ATK ALLIANT TECHSYSTEMS
THIOKOL PROPULSION

CRITICAL ITEMS LIST (CIL)

No. 10-05-01-01R/01

SYSTEM:	Space Shuttle RSRM 10	CRITICALITY CATEGORY:	1
SUBSYSTEM:	Assembly Hardware/Interfaces 10-05	PART NAME:	Field Joint, Metal Components (1)
ASSEMBLY:	Field Joints and Kits 10-05-01		
FMEA ITEM NO.:	10-05-01-01R Rev N	PART NO.:	(See Section 6.0)
CIL REV NO.:	N	PHASE(S):	Boost (BT)
DATE:	27 Jul 2001	QUANTITY:	(See Section 6.0)
SUPERSEDES PAGE:	222-1ff.	EFFECTIVITY:	(See Table 101-6)
DATED:	31 Jul 2000	HAZARD REF.:	BC-01, BC-09
CIL ANALYST:	F. Duersch		
APPROVED BY:		DATE:	

RELIABILITY ENGINEERING: K. G. Sanofsky 27 Jul 2001

ENGINEERING: V. B. Call 27 Jul 2001

1.0 FAILURE CONDITION: Failure during operation (D)

2.0 FAILURE MODE: 1.0 Structural failure

3.0 FAILURE EFFECTS: Failure of components could result in case burst or joint deformation and seal leakage, causing loss of RSRM, SRB, crew, and vehicle

4.0 FAILURE CAUSES (FC):

FC NO.	DESCRIPTION	FAILURE CAUSE KEY
1.1	Nonconforming materials	A
1.2	Nonconforming heat treatment	B
1.3	Corrosion	C
1.4	Stress corrosion	D
1.5	Fracture of tang or clevis leg	E
1.6	Nonconforming dimensions	F
1.7	Transportation and handling damage	G
1.8	In-service degradation/fatigue	H
1.9	Cracks, voids, or other material defects	I
1.10	Improper assembly techniques	J
1.11	Bushing replacement	
1.11.1	Nonconforming material	K
1.11.2	Nonconforming heat treatment of bushing	L
1.11.3	Corrosion	M
1.11.4	Stress corrosion	N

1.11.5	Nonconforming dimensions	O
1.11.6	Cracks, voids, or other material defects	P
1.11.7	Improper assembly techniques	Q

5.0 REDUNDANCY SCREENS:

SCREEN A: N/A
SCREEN B: N/A
SCREEN C: N/A

6.0 ITEM DESCRIPTION:

1. Field joint metal components are depicted in Figures 1 and 2. Field joints are assembled at KSC per engineering drawings. Materials are listed in Table 1.

TABLE 1. MATERIALS

Drawing No.	Name	Material	Specification	Quantity
1U76796	Case Segment, Cylinder, Forging	D6AC Steel	STW4-2606, STW7-2608	6/motor
1U76797	Case Segment, Attach, Forging	D6AC Steel	STW4-2606, STW7-2608	1/motor
1U50130	Case Segment, Attach, Std Weight (refurb. Only)	D6AC Steel	STW7-2744	1 (alt.)
1U50716	Case Segment, Attach, Light Weight	D6AC Steel	STW7-2744	1/motor
1U50717	Case Segment, Cyl, Light Weight (refurb. Only)	D6AC Steel	STW7-2744	2/motor
1U52982	Case Segment, Capture Cylinder, Light Weight	D6AC Steel	STW7-2744	2/motor
1U52983	Case Segment, Capture Cylinder, Std Weight	D6AC Steel	STW7-2744	1/motor
1U77714	Case Assembly, Center Segment	Various		2/motor
1U77648	Assembly and Closeout, RSRM, KSC	Various		1/motor
	Top Coating (paint)	Epoxy	STW5-3225	A/R
	Primer, Zinc-rich	Epoxy	STW5-3226	A/R
	Corrosion-Preventive Compound and HD Calcium Grease O-ring Lubricant		STW5-2942	A/R
1U51916	Cartridge Assembly	HD Filtered Calcium Grease	STW7-3657	A/R
	Forging preservative	Oil, Grade 4	MIL-C-16173	A/R
1U51055	Pin, Straight, Headless	MP35N	AMS 5844	1062/motor
1U51899	Pin Retainer, Field Joint, SRM	Inconel 718	AMS 5596	1062/motor
1U82840	Pin Retainer Band, Joint Steel/Steel Case	Inconel 718	AMS 5662, AMS 5596, AMS 5605, AMS 5606	18/motor
	Socket Head Cap screw		NAS135IN4H36S	36/motor
	Bushing, RSRM Replacement	D6AC Steel	STW7-9135	A/R

6.1 CHARACTERISTICS:

1. The RSRM case functions as a pressure vessel and structural frame through which static and flight loads react and are transmitted. Three field joints (Figures 1 and 2) that make up the case are as follows:

    a. Forward segment cylinder standard weight-to-center forward segment cylinder lightweight
    b. Center forward segment cylinder lightweight-to-center aft segment cylinder lightweight
    c. Center aft segment cylinder lightweight-to-aft segment attach lightweight

2. Case segments are formed from D6AC steel, forged without welds, and rough machined by the supplier. Segments are heat treated, final machined, inspected, and delivered to Thiokol. Segments are pinned together with a steel retainer band used to keep the pins in place.

7.0 FAILURE HISTORY/RELATED EXPERIENCE:

1. Current data on test failures, flight failures, unexplained failures, and other failures during RSRM ground processing activity can be found in the PRACA database.

8.0 OPERATIONAL USE: N/A

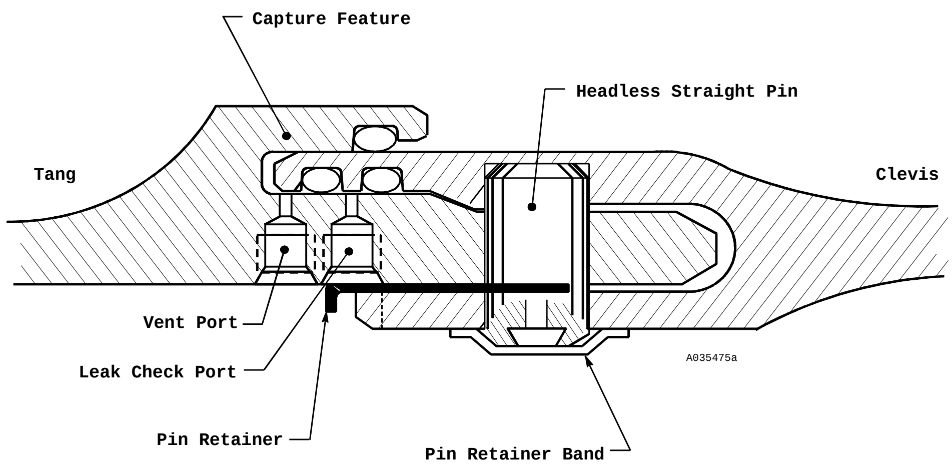

Figure 1. Field Joint Metal Components

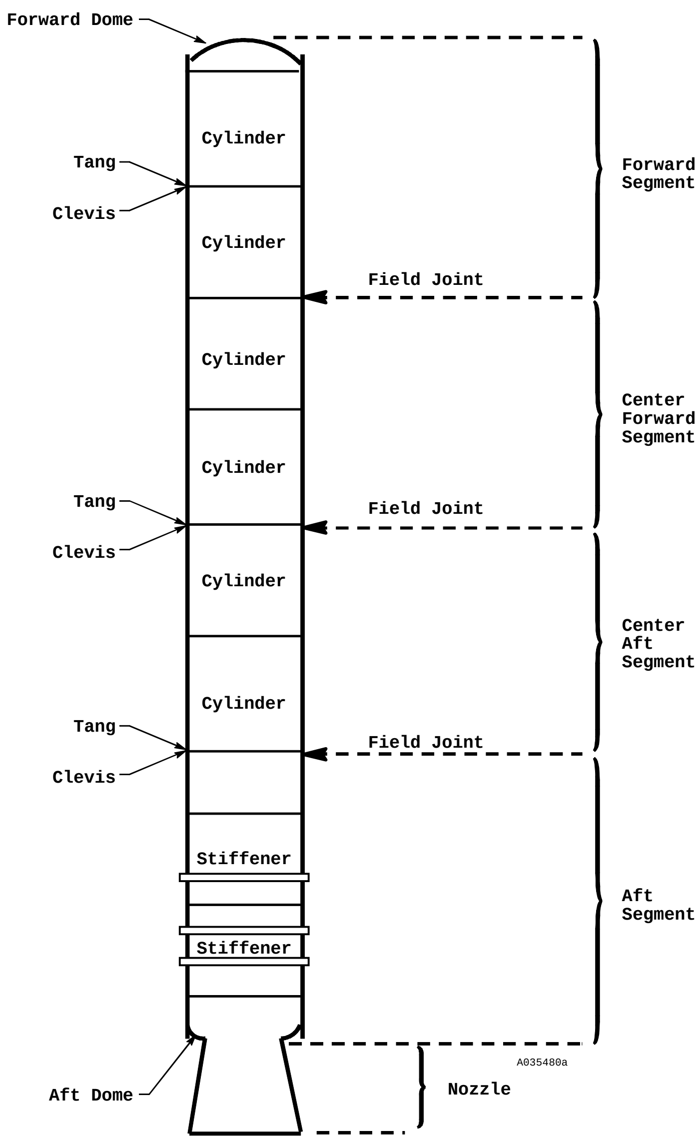

Figure 2. Field Joint Locations

9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN FAILURE CAUSES

A,B,C,F 1. The joints (tang and clevis) are an integral part of the case and are made from low alloy, high strength D6AC steel per engineering. D6AC mechanical properties meet the design intent. Structural integrity of the case material meets the positive margin of safety requirement with a safety factor of 1.4 in all areas except the forward most stub of reused stiffener segments which is certified safe for flight by proof testing. TWR-11269 and TWR-17118 establish the design safety factor. Corrosion prevention is controlled by application of filtered grease prior to assembly per engineering. Refurbishment is per engineering.

A,B 2. Case segment D6AC steel is heat treated per engineering. Heat-treated sample material representative of each heat of steel meets physical and mechanical properties per engineering. Engineering calls for heat treatment and test verification of tensile properties, fracture toughness, micro-hardness, grain size, macro structure, and inclusion content. Characteristics of D6AC steel provide capability of obtaining excellent heat treat results.

A,B 3. A forging evaluation of a center segment aft capture cylinder was conducted per TWR-16130. This evaluation also qualified the forging and heat-treatment processes used for the forward segment aft capture cylinder. The evaluation verified conformance to requirements regarding principal grain flow patterns, metalographic considerations, and mechanical properties per TWR-18899. Certification for the case assembly is reported in TWR-18764-01.

D,E,H,I 4. Prior to heat treatment, new case segments are ultrasonically inspected per engineering.

A,B 5. Per TWR-16635, NASA requisitioned an SRM cylinder from the supplier for nondestructive and destructive testing. Thiokol requested and received portions of this case for in-house mechanical properties and macro-etch characterization studies of clevis, tang, and membrane regions. Results of evaluations are per engineering. Mechanical properties included ultimate tensile strength, yield strength, elongation, and reduction in area.

A,B 6. Tests conducted on the forgings for the SRM forward case segment, SRM attach case segment, and SRM aft dome segment per TWR-10701, TWR-10703, and TWR-10705 showed that the forgings meet requirements per JSC Specifications.

A,B 7. Metal components used on the RSRM are tested in pressure test articles, joint environmental simulation tests, and full-scale static tests to qualify metal components as reported in TWR-18764-02.

C 8. Composition of the steels used in field joint metal components (MP35N, Inconel 718, and NAS 1351N) form an incompatible couple to galvanic corrosion with D6AC steel used in the case. Protection against galvanic corrosion at the field joint is provided by greasing the joint retainer pins with filtered grease, dry film lubrication of the back side of the pin retaining band to prevent scratching of the clevis leg paint, and a bonded moisture seal around the outside of the field joint that prevents moisture from setting up a galvanic cell. Inspection of the field joint after several test firings and flights did not produce any evidence of galvanic corrosion.

F 9. The joints (tang and clevis) are machined to critical dimensions that affect component performance per engineering.

C,F — 10. Factors with the potential to cause nonconforming dimensions such as machining processes, effects of hydroproof testing, effects of water impact loads, and corrosion are as follows:

a. New and refurbished case hardware acceptance criteria and dimensions are per engineering drawings and specifications.
b. The Supplier applies corrosion-preventive oil to rough-machined forgings and grease to machined case parts for corrosion protection.
c. During processing, Thiokol takes steps to protect all case segment exposed bare metal surfaces as required to minimize corrosion. Superficial discoloration is allowed as long as it does not interfere with inspection of the hardware. Corrosion is removed prior to hardware assembly per engineering.
d. During local transportation, Thiokol uses environmentally controlled shipping containers, which allow case segments to be shipped without grease per TWR-65920.
e. Case segments are painted with primer and topcoat.

F — 11. Acceptance criteria at refurbishment per engineering, identifies acceptable dimensions critical to case design for multiple use.

D,E,F,H,I — 12. Case assembly and hydroproof qualification (Referee 3A, hydroproofs 6,7, and 8) per TWR-16205 demonstrates that case dimensional growth is negligible after three hydroproofs.

D,E,H,I — 13. The case is fabricated from D6AC steel. Sustained tensile stresses in a corrosive environment are below the stress corrosion-cracking threshold. A Material Use Agreement is required per MSFC specifications.

D,E,H,I — 14. TWR-12718 describes development test methods used to determine residual stresses in development case segments. A hole-drilling method with strain gauge instrumentation was used to measure stress levels. Maximum tensile stress was found to be less than the stress corrosion-cracking threshold.

A,B,D,E,F,H,I — 15. Case segments are fracture-controlled items per TWR-16873. This report indicates that proof test, complemented by nondestructive evaluation, shall satisfy safe life requirements of four missions of the case membrane. In some elastic regions of case segments where proof test logic is not applicable, nondestructive evaluation alone shall satisfy the safe-life requirements. Fracture mechanics analysis is performed to determine the proof factor for the proof test is equal to or greater than 1.12 to satisfy safe-life requirements. However, for some regions in the case components where proof test cannot adequately screen the critical initial flaws, more sensitive methods for detecting flaws are required. The detectable flaw size has to be smaller than the critical initial flaw size.

D,E,H,I — 16. TWR-16873 identifies all areas that are not verified by proof testing, which include specific areas of the tang-clevis joint. For these areas, the report 1) identifies the maximum limit applied stress in flight, 2) calculates the minimum critical flaw size during the flight loading condition, and 3) compares the critical flaw size with that detectable in a part by nondestructive inspection methods. The report asserts acceptability of the design based on readily detectable critical flaw sizes in the critical areas.

D,E,F,H,I — 17. Hydroproof tests are performed on each new RSRM case segment three times, followed by magnetic particle inspection per engineering to detect and monitor flaws having potential to initiate part failure. Also, each time a case is refurbished it is hydroproof tested followed by magnetic particle inspection on the entire surface of the case per engineering. Concerns about crack detection capability of magnetic particle inspection in the case joint clevis and capture feature gap as documented in TWR-65649, led to qualification of eddy current inspection in these areas.

D,E,H,I — 18. Leak check ports and vent ports are stress risers in the case, but are too small for magnetic particle inspection. After each hydroproof test, the interior of vent ports, leak check ports, bolt holes, alignment slots, and clevis pin holes is examined for cracks by eddy current inspection as documented in TWR-17191 and TWR-66310.

D,E,H,I — 19. Development Motors DM-8 and DM-9 were static test fired to evaluate performance of accepted baseline RSRM case hardware. The field joint is certified based on Qualification Motor QM-6 static test as reported in TWR-18764-02.

D,E,H,I — 20. The metal parts that make up the motor case and RSRM components are designed for loads and safety factors for 20 uses. TWR-16872 and TWR-13236 provide justification for use and criteria for acceptance of RSRM components. Controls in this program are detailed per engineering, and provide justification of use or reuse of parts containing cracks, voids, or other material defects.

D,E,H,I — 21. Heat treatment provides for high strength and high toughness with reduced internal and surface stresses per engineering.

D,E,H,I — 22. Three capture feature field joints connect four segments. Each field joint joins case segments using 177 pins per joint to make the tang to clevis connection. All three field joints are of similar design. The capture feature tang-to-clevis joint is designed to withstand tensile and bending load combination, with critical flight loads on the case. Since the capture feature tang or clevis is an integral part of the segments; its properties are those of the parent part.

D,E,H,I — 23. Structural Test Article tests are performed to demonstrate strength and service life of the SRM when subject to design loads. STA-1 test results are per TWR-12051, TWR-12679, TWR-12726, and TWR-12727. STA-3 test results are per TWR-16343.

D,E,F,H,I — 24. The clevis side of the RSRM field joint is the same as the High Performance Motor field joint, but the tang side is redesigned. The most significant change is the addition of a capture leg on the inboard side of the main tang. The capture leg is an integral part of the case segment tang. The outer diameter of the capture leg and the inner diameter of the inner clevis leg are toleranced to provide an interference fit during assembly. Structural analysis of the RSRM field joint demonstrates positive margins of safety per TWR-17118.

A,B,C,D, E,F,H,I — 25. Headless straight pins are made from cobalt alloy (MP35N) with specific mechanical property requirements, and heat-treated per engineering. MP35N has excellent corrosion resistance. The pins were designed to meet positive margins of safety for an ultimate safety factor of 1.4. TWR-17118 verifies design safety factors. They are refurbished per engineering.

D,E,H,I — 26. Headless straight pins are made of MP35N cobalt alloy. Sustained tensile stresses in a corrosive environment are below the stress corrosion-cracking threshold. A Material Use Agreement is required per MSFC specifications.

