ATK ALLIANT TECHSYSTEMS
THIOKOL PROPULSION

CRITICAL ITEMS LIST (CIL)

No. 10-05-01-02R/01

SYSTEM:	Space Shuttle RSRM 10	CRITICALITY CATEGORY:	1R
SUBSYSTEM:	Assembly Hardware/Interfaces 10-05	PART NAME:	Field Joint, Thermal Protection System (J-Joint Insulator, Capture Feature O-Ring, Interference Fit, V-2 Filler, and Tang and Clevis Metal Interface Gap) (2)
ASSEMBLY:	Field Joint and Kits 10-05-01		
FMEA ITEM NO.:	10-05-01-02R Rev N		
CIL REV NO.:	N		
DATE:	27 Jul 2001		
SUPERSEDES PAGE:	223-1ff.	PART NO.:	(See Section 6.0)
DATED:	31 Jul 2000	PHASE(S):	Boost (BT)
CIL ANALYST:	S. E. Rodgers	QUANTITY:	(See Section 6.0)
		EFFECTIVITY:	(See Table 101-6)
		HAZARD REF.:	BC-01
APPROVED BY:		DATE:	
RELIABILITY ENGINEERING:	K. G. Sanofsky		27 Jul 2001
ENGINEERING:	G. A. Ricks		27 Jul 2001

1.0 FAILURE CONDITION: Failure during operation (D)

2.0 FAILURE MODE: 1.0 Thermal Failure

3.0 FAILURE EFFECTS: Failure of the thermal protection system could result in a burn-through causing loss of the RSRM, SRB, crew, and vehicle

4.0 FAILURE CAUSES (FC):

FC NO.	DESCRIPTION	FAILURE CAUSE KEY
1.1	Failure of the insulator bonding system	
1.1.1	Nonconforming physical, mechanical, and thermal properties	A
1.1.2	Voids/air entrapment in the adhesive	B
1.1.3	Blowhole through adhesive	C
1.1.4	Contamination of adhesive or area to be bonded (J-joint)	D
1.1.5	Damage to J-joint during handling, transportation, and assembly	E
1.1.6	Inadequate dimensions for insulation/insulation bonded area	F
1.1.7	Insulation/insulation faying surface distortion resulting from propellant grain sag during storage	G
1.2	Thermal failure of the capture feature O-ring	
1.2.1	O-ring gland does not meet dimensional and surface finish requirements	H
1.2.2	Nonconforming dimensions of clevis inner leg	I
1.2.3	Nonconforming O-ring dimensions, or improper O-ring splice joint	J
1.2.4	O-ring voids, inclusions, or subsurface indications	K

	1.2.5	O-ring cut, damaged, or improperly installed	L
	1.2.6	Damage to sealing surface during transportation and handling	M
	1.2.7	Sealing surface contamination	N
	1.2.8	Aging degradation of O-ring. Degraded resiliency and mechanical properties	O
	1.2.9	Improper machining of sealing surface profile	P
	1.2.10	Nonconforming material properties	Q
1.3		Thermal failure of the insulator	
	1.3.1	Improper handling, application, or cure cycle	R
	1.3.2	Nonconforming material properties	S
	1.3.3	Pin holes or ply separations	T
	1.3.4	Voids or inclusions	U
	1.3.5	Age degradation, storage, transportation, and handling	V
	1.3.6	Thin spot or insufficient material thickness	W
1.4		Failure to obtain an interference fit/excessive metal interface gap (Volume between Capture feature and Primary O-ring)	
	1.4.1	Nonconforming dimensions	X
	1.4.2	Improper assembly	Y
	1.4.3	Contamination	Z
	1.4.4	Corrosion	AA
	1.4.5	Surface defects	AB
1.5		Failure of the V-2 filler	
	1.5.1	Nonconforming dimensions	AC
	1.5.2	Nonconforming material	AD
	1.5.3	Improper assembly	AE
	1.5.4	Contamination	AF

5.0 REDUNDANCY SCREENS:

SCREEN A: Fail--The J-joint and the capture feature O-ring cannot be verified.
SCREEN B: Fail--No failure indication is available to the crew.
SCREEN C: Pass--Loss of all redundant items in the thermal protection system cannot be the result of a credible single failure cause.

6.0 ITEM DESCRIPTION:

1. The field joint internal thermal protection system consists of the J-joint insulator, capture feature O-ring, tang/clevis interference fit, V-2 filler, and tang and clevis metal interface gap (Figures 1 and 2). Materials are listed in Table 1.

TABLE 1. MATERIALS

Drawing No.	Name	Material	Specification	Quantity
	Adhesive, Pressure-Sensitive, (Unmixed-Rubber Based)		STW4-3431	A/R
	Adhesive, Pressure-Sensitive,		STW5-3479	A/R
1U75150	Packing, Preformed Fluorocarbon	Black Fluorocarbon Rubber	STW4-3339	9/Motor
	Volume Filler, Capture Feature	Black Fluorocarbon Rubber	STW3-9022	A/R
	Insulation	NBR, Asbestos Silica-Filled	STW4-2621	17,100 lb
	Bonding Agent	Chemlok 233	STW5-2712	12 gal/Motor
	Adhesive Primer	Chemlok 205	STW5-2664	8 gal/Motor
	Insulation	NBR Extrusion	STW4-3442	21 lb/Motor
	Insulation	NBR Extrusion	STW4-3443	21 lb/Motor
	Insulation	Carbon Fiber-Filled EPDM	STW4-2868	98 lb/Motor
	Insulation	NBR Extrusion	STW4-2545	2 lb/Motor
	Bonding Agent	Chemlok 236A	STW5-2798	11qt/Motor
	Teflon Tape		MIL-I-23594 Ty I	8 rl/Motor
	FEP	Plastic Film	ASTM D 3368-81 Cl 1	25 lb/Motor
1U51916	Cartridge Assembly (Filled with Corrosion Preventative Compound)	HD Calcium Grease filtered & placed in application cartridge	STW7-3657	AR
1U77648	Assembly and Closeout, RSRM, KSC	Composite of Various Components		1/motor
1U51899	Pin Retainer	Retainer Pin, Field Joint	531/Motor	
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	D6AC Steel	STW7-2744	1 (alt.)
1U50716	Case Segment, Attach, Light Wt	D6AC Steel	STW7-2744	1/Motor
1U50717	Case Segment, Cylinder, Light Wt	D6AC Steel	STW7-2744	2/Motor
1U52982	Case Segment, Capt Cyl, Light Wt	D6AC Steel	STW7-2744	2/Motor
1U52983	Case Segment, Capt Cyl, Std Wt	D6AC Steel	STW7-2744	1/Motor
1U76666	Forward Segment Insulated			1 ea./Motor
1U76667	Center Segment Insulated			2 ea./Motor
1U77503	Case Assembly, Aft Segment Insul			1 ea./Motor
1U77502	Barrel Assembly, Coated			1 ea./Motor
1U76674	Forward Segment, Loaded			1 ea./Motor
1U76675	Center Segment, Loaded			2 ea./Motor
1U77504	Segment Assembly-Loaded, Aft			1 ea./Motor

6.1 CHARACTERISTICS:

1. Field joint characteