LIMITED BY MAJOR WAIVER (18).

DOCUMENT REF.

(1) RS007707
(2) RS007710
(3) RS007914
(4) RS007915
(5) RSS-8578-11
(6) R0016027
(7) RS007913
(8) 1035848
(9) RL00814
(10) RS007779
(11) RS007910
(12) RL00816
(13) RL00532, CP320R0003B
(14) RSS-403-15, RSS-403-30
(15) RSS-403-29
(16) DAR 2272
(17) DAR 2275
(18) DAR 2603

CIL ITEM: B400-03 | **DESIGN** | **DOCUMENT REF.**

FAILURE CAUSE E: INADEQUATE COOLING FLOW

THE FIRST-STAGE (1) AND SECOND-STAGE TURBINE BLADES (2) ARE COOLED BY A HYDROGEN-STEAM MIXTURE SUPPLIED THROUGH A MULTIPLE NETWORK OF SERIES AND PARALLEL CIRCUITS. HYDROGEN GAS IS SUPPLIED FROM THE PREBURNER COOLANT SUPPLY AT THE TURBINE HOUSING INTERFACE (3), WHERE AN INBOARD (4) AND OUTBOARD PRESSURE-ASSISTED SEAL (5) IS EMPLOYED TO PREVENT BYPASS LEAKAGE. EIGHT ORIFICE PLUGS (6) METER HYDROGEN GAS INTO THE INTERNAL BELLOWS CAVITY OF THE TURBINE HOUSING WHERE IT MIXES WITH HOT-GAS ACQUIRED THROUGH EIGHT ORIFICE HOLES IN THE HOUSING. PART OF THIS RESULTANT MIXTURE IS FED INTERNALLY ACROSS THE TWELVE INLET STRUTS, EACH OF WHICH CONTAINS THREE PARALLEL PASSAGES, TO A MANIFOLD THAT SUPPLIES THE JET RING (7). THE JET RING UTILIZES SIX FEED TUBES TO TRANSFER COOLANT FROM THE STRUT MANIFOLD TO THE RING MANIFOLD, WHERE IT IS DISCHARGED TO THE FIRST-STAGE UPSTREAM LOCATION VIA 19 JETS. EIGHTEEN BOLTS (8) WITH CUP WASHERS (9) ARE USED TO SECURE THE JET RING TO THE TURBINE HOUSING. JET RING CUPWASHERS (9) ARE TO BE REMOVED AND REPLACED AT INTERVALS SPECIFIED BY MAJOR WAIVER (25). THE FIRST-STAGE DOWNSTREAM AND SECOND-STAGE UPSTREAM LOCATION IS COOLED BY THE SECOND-STAGE NOZZLE (10). FORTY-ONE TUBES TRANSFER MIXED COOLANT FROM THE TURBINE HOUSING TO THE BOX STRUCTURE MANIFOLD OF THE NOZZLE, WHERE IT IS DISCHARGED AT EACH SIDE OF THE BOX STRUCTURE VIA 19 ORIFICES. THE PASSAGES WHICH CONTAIN THE TUBES ARE PRESSURE LOADED AGAINST THE TURBINE HOUSING DURING OPERATION, PROVIDING A METAL-TO-METAL SEAL. THE TUBES INCORPORATE A PISTON SEAL (11) ON ITS BORE JOURNAL TO GUARD AGAINST EXTERNAL LEAKAGE FROM THE NOZZLE ASSEMBLY. THE REMAINING SECOND-STAGE DOWNSTREAM LOCATION RECEIVES COOLANT FROM FOUR PARALLEL CIRCUITS ACROSS THE SECOND-STAGE NOZZLE FLANGE (12), TURBINE DISCHARGE STRUT (13), AND THE MAIN HOUSING (14). THE COOLANT IS INTRODUCED INTERNALLY ACROSS FOUR OF THE STRUTS AND UTILIZES THE COMPRESSION LOADS AT THE INTERFACES TO SEAL AGAINST LEAKAGE. FOUR CORRESPONDING PASSAGES IN THE MAIN HOUSING DELIVER THE COOLANT FROM THE STRUT TO A MANIFOLD WHERE IT IS SUBSEQUENTLY DISCHARGED VIA 19 ORIFICE JETS. THE FIRST-STAGE AND SECOND-STAGE TURBINE BLADES AND SECOND-STAGE NOZZLE ARE MANUFACTURED UTILIZING MAR-M-246, AND THE JET RING, BOLTS, AND WASHERS ARE EITHER A-286 CRES, 321 CRES, OR 347 CRES. THESE ALLOYS DO NOT REQUIRE HYDROGEN PROTECTION BECAUSE OF THEIR MINOR EFFECT ON MATERIAL PROPERTIES (15). THE SECOND-STAGE NOZZLE FLANGE IS MANUFACTURED UTILIZING RENE 41 AND IS COPPER PLATED AT THE CRITICAL STRESS LOCATION FOR HYDROGEN PROTECTION (12). THE TURBINE HOUSING AND DISCHARGE STRUT ARE MANUFACTURED UTILIZING INCOLOY 903. INCOLOY 903 IS AN IRON BASE ALLOY WHICH IS RESISTANT TO HYDROGEN EFFECTS (15). THE BOX STRUCTURE OF THE SECOND-STAGE NOZZLE IS MANUFACTURED UTILIZING WASPALOY, AND THE PRESSURE-ASSISTED SEALS ARE MANUFACTURED UTILIZING INCONEL 718. THESE ALLOYS ARE SUSCEPTIBLE TO HYDROGEN ENVIRONMENT EFFECTS BUT ARE IN LOW STRESS, ELASTIC RANGE APPLICATIONS, AND DO NOT REQUIRE PROTECTION (15). CLEANLINESS REQUIREMENTS DURING HANDLING AND ASSEMBLY (16) AND BY THE VEHICLE PROPELLANT FILTERS (17) REDUCE THE POTENTIAL OF COOLANT PASSAGE BLOCKAGE BY CONTAMINATION. ENGINE DRYING AND PURGING PRECLUDES THE OCCURRENCE OF ICE FORMATION. THE REFERENCED PARTS MEET CEI REQUIREMENTS FOR HIGH CYCLE AND LOW CYCLE FATIGUE LIFE (18), WITH THE EXCEPTION OF THE SECOND-STAGE NOZZLE WHICH IS LOW CYCLE FATIGUE LIFE LIMITED (19), AND THE TURBINE HOUSING WHICH IS LOW CYCLE FATIGUE LIFE LIMITED BY MAJOR WAIVER (22). THE FIRST-STAGE TURBINE BLADES ARE HIGH CYCLE AND LOW CYCLE FATIGUE LIFE LIMITED BY MAJOR WAIVER (23). THE SECOND-STAGE TURBINE BLADES ARE HIGH CYCLE AND LOW CYCLE FATIGUE LIFE LIMITED BY MAJOR WAIVER (24). THE MAIN HOUSING AND THE TURBINE HOUSING HAVE COMPLETED DESIGN VERIFICATION TESTING FOR PROOF PRESSURE-STRESS DISTRIBUTION RESPECTIVELY (20) (21).

DOCUMENT REF.

(1) RS007707
(2) RS007710
(3) RS007746
(4) RS008848
(5) RS008857
(6) RS007799
(7) RS007757
(8) RS007890
(9) MS9880
(10) R0016027
(11) RES1264
(12) RS007910
(13) RS007779
(14) RS007729
(15) RSS-8578-11
(16) RL10001
(17) ICD 13M15000
(18) RL00532,
CP320R0003B
(19) DAR 2147
(20) RSS-403-5B
(21) RSS-403-60A
(22) DAR 2141
(23) DAR 2272
(24) DAR 2275
(25) DAR 2631

CIL ITEM: B400-03	DESIGN	DOCUMENT REF.
	FAILURE CAUSE F: LOSS OF DAMPER FUNCTION FAILURE CAUSE G: OPERATION AT RESONANCE	
	THE TURBINE IS A TWO-STAGE REACTION DESIGN WHICH UTILIZES TURBINE BLADE DAMPERS FOR COULOMB DAMPING. THE FIRST-STAGE TURBINE BLADES (1) INCORPORATE TWO-PIECE DAMPERS, CONSISTING OF A DAMPER ELEMENT (2) AND A CENTERPLATE (3), WHILE THE SECOND-STAGE TURBINE BLADES (4) USES SINGLE-PIECE DAMPERS (5). THE BLADES ARE MACHINED FROM INVESTMENT SHELL CASTINGS UTILIZING DIRECTIONALLY SOLIDIFIED MAR-M-246 WITH HAFNIUM ADDITION TO THE BASIC ALLOY. THE HAFNIUM ADDITION IMPROVES DUCTILITY AND CASTABILITY IN THIN WALLED HOLLOW SECTIONS (6). THE MATERIAL IS A NICKEL BASE ALLOY WHICH WAS SELECTED FOR ITS COMBINATION OF RUPTURE STRENGTH, RESISTANCE TO CREEP, AND REQUIRED STATIC MECHANICAL PROPERTIES FROM ROOM TO ELEVATED TEMPERATURES (6). THE DIRECTIONAL SOLIDIFICATION PROCESS IMPARTS INCREASED DUCTILITY RESULTING IN IMPROVED RUPTURE, HIGH CYCLE, AND LOW CYCLE FATIGUE LIFE (6). STRUCTURAL ANALYSIS OF THE TURBINE BLADES USING HYDROGEN PROPERTIES SHOW ADEQUATE MARGIN WITHOUT PROTECTION. THE ALLOY IS SOLUTION HEAT TREATED AND AGE-HARDENED (1) (4). THE DAMPERS ARE MANUFACTURED UTILIZING HAYNES 188, WHICH WAS SELECTED FOR ITS REQUIRED STRENGTH AT ELEVATED TEMPERATURES AND RESISTANCE TO DEGRADATION IN HIGH PRESSURE GASEOUS HYDROGEN ENVIRONMENT (6). THE ALLOY IS ANNEALED AND IS RESISTANT TO CORROSION (6). THE DAMPERS FIT BETWEEN ADJACENT TURBINE BLADES AND ARE RETAINED BY THE PLATFORM SHROUDS AND DAMPER POCKETS (1) (4). DYNAMIC RETENTION TESTING WAS CONDUCTED ON A TWO-AXES TESTER WHICH SIMULATED SEVERE HANDLING AND TRANSPORTATION VIBRATION ENVIRONMENTS (7). THE DAMPERS AND CENTERPLATES WERE RETAINED AND IN PROPER POSITION AT THE COMPLETION OF TESTING. THE FIRST-STAGE TURBINE BLADES ARE HIGH CYCLE AND LOW CYCLE FATIGUE LIFE LIMITED BY MAJOR WAIVER (12). THE SECOND-STAGE TURBINE BLADES ARE HIGH CYCLE AND LOW CYCLE FATIGUE LIFE LIMITED BY MAJOR WAIVER (13). THE FIRST-STAGE AND SECOND-STAGE TURBINE BLADES HAVE COMPLETED DESIGN VERIFICATION TESTING FOR NATURAL FREQUENCY, MODE SHAPE (9), AND STRESS DISTRIBUTION AT THE FIR TREES (10).	(1) RS007707 (2) RS007980 (3) RS007981 (4) RS007710 (5) RS007711 (6) RSS-8578-11 (7) RL170TM-3003, SSME 86-1417 (8) RL00532, (9) RSS-403-15, RSS-403-30 (10) RSS-403-29 (11) RL00532, CP320R0003B (12) DAR 2272 (13) DAR 2275
	FAILURE CAUSE H: DISC FIR TREE YIELDING AND FRACTURE	
	THE FIR TREES OF THE DISC (1) AND SHAFT (2) TRANSMIT TORQUE DEVELOPED BY THE TURBINE BLADES TO THE ROTATING ASSEMBLY. THE DISC AND SHAFT ARE MANUFACTURED UTILIZING WASPALOY DIE FORGINGS, WHICH WAS SELECTED FOR ITS TENSILE STRENGTH AND DUCTILITY AT ELEVATED TEMPERATURES. THE ALLOY IS VACUUM MELTED TO MINIMIZE IMPURITY FORMATION AND THERMO-MECHANICALLY PROCESSED TO IMPROVE HIGH TEMPERATURE STRESS RUPTURE DUCTILITY (1) (2). THE ALLOY IS CORROSION RESISTANT AND EXHIBITS A RECRYSTALLIZED STRUCTURE WHICH REQUIRES THE USE OF A HYDROGEN BARRIER TO PREVENT EMBRITTLEMENT (3). 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. FORGING GRAIN FLOW IS SPECIFIED TO MAXIMIZE MATERIAL PROPERTIES IN THE DIRECTION OF STRESS INTENSITY (1) (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) RS007705 (3) RSS-8578-11 (4) RL00532, CP320R00058 (5) DAR 2024 (6) DAR 2023 (7) RSS-403-10A, RSS-403-11 (8) RSS-403-32 (9) DAR 2432 (10) DAR 2474

CIL ITEM: B400-03	DESIGN	DOCUMENT REF.
	FAILURE CAUSE I: NOZZLE FAILURE THE FIRST-STAGE (1) AND SECOND-STAGE (2) NOZZLES PROVIDE AERODYNAMIC CONTROL AND GUIDANCE TO THE TURBINE HOT-GAS FLOWSTREAMS. THE FIRST-STAGE NOZZLE IS CAST FROM MAR-M-246 WITH HAFNIUM ADDITION TO THE BASIC ALLOY. THE HAFNIUM ADDITION IMPROVES DUCTILITY AND CASTABILITY IN THIN WALLED HOLLOW SECTIONS (3). THE ALLOY WAS SELECTED FOR ITS COMBINATION OF RUPTURE STRENGTH, RESISTANCE TO CREEP, AND REQUIRED STATIC MECHANICAL PROPERTIES FROM ROOM TO ELEVATED TEMPERATURES (3). THE FIRST-STAGE NOZZLE IS NOT ISOSTATIC PRESSED TO FURTHER IMPROVE MATERIAL PROPERTIES (1). THE FIRST-STAGE NOZZLE IS AXIALLY SECURED TO THE TURBINE HOUSING STRUT ASSEMBLY (4) BY 36 STRETCH BOLTS (5) AND LOCKED BY 18 WASHERS (6). THE AIRFOIL VANES ARE HOLLOW CAST TO REDUCE THERMAL STRESSES DURING OPERATION. COOLANT IS INTRODUCED FROM THE STRUT TO THE NOZZLE FLANGE TO REDUCE THE THERMAL GRADIENT BETWEEN THE TWO PARTS FOR STABILIZATION OF THE RADIAL INTERFERENCE FIT. THE SECOND-STAGE NOZZLE AIRFOIL STRUCTURE IS CAST FROM MAR-M-246 WITH HAFNIUM ADDITION TO THE BASIC ALLOY. THE SECOND-STAGE NOZZLE CASTING IS NOT ISOSTATIC PRESSED TO FURTHER IMPROVE MATERIAL PROPERTIES. THE BOX STRUCTURE IS MANUFACTURED UTILIZING FORGED WASPALOY. THE ALLOY IS SOLUTION HEAT TREATED, STABILIZED, AND AGE-HARDENED (2) AND WAS SELECTED FOR ITS REQUIRED TENSILE STRENGTH (3). 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 (2). THE TUBES ARE MANUFACTURED UTILIZING A-286 CRES, WHICH WAS SELECTED FOR ITS TENSILE STRENGTH AND RESISTANCE TO CORROSION AND STRESS CORROSION CRACKING (3). THE ALLOY IS SOLUTION HEAT TREATED, AND AGE-HARDENED (2) AND DOES NOT REQUIRE HYDROGEN PROTECTION (3). 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 (3). THE ALLOY IS ANNEALED, FORMED INTO HONEYCOMB CELLS, AND BRAZED (2) ONTO THE RETAINER. ALTHOUGH INCONEL 625 IS AFFECTED BY HIGH PRESSURE HYDROGEN, PROTECTION IS NOT REQUIRED DUE TO THE LOW OPERATIONAL STRAINS (3). THE RETAINER IS MANUFACTURED UTILIZING ANNEALED HAYNES 188, WHICH WAS SELECTED FOR ITS STRENGTH AT ELEVATED TEMPERATURES, CORROSION RESISTANCE, AND RESISTANCE TO DEGRADATION IN HIGH PRESSURE GASEOUS HYDROGEN (3). THE RETAINER, WITH THE ATTACHED SEAL, IS SECURED TO THE BOX STRUCTURE BY 8 RIVETS (2). THE NOZZLE IS PILOTED TO THE TURBINE HOUSING (4) AND THE SECOND-STAGE NOZZLE FLANGE (7). TANGENTIAL ROTATION IS PREVENTED BY SCALLOPS IN THE NOZZLE FLANGE WHICH ENGAGES WITH THE RADIAL COOLANT TUBE PASSAGES AT THE OUTER DIAMETER (2). 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. ENGINE TEST EXPERIENCE WITH THIS ALLOY FROM CONTAMINATION IMPACT AND INGESTION IN THE HPFTP TURBINE HAVE NOT RESULTED IN NOZZLE FAILURE. 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 NOZZLES MEET CEI REQUIREMENTS FOR HIGH CYCLE FATIGUE LIFE (8), BUT ARE LOW CYCLE FATIGUE LIFE LIMITED BY MAJOR WAIVER (9) (10). CONTINUED USE WITH ALLOWABLE DISCREPANCIES RESULTING FROM OPERATION IS EVALUATED AND CONTROLLED PER THE REQUIREMENTS OF THE MAINTENANCE CONTROL DOCUMENT (11).	(1) RS007754 (2) RO016027, RS007752 (3) RSS-8578-11 (4) RS007746 (5) RS007870 (6) RS007872 (7) RS007910 (8) RL00532, CP320R0003B (9) DAR 2147 (10) DAR 2148 (11) RSS-8793

CIL ITEM: B400-03	DESIGN	DOCUMENT REF.
	ALL CAUSES: THE MINIMUM FACTORS OF SAFETY FOR THE FIRST-STAGE TURBINE BLADES, DAMPERS, TIP SEAL, RETAINER, NOZZLE, DISC, AND THE SECOND-STAGE TURBINE BLADES, DAMPERS, TIP SEAL, NOZZLE, NOZZLE FLANGE, AND THE TURBINE HOUSING, DISCHARGE STRUT, MAIN PUMP HOUSING, JET RING, AND SHAFT MEET CEI REQUIREMENTS (1). THE HARDWARE PARENT MATERIALS WERE CLEARED FOR FRACTURE MECHANICS/NDE FLAW GROWTH SINCE THEY ARE NOT FRACTURE CRITICAL PARTS, EXCEPT FOR THE ROTOR SHAFT AND DISCHARGE STRUT WHICH WERE CLEARED BY CRITICAL INITIAL FLAW SIZE DETECTABILITY. THE MAIN HOUSING, TURBINE HOUSING, FIRST-STAGE TURBINE BLADES, NOZZLE, DISK, AND THE SECOND-STAGE TURBINE BLADES AND NOZZLE WERE CLEARED BY RISK ASSESSMENT (2). REUSE OF PARTS DURING OVERHAUL ARE CONTROLLED BY THE REQUIREMENTS OF THE OVERHAUL SPECIFICATIONS (3).	(1) RSS-8546-16, CP320R0003B (2) NASA TASK 117 (3) RL00874

CIL ITEM: B400-03	INSPECTION AND TEST		
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
FAILURE CAUSE A:	RS007707 - FIRST-STAGE BLADES RS007710 - SECOND-STAGE BLADES		RS007707 RS007710
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RB0170-157
		BLADE CASTINGS ARE RADIOGRAPHICALLY INSPECTED PER DRAWING REQUIREMENTS.	RS007707 RS007710
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RB0170-157
	ASSEMBLY INTEGRITY	THE FIRST-STAGE TURBINE BLADES ARE BORESCOPE INSPECTED AFTER EACH ENGINE HOT FIRE AND AFTER EACH TURBOPUMP REMOVAL.	RF0001-055 RL00461 OMRSD V41BU0.040 OMRSD C00BA0.010
		BLADE FINAL SURFACE IS PENETRANT AND RADIOGRAPHIC INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116 RA0115-006
		BLADE WEIGHT, FINISH, BLADE SET BALANCING, AND ACCEPTABILITY IS VERIFIED BY ENGINEERING PER SPECIFICATION REQUIREMENTS.	RL00814 RL00816
		AIRFOIL DIMENSIONS, CASTING TRANSITION, AND RADII ARE INSPECTED PER DRAWING REQUIREMENTS.	RS007707 RS007710