A,B,C,D, E,F,H,I — 27. The pin retainer acts as a shim to adjust the tang-to-clevis joint fit. The pin retainer is made from Inconel 718 per engineering, and is solution heat-treated and aged. The pin retainer is designed to meet positive margins for an ultimate safety factor of 1.4 per TWR-17118. Inconel 718 has excellent corrosion resistance. Further corrosion prevention is controlled by application of filtered grease prior to assembly.

D,E,H,I — 28. The pin retainer and pin retainer band are made of Inconel 718. Sustained tensile stresses in a corrosive environment are below the stress corrosion-cracking threshold. A Material Use Agreement is required per MSFC specifications.

A,B,C,D, E,F,H,I — 29. The pin retainer band joint is fabricated from Inconel 718 and heat treated to ultimate tensile strength per engineering drawings. It was designed to meet positive margins of safety for an ultimate safety factor of 1.4 per TWR-17118. Inconel 718 has excellent corrosion resistance.

a. Strap and retainer material (Inconel) 718 steel
b. Socket head cap screws (NAS 1351N)
c. Trunnion material (Inconel) 718 steel

G,J — 30. Railway coupling and transportation tests were conducted on an inert forward segment per TWR-11712 to verify the adequacy of tie down provisions and to record actual g-loads during transit. Acceleration of 1.01 g longitudinal and 0.86 g vertical were measured and were less than vibration and shock transportation design loads.

G,J — 31. Additional tests are per TWR-12079 to analyze transportation loads on the RSRM forward segment grain. This testing provided additional data for verification of vibration and shock transportation environment.

G,J — 32. Requirements for handling RSRM components during assembly, storage, and transportation are similar to those for previous and other current programs at Thiokol. These requirements dictate that RSRM case segments must be handled by or near a joint to avoid damage. All lifting hooks and slings are fitted with safety hooks per TWR-13880.

G — 33. Positive cradling or support devices and tie downs that conform to shape, size, weight, and contour of components to be transported are provided to support RSRM segments and other components. Shock mounting and other protective devices are used on trucks and dollies to move sensitive loads per TWR-13880.

G — 34. To assure that no damage occurs to flight hardware during transportation to the launch site, specially designed 200-ton railroad flatcars are used per TWR-13880.

G — 35. Railcar transportation shock and vibration levels are monitored per engineering with loads derived per analysis. Monitoring records are evaluated to verify that shock and vibration levels per MSFC specification were not exceeded.

G,J — 36. To assure that no damage occurs to RSRM components during assembly and transportation, periodic proof loading of all lifting equipment is conducted to verify the integrity of the hardware. Structural support items are tested after fabrication completion. Changes to structural equipment require an additional proof test. GSE is proof loaded by Thiokol. Proof-load requirements and general equipment categories are per TWR-10299.

G,J — 37. Field joints are assembled at KSC per engineering, which minimizes assembly and post-assembly stresses. In the final stages of mating operations, micro inch controls (extremely slow speeds) are used so that precise final alignments can be made.

G,J — 38. Testing performed at KSC per CTP-0020 and TWR-16979 included the following:

a. Develop and finalize installation procedures for the FJAF
b. Provide an acceptable insertion rate for mating
c. Demonstrate that FJAF "squeezing" optimizes installation geometry

G,J — 39. An Assembly Test Article test (TGX-10.0) included verification that the capture feature joint configuration can be successfully assembled or disassembled, and also served to characterize the joint configuration during mating and de-mating. One of the joints involved an ET attach segment per TWR-16829.

D,E,F,G,H,I — 40. TWR-61410 was updated to include boundary conditions created by the Performance Enhancement (PE) Program. This report analyzed temperature conditions created from flight loads. PE temperatures are equal to current generic temperatures for all locations for the critical time of liftoff. For a few locations at the factory joints and case acreage during flight, temperatures rise, but only slightly, and maximum case temperatures are lower than current generic certification. For flight load events, PE temperatures are not significantly different from current generic temperatures. There is no impact on previous analyses or margins of safety for the case membranes, factory joints, and field joints per TWR-61410.

A,B,C,D,E,F,H,I — 41. The factory joint has a tang and clevis configuration held together by 177 straight headless pins with a 3-piece retainer band to hold the pins in place and 177 pin retainers (shims) to ensure proper O-ring squeeze and minimize joint rotation. Pin retainer band torque analyses are per TWR-17118, Supplement E. The pin retainer band can be refurbished and used again if inspection requirements are met per TWR-73775.

A,B,D,E,F,H,I — 42. All new RSRM case segments are hydroproof tested three times followed by magnetic particle inspection per engineering. The final hydroproof and magnetic particle inspection ensure a four-mission capability. Each refurbished RSRM case segment is hydroproofed one time to ensure a four-mission capability. The use of new tooling spools simulates joint hoop loads and therefore produces joint deflections similar to flight conditions. TWR-66845 reported test results and comparisons of measured strains to analytically predicted strains, thus verifying the analytical models. TWR-64835 analytically determined the joint stress ratios between proof test and flight meet or exceed the 1.05 proof factor requirement. TWR-16873 verifies that safe-life requirements are met. For all joint locations it was shown that safe-life is met by proof test, magnetic particle, and eddy current inspections.

K,L — 43. Bushings are made from a low alloy, high strength D6AC steel per engineering. D6AC mechanical properties meet the design intent.

K,L — 44. Tensile properties of the bushings are per engineering. Heat treated sample material, representative of each heat of steel, must meet the properties and other requirements per engineering. Properties are verified by test methods and standards.

K,L — 45. Chemical composition of D6AC steels tested per mill analysis for each heat of steel. The analysis is per engineering.

M — 46. Bushings are made from the same material as the base material of the factory joint. Bushings and other metals used in the joint (MP35N, Inconel 718, and NAS 1135N) form an incompatible couple to galvanic corrosion with the D6AC steel used in the bushings. Protection against galvanic corrosion at the joint is provided by an application of grease to the bushings and other joint metal components. External covering around the outside of the joints prevents moisture from setting up a galvanic cell.

N 47. The bushing is fabricated from D6AC steel. D6AC steel has low-to-moderate resistance to stress corrosion. A Material Use Agreement (MUA) is required for D6AC steel per MSFC specifications.

N 48. Fracture control of the bushings and parent hole is addressed as follows:

a. Fracture control procedures are described in TWR-16873
b. Analysis of bushings and parent material found the increased tensile stresses of the parent material to be insignificant per TWR-73519.
c. At refurbishment, bushings shall be removed, the parent material of the hole inspected for crack-like defects, raised metal, and sharp edges. Bushings and holes shall be protected by filtered grease, bushings shall be protected by filtered grease prior to installation. Subsequent to bushing installation, case segments are proof tested. Joints, including bushed holes, are covered after assembly that provides protection from environments.
d. Results of the safe-life analysis in the elastic-plastic regions of the tang and clevis joint are presented in TWR-16873.

N 49. Heat treatment of bushings provides for high strength and high toughness with reduced internal and surface stresses per engineering.

O 50. Bushing general features and dimensions are per engineering. Machining and fabrication are also per engineering.

P 51. Bushing surfaces shall be visually inspected for surface defects. Defects or flaws that are crack-like in nature shall be unacceptable per engineering.

Q 52. Bushings shall be removed and installed per engineering. This technique was shown to have no detrimental impact per TWR-73965.

582 D,E,F,G,H,I 53. As a result of implementing the SSME Block II engine, analyses were performed to determine structural responses to Block II engine load cases. Based on these loads, critical generic ground wind speeds were reduced to ensure that stiffener segments maintain a safety factor equal to or greater than 1.4, as referenced in TWR-61408.

9.2 TEST AND INSPECTION:

DCN	FAILURE CAUSES and TESTS	(T)			CIL CODE
			1.	For New Case Segment, Cylinder, Forging, verify:	
	A,B,D, E,H,I	(T)	a.	Chemical composition (D6AC)	ADW123
	A,B	(T)	b.	Heat treatment or re-heat treatment - austenitize	FAA032
	A,B	(T)	c.	Heat treatment or re-heat treatment - quench	FAA033
	A,B	(T)	d.	Heat treatment or re-heat treatment - snap temper	FAA034
	A,B	(T)	e.	Heat treatment or re-heat treatment - cleaning	FAA035
	A,B	(T)	f.	Heat treatment or re-heat treatment - first and second tempers	FAA036
	A,B	(T)	g.	Heat treatment or re-heat treatment - additional thermal sizing	FAA038
	A,B,D, E,H,I	(T)	h.	Ultimate strength, uniaxial, after heat treatment	ADW167,ADW169
	A,B,D, E,H,I	(T)	i.	Yield strength after heat treatment	ADW189,ADW193
	A,B,D, E,H,I	(T)	j.	Elongation after heat treatment	ADW061,ADW065
	A,B,D, E,H,I	(T)	k.	Reduction in area after heat treatment	ADW009,ADW137
	A,B,D, E,H,I	(T)	l.	Fracture toughness after heat treatment	ADW069,ADW074
	A,B	(T)	m.	Micro-hardness/decarburization after heat treatment	FAA041,FAA042
	A,B,D, E,H,I	(T)	n.	Grain size after heat treatment	FAA039A
	A,B,D, E,H,I	(T)	o.	Macro structure after heat treatment	FAA040A
	A,B,D, D,E,H,I	(T)	p.	Inclusion rating after heat treatment	ADX085A
	C		q.	Application of oil preservative to the forging	FAA030A
	D,E,H,I	(T)	r.	Ultrasonic inspection of the forging	ADW175
			2.	For New Case Segment, Attach, Forging, verify:	
	A,B,D, E,H,I	(T)	a.	Chemical composition (D6AC)	ABL118
	A,B	(T)	b.	Heat treatment or re-heat treatment - austenitize	FAA332
	A,B	(T)	c.	Heat treatment or re-heat treatment - quench	FAA333
	A,B	(T)	d.	Heat treatment or re-heat treatment - snap temper	FAA334
	A,B	(T)	e.	Heat treatment or re-heat treatment - cleaning	FAA335
	A,B	(T)	f.	Heat treatment or re-heat treatment - first and second tempers	FAA336
	A,B	(T)	g.	Heat treatment or re-heat treatment - additional thermal sizing	FAA338
	A,B,D, E,H,I	(T)	h.	Ultimate strength, uniaxial, after heat treatment	ABL154,ABL159
	A,B,D, E,H,I	(T)	i.	Yield strength after heat treatment	ABL182,ABL183
	A,B,D, E,H,I	(T)	j.	Elongation after heat treatment	ABL036,ABL037
	A,B,D, E,H,I	(T)	k.	Reduction in area after heat treatment	ABL002,ABL003
	A,B,D, E,H,I	(T)	l.	Fracture toughness after heat treatment	ABL043,ABL044
	A,B	(T)	m.	Micro-hardness/decarburization after heat treatment	FAA341,FAA342
	A,B,D, E,H,I	(T)	n.	Grain size after heat treatment	FAA339

A,B,D, E,H,I	(T)	o.	Macro structure after heat treatment	FAA340
A,B,C, D,E,H,I	(T)	p.	Inclusion rating after heat treatment	ABL066
C		q.	Application of oil preservative to the forging	FAA330
D,E,H,I	(T)	r.	Ultrasonic inspection of the forging	ABL163