CIL ITEM: B400-03	INSPECTION AND TEST		
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
FAILURE CAUSES B, C:	RS007913 - RETAINER RS007914 - FIRST-STAGE HONEYCOMB SEAL RS007915 - SECOND-STAGE HONEYCOMB SEAL		RS007913 RS007914 RS007915
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007913 RS007914
	HEAT TREAT	HEAT TREAT AND ANNEALING ARE VERIFIED PER DRAWING REQUIREMENTS.	RS007913 RS007914 RS007915
	SURFACE FINISH	NICKEL PLATING IS INSPECTED PER DRAWING REQUIREMENTS.	RS007914 RS007915
	BRAZE INTEGRITY	HONEYCOMB BRAZING IS INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0107-010
	ASSEMBLY INTEGRITY	HONEYCOMB SEALS ARE INSPECTED PER SPECIFICATION REQUIREMENTS.	RF0001-004
		THE RETAINER ASSEMBLY, SCREW TORQUE, AND STAKING OPERATIONS ARE INSPECTED PER DRAWING REQUIREMENTS AND MAJOR WAIVER.	RS007701 DAR 2696
		THE RETAINER TO SECOND-STAGE NOZZLE ASSEMBLY GAP IS INSPECTED PER SPECIFICATION REQUIREMENTS AND MAJOR WAIVER.	RL00814 OMRSD V41BU0.066 DAR 2696
		SEAL DIAMETERS ARE INSPECTED PER SPECIFICATION REQUIREMENTS.	RL00814
FAILURE CAUSE D:	RS007707 - FIRST-STAGE BLADES RS007710 - SECOND-STAGE BLADES		RS007707 RS007710
	ASSEMBLY INTEGRITY	THE FIRST-STAGE TURBINE BLADES AND UPSTREAM COMPONENTS ARE BORESCOPE INSPECTED AFTER EACH ENGINE HOT FIRE AND AFTER EACH TURBOPUMP REMOVAL.	RF0001-051 RL00461 OMRSD V41BU0.040 OMRSD C00BA0.010

CIL ITEM: 8400-03	INSPECTION AND TEST		
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
	CLEANLINESS OF COMPONENTS	COMPONENTS ARE VERIFIED CLEANED PER SPECIFICATION REQUIREMENTS.	RL10001
FAILURE CAUSE E:	RS007701 - HPOTP COMPONENTS		RS007701
	CLEANLINESS OF COMPONENTS	COOLANT CIRCUITS ARE FLOW-INSPECTED DURING ASSEMBLY PER SPECIFICATION REQUIREMENTS.	RL00814
		COMPONENTS ARE VERIFIED CLEANED PER SPECIFICATION REQUIREMENTS.	RL10001
FAILURE CAUSE F, G:	RS007980 - FIRST-STAGE DAMPER RS007981 - FIRST-STAGE CENTERPLATE RS007711 - SECOND-STAGE DAMPER		RS007980 RS007981 RS007711
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS007980 RS007981 RS007711
	HEAT TREAT	ANNEALING IS VERIFIED PER DRAWING REQUIREMENTS.	RS007980 RS007981 RS007711
	ASSEMBLY INTEGRITY	BLADES AND DAMPERS ARE INSPECTED FOR MOVEMENT PER SPECIFICATION REQUIREMENTS.	RL00814
		DAMPER POCKET DIMENSIONS ARE INSPECTED PER DRAWING REQUIREMENTS.	RS007707 RS007710
FAILURE CAUSE H:	RS007703 - SHAFT RS007705 - DISC		RS007703 RS007705
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RB0170-182
		THE SHAFT IS PENETRANT AND ULTRASONIC INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116 RA0115-012

CIL ITEM: B400-03	INSPECTION AND TEST		
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RB0170-182
		DISC IS PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116
	ASSEMBLY INTEGRITY	MAXIMUM GROWTH IS VERIFIED BY THE SHAFT AND DISC SPIN AT HIGH SPEED PER DRAWING REQUIREMENTS.	RS007703 RS007705
		THE GOLD PLATING IN THE HOT-GAS AREA OF THE SHAFT AND DISC IS VERIFIED PER SPECIFICATION AND DRAWING REQUIREMENTS.	RA1109-009 RS007703 RS007705
		THE SHAFT DRY-FILM LUBRICATION IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007703 RA0112-003
		TURBINE END COMPONENTS ARE BORESCOPE INSPECTED FOR EVIDENCE OF LOSS OF GOLD PLATING PRIOR TO EACH FLIGHT.	OMRSD V41BU0.040
FAILURE CAUSE I:	RS007750 - FIRST-STAGE NOZZLE RS007752 - SECOND-STAGE NOZZLE R0016027 - NOZZLE ASSEMBLY		RS007750 RS007752 R0016027
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION AND DRAWING REQUIREMENTS.	RB0170-166 RS007752
		THE FIRST AND SECOND-STAGE NOZZLE CASTINGS ARE HOT ISOSTATIC PRESSED PER SPECIFICATION REQUIREMENTS.	RL00368
		NOZZLES ARE PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0611-020

CIL ITEM: B400-03	INSPECTION AND TEST		
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
	ASSEMBLY INTEGRITY	NOZZLES ARE ULTRASONICALLY INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-012
		NOZZLES INACCESSIBLE SURFACES ARE INSPECTED PER SPECIFICATION REQUIREMENTS.	RL00314
		AIRFOIL CONTOURS ARE INSPECTED PER DRAWING REQUIREMENTS.	RS007760 RS007750
ALL CAUSES:	RS007701 - HPOTP		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 RA0115-116
		OPERATION/PERFORMANCE IS VERIFIED BY ENGINE HOT FIRE TESTING AND 2ND E & M INSPECTIONS.	RL00050-04 RL00056-06 RL00056-07 RL00461
		AN INTERNAL BORESCOPE INSPECTION OF THE FIRST STAGE NOZZLE AND BLADES IS PERFORMED PRIOR TO EACH FLIGHT.	OMRSD V41BU0.065 OMRSD C00BA0.010
		TORQUE CHECKS ARE PERFORMED PRIOR TO EACH FLIGHT.	OMRSD V41BS0.040
		HPOTP MICROSHAFT TRAVEL IS PERFORMED PRIOR TO EACH FLIGHT PER SPECIFICATION REQUIREMENTS.	RL00050-04 OMRSD V41BS0.045 RL01034
		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	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	14-17,46	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	I	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	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			

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	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	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	X	
HOUSING	RS007746	30-41	GTAW	II		X	X	
BELLOWS	RS007748	1	EBW	I				
BELLOWS	RS007749	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		

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
FAIRING	RS007774	25-36	GTAW	I		X		
FAIRING	RS007774	74	GTAW	I				
FAIRING	RS007774	75,76	GTAW	II	X			
STRUT	RS007779	23-44, 143-164	GTAW	II	X			
STRUT	RS007779	45-66, 165-186	GTAW	II	X			
STRUT	RS007779	67	GTAW	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	GTAW	II				
SHIELD	RS007781	2,3,4	GTAW	II				
SEAL	RS008848	1 PLC	GTAW	I				
SEAL	RS008857	1 PLC	GTAW	I		X	X	

CIL ITEMS: B400-XX	HPOTP		P/N RS007701
BASE LINE RATIONALE	VARIANCE	CHANGE RATIONALE	VARIANT DASH NUMBER
1. B400-02, B400-03 SECOND STAGE NOZZLE CASTING IS NOT 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 EXTENDED 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-8793).	-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

CIL ITEMS: B400-NK	HPOTP		P/N 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.	THE ADDED NDE 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. B400-21 FITTING MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS (INCONEL 718, RB0170-153).	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 RL00387. 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