3. For New Case Segment, Capture Cylinder, Standard Weight, verify:

C		a.	Corrosion protection	ADX018
D,E,H,I	(T)	b.	Hydroproof test	ADX074
D,E,H,I	(T)	c.	Magnetic particle inspection after hydroproof test	ADX105
D,E,H,I	(T)	d.	Vent port and leak check port by eddy current probe after hydroproof	ADX057
F		e.	Depth of capture feature O-ring groove	ADX013,ADX044B
F		f.	Width of capture feature O-ring groove	ADX014,ADX044C
F		g.	Capture feature gap	ADX011,ADX094
F		h.	Capture feature outer diameter	FAC012
F		i.	Capture feature O-ring groove corner radius (two places)	ADX016,ADX016A
F		j.	Distance from Datum -A- to capture feature inner diameter	MKL013
F		k.	Sealing surface diameter at tang	ADX015,ADX052
F		l.	Tang outer diameter	FAC010
F		m.	Tang pin hole diameter	ADX155,ADX155A
F		n.	Tang sealing surface thickness	ADX156,ADX156A
F		o.	Tang thickness	ADX157,ADX157A
F		p.	Alignment pin slot dimensions at tang	ADX001,ADX001A
F	(T)	q.	Alignment slots at tang by eddy current after hydroproof	RAA254
D,E,H,I	(T)	r.	Clevis pin hole by eddy current for cracks	BAA513A

4. For Refurbished Case Segment, Capture Cylinder, Standard Weight, verify:

D,E,H,I	(T)	a.	Hydroproof test	ADX073
D,E,H,I	(T)	b.	Magnetic particle inspection after hydroproof test	ADX113
D,E,H,I	(T)	c.	Vent port and leak check port by eddy current probe after hydroproof test	FAA073
D,E,H,I		d.	Tang joint holes for galling or other surface defects, and no raised metal	FAC092
F		e.	Capture feature gap	ADX141
F		f.	Depth of capture feature O-ring groove	ADX147A
F		g.	Width of capture feature O-ring groove	ADX147
F		h.	Capture feature outer diameter	FAC015
F		i.	Leak check port and vent port dimensions	FAB244
F		j.	Tang pin hole diameter	FAB239
F		k.	Tang thickness	ADX153
F		l.	Tang sealing surface thickness	ADX152
F		m.	Tang outer diameter	FAC013
F		n.	Sealing surface diameter at tang	FAC014
D,E,H,I	(T)	o.	Alignment slots at tang by eddy current after hydroproof test	RAA263
D,E,F,H,I	(T)	p.	Clevis pin hole by eddy current for cracks	BAA513
N	(T)	q.	Eddy current inspection for crack-like flaws in parent material of tang pin hole requiring bushing reinstallation	SER030
O		r.	Bushing outside diameter	SER028
M,N,P		s.	Inner and outer surface of bushing for contamination, crack-like defects, raised metal, and sharp edges	SER033
M,N		t.	Filtered grease applied to outer surface of bushing and surface of tang pin hole requiring bushing reinstallation	SER032
P		u.	Visual inspection for contamination, raised metal, and sharp edges of tang pin hole requiring bushing reinstallation	SER031

Q	(T)	v.	Tang bushing position following hydroproof test	SER034
Q	(T)	w.	Tang bushing pull test following hydroproof test	SER213

5. For New Case Segment, Capture Cylinder, Light Weight, verify:

C		a.	Corrosion protection	ADW019
D,E,H,I	(T)	b.	Hydroproof test	ADW084
D,E,H,I	(T)	c.	Magnetic particle inspection after hydroproof test	ADW107
D,E,H,I	(T)	d.	Vent port and leak check port by eddy current probe after hydroproof	FAH004
F		e.	Depth of capture feature O-ring groove	ADW018,ADW152
F		f.	Width of capture feature O-ring groove	ADW015,ADW016
F		g.	Capture feature gap	ADW012,ADW098
F		h.	Capture feature outer diameter	FAC203
F		i.	Capture feature O-ring groove corner radius (two places)	ADW017,ADW017A
F		j.	Distance from Datum -A- to capture feature inner diameter	MKL012
F		k.	Sealing surface diameter at tang	ADW149,ADW053
F		l.	Tang outer diameter	FAC201
F		m.	Tang pin hole diameter	ADW159,ADW159A
F		n.	Tang sealing surface thickness	ADW160,ADW160A
F		o.	Tang thickness	ADW161,ADW161A
F		p.	Alignment pin slot dimensions at tang	ADW001,ADW001A
D,E,H,I	(T)	q.	Alignment slots at tang by eddy current after hydroproof test	RAA253
D,E,H,I	(T)	r.	Clevis pin hole by eddy current for cracks	BAA511A

6. For Refurbished Case Segment, Capture Cylinder, Light Weight, verify:

D,E,H,I	(T)	a.	Hydroproof test	ADW077
D,E,H,I	(T)	b.	Magnetic particle inspection after hydroproof test	ADW117
D,E,H,I	(T)	c.	Vent port and leak check port by eddy current probe after hydroproof test	AFS030
D,E,H,I		d.	Tang joint holes for galling or other surface defects, and no raised metal	FAC091
F		e.	Capture feature gap	ADW145
F		f.	Depth of capture feature O-ring groove	ADW151
F		g.	Width of capture feature O-ring groove	FAB236
F		h.	Capture feature outer diameter	ADW051
F		i.	Leak check port and vent port dimensions	FAB233
F		j.	Tang pin hole diameter	FAB228
F		k.	Tang thickness	ADW155
F		l.	Tang sealing surface thickness	FAB231
F		m.	Tang outer diameter	FAC204
F		n.	Sealing surface diameter at tang	FAC205
D,E,H,I	(T)	o.	Alignment slots at tang by eddy current after hydroproof test	RAA262
D,E,F,H,I	(T)	p.	Clevis pin hole by eddy current for cracks	BAA511
N	(T)	q.	Eddy current inspection for crack-like flaws in parent material of tang pin hole requiring bushing reinstallation	SER050
O		r.	Bushing outside diameter	SER048
M,N,P		s.	Inner and outer surface of bushing for contamination, crack-like defects, raised metal, and sharp edges	SER053
M,N		t.	Filtered grease applied to outer surface of bushing and surface of tang pin hole requiring bushing reinstallation	SER052
P		u.	Visual inspection for contamination, raised metal, and sharp edges of tang pin hole requiring bushing reinstallation	SER051
Q	(T)	v.	Tang bushing position following hydroproof test	SER054
Q	(T)	w.	Tang bushing pull test following hydroproof test	SER214

7. For New Case Segment, Cylinder, Light Weight, verify:

D,E,H,I	(T)		a.	Clevis pin hole by eddy current for cracks	BAA509A
		8.		For Refurbished Case Segment, Cylinder, Light Weight, verify:	
D,E,H,I	(T)		a.	Hydroproof test	ABM060
D,E,H,I	(T)		b.	Magnetic particle inspection after hydroproof test	ABM107
D,E,H,I			c.	Inner and outer clevis joint holes for galling or other surface defects, and no raised metal	FAC098
F			d.	Depth of clevis O-ring grooves	ABM028
F			e.	Width of clevis O-ring grooves	ABM174
F			f.	Clevis pin hole depth	FAB219
F			g.	Clevis pin hole diameter	FAB220
F			h.	Inner clevis leg wall thickness	ABM083
F			i.	Outer clevis leg wall thickness	FAB221
F			j.	Clevis sealing surface gap	FAB222
F			k.	Outer clevis leg inner diameter (two places)	FAC601
F			l.	Inner clevis leg inner diameter	FAC602
D,E,F,H,I	(T)		m.	Clevis pin hole by eddy current for cracks	BAA509
N	(T)		n.	Eddy current inspection for crack-like flaws in parent material of clevis pin hole requiring bushing reinstallation	SER035
O			o.	Bushing outside diameter	SER038
M,N,P			p.	Inner and outer surface of bushing for contamination, crack-like defects, raised metal, and sharp edges	SER043
M,N			q.	Filtered grease applied to outer surface of bushing and surface of clevis pin hole requiring bushing reinstallation	SER037
P			r.	Visual inspection for contamination, raised metal, and sharp edges of clevis pin hole requiring bushing reinstallation	SER036
Q	(T)		s.	Clevis bushing position following hydroproof test	SER039
Q	(T)		t.	Clevis bushing pull test following hydroproof test	SER215
		9.		For Refurbished Case Segment, Attach, Standard Weight, verify:	
D,E,H,I	(T)		a.	Hydroproof test	ABL054A
D,E,H,I	(T)		b.	Magnetic particle inspection after hydroproof test	FAB921
D,E,H,I			c.	Inner and outer clevis joint holes for galling or other surface defects, and no raised metal	FAC093
F			d.	Clevis pin hole depth	FAB701
F			e	Clevis pin hole diameter	FAB702
F			f.	Outer clevis leg wall thickness	FAB703
F			g.	Clevis sealing surface gap	FAB704
F			h.	Outer clevis leg inner diameter (two places)	FAC701
F			i.	Inner clevis leg inner diameter	FAC702
F			j.	Depth of clevis O-ring grooves	MAA101
F			k.	Width of clevis O-ring grooves	MAA102
F			l.	Inner clevis leg wall thickness	MAA104
D,E,F,H,I	(T)		m.	Clevis pin hole by eddy current for cracks	BAA502
N	(T)		n.	Eddy current inspection for crack-like flaws in parent material of clevis pin hole requiring bushing reinstallation	SER055
O			o.	Bushing outside diameter	SER058
M,N,P			p.	Inner and outer surface of bushing for contamination, crack-like defects, raised metal, and sharp edges	SER068
M,N			q.	Filtered grease applied to outer surface of bushing and surface of clevis pin hole requiring bushing reinstallation	SER057
P			r.	Visual inspection for contamination, raised metal, and sharp edges of clevis pin hole requiring bushing reinstallation	SER056
Q	(T)		s.	Clevis bushing position following hydroproof test	SER059
Q	(T)		t.	Clevis bushing pull test following hydroproof test	SER216

10. For New Case Segment, Attach, Light Weight, verify:

C		a.	Corrosion protection	ABL008
D,E,H,I	(T)	b.	Hydroproof test	ABL055
D,E,H,I	(T)	c.	Magnetic particle inspection after hydroproof test	ABL094
F		d.	Clevis pin hole depth	ABL017,ABL017A
F		e.	Clevis pin hole diameter	ABL018,ABL018A
F		f.	Outer clevis leg wall thickness	ABL127,ABL127A
F		g.	Inner clevis leg wall thickness	ABL078,ABL081
F		h.	Clevis gap	ABL016,ABL016A
F		i.	Clevis sealing surface gap	ABL019,ABL019A
F		j.	Depth of clevis O-ring grooves	ABL031,ABL031A
F		k.	Width of clevis O-ring grooves	ABL181,ABL181A
F		l.	Clevis O-ring grooves corner radius (4 places)	ABL129,ABL129A
F		m.	Outer clevis leg inner diameter (two places)	FAC301
F		n.	Inner clevis leg inner diameter	FAC302
F		o.	Inner clevis leg outer diameter (Datum -C-)	ABL075
F		p.	Alignment pin hole diameters at clevis	ABL000
D,E,H,I	(T)	q.	Clevis pin holes by eddy current for cracks	BAA508A

11. For Refurbished Case Segment, Attach, Light Weight, verify:

D,E,H,I	(T)	a.	Hydroproof test	ABL054
D,E,H,I	(T)	b.	Magnetic particle inspection after hydroproof test	ABL112
D,E,H,I		c.	Inner and outer clevis joint holes for galling or other surface defects, and no raised metal	FAC097
F		d.	Clevis pin hole depth	FAB210
F		e.	Clevis pin hole diameter	FAB211
F		f.	Outer clevis leg wall thickness	FAB212
F		g.	Inner clevis leg wall thickness	ABL077
F		h.	Clevis sealing surface gap	FAB213
F		i.	Depth of clevis O-ring grooves	ABL028
F		j.	Width of clevis O-ring grooves	ABL179
F		k.	Outer clevis leg inner diameter (two places)	FAC305
F		l.	Inner clevis leg inner diameter	FAC306
D,E,F,H,I	(T)	m.	Clevis pin hole by eddy current for cracks	BAA508
N	(T)	n.	Eddy current inspection for crack-like flaws in parent material of clevis pin hole requiring bushing reinstallation	SER070
O		o.	Bushing outside diameter	SER073
M,N,P		p.	Inner and outer surface of bushing for contamination, crack-like defects, raised metal, and sharp edges	SER078
M,N		q.	Filtered grease applied to outer surface of bushing and surface of clevis pin hole requiring bushing reinstallation	SER072
P		r.	Visual inspection for contamination, raised metal, and sharp edges of clevis pin hole requiring bushing reinstallation	SER071
Q	(T)	s.	Clevis bushing position following hydroproof test	SER074
Q	(T)	t.	Clevis bushing pull test following hydroproof test	SER217

12. For New Case Segment, Aft, verify:

D,E,H,I	(T)	a.	Clevis pin hole by eddy current for cracks	BAA501A

13. For New Case Segment, Stiffener, Standard Weight, verify:

D,E,H,I	(T)	a.	Clevis pin hole by eddy current for cracks	BAA504A

14. For New Case Segment, Stiffener, Light Weight, verify:

D,E,H,I	(T)		a.	Clevis pin holes by eddy current for cracks	BAA506A
		15.	For New Pin, Straight, Headless, verify:		
A,B	(T)		a.	Elongation	ABR014
A,B	(T)		b.	Area reduction	ABR021
A,B	(T)		c.	Shear strength	ABR026
A,B	(T)		d.	Tensile strength	ABR031
A,B	(T)		e.	Yield strength	ABR036
A,B			f.	Material and heat treat	FAA111
D,E,H,I	(T)		g.	Eddy current inspection, no cracks allowed	ABR009
F			h.	Pin diameter	ABR016A,ABR016
F			i.	Pin length	ABR018A,ABR018
		16.	For Refurbished Pin, Straight, Headless, verify:		
D,E,H,I			a.	No visible cracks, or surface defects	FAB201
D,E,F,H,I			b.	Straightness	FAB202
D,E,F,H,I			c.	Minimum diameter	FAB203
		17.	For New Pin Retainer, verify:		
F			a.	Shim thickness	ACO007
		18.	For Refurbished Pin Retainer, verify:		
D,E,H,I			a.	No bends, cracks, or scratches	RAA213
		19.	For New Assembly, Retainer Band, Pin, verify:		
C			a.	Complete and acceptable coverage of primer on interior surfaces of band	FAA118
D,E,H,I	(T)		b.	Fluorescent dye penetrant inspection of assembly, after load test, no cracks allowed	FAA119
F			c.	Cross-sectional dimensions of band	AHG001
F			d.	Radius when part is restrained in fixture	AHG002
		20.	For Refurbished Assembly, Retainer Band, Pin, verify:		
C			a.	Complete and acceptable coverage of primer on interior surfaces of band	FAA118A
F			b.	Cross-sectional dimensions of band	AHG001A
F			c.	Visual for cracks and damage	AHG002A
		21.	For New Case Assembly, Painted Segment (Forward, Center, and Aft) verify:		
C			a.	Surfaces to be primed are clean and free from contamination	AEY005,AEZ005,AFB005
C			b.	For application of paint and primer, humidity and case temperature	AEY018,AEZ016,AFB016
C			c.	Container is covered after mixing, paint and primer	AEY034,AEY040,AEZ031 AEZ037,AFB031,AFB037
C			d.	Full cover coat, paint and primer	AEY014,AEY015,AEZ012 AEZ013,AFB012,AFB013
C			e.	Runs, sags, drips, and inclusions are acceptable per specification, paint and primer	AEY033,AEY047,AEZ030 AEZ044,AFB044,FAA103
C			f.	Dry film thickness, paint and primer	AEY025,AEY002,AEZ022

				AEZ002,AFB022,AFB002
G,J		g.	Proper handling operations for case segments	AEY017,AEZ015,AFB015
C		h.	Shelf life and environmental history, paint and primer	AEY035,AEY048,AEZ035 AEZ045,AFB035,AFB045
C		i.	For application of paint and primer, facilities and equipment are clean	AEY037,AEZ034,AFB034
F		j.	Final grit blast is complete and acceptable	RAA270,RAA271,RAA272
	22.	For New Bushing, Replacement verify:		
K		a.	Bushing material is D6AC	SER001
L		b.	Bushing material is heat treated	SER002
	23.	KSC verifies:		
G,J		a.	Clevis Joint Leak Test results are acceptable for each segment per OMRSD File V, Vol I, B47CJ0.011	OMD026
C,G,J		b.	Repair of damaged painted metal surfaces or protection of bare metal surfaces with filtered grease per OMRSD File V, Vol I, B47GEN.070	OMD033
C,G,J		c.	Segments and nozzle components are free of damage per OMRSD File V, Vol I, B47SG0.061	OMD079
D,E,H,I		d.	Tang and Clevis Field Joint unpainted surfaces are free from surface defects or contamination per OMRSD File V, Vol I, B47SG0.122	OMD085
G,J		e.	RSRM field joint (segments) radial alignment prior to mating per OMRSD File V, Vol I, B47SG0.170	OMD089
G,J		f.	RSRM field joint parallel alignment per OMRSD File V, Vol I, B47SG0.180	OMD090
G,J		g.	Tang/clevis joint clocking, matching pins and slots are vertically aligned per OMRSD File V, Vol I, B47SG0.191	OMD091
G,J		h.	Skirt mating occurs with contact of chamfered surfaces, no flat-on-flat contact per OMRSD File V, Vol I, B47SG0.200	OMD092
G,J		i.	Segment joint pin protrusion acceptable per OMRSD File V, Vol I, B47SG0.214	OMD093
G,J		j.	Acceptable field joint engagement rate during segment mating per OMRSD File V, Vol I, B47SG0.290	OMD095
G,J		k.	RSRM field joint geometry (tang and outer clevis leg) prior to mating per OMRSD File V, Vol I, B47SG0.330	OMD100
G,J		l.	Acceptable contact between FJAF and segment outer clevis leg during mating operations per OMRSD File V, Vol I, B47SG0.390	OMD105
G,J		m.	Correct field joint pin retainer clips (custom shims) are installed per OMRSD File V, Vol I, B47SG0.510	OMD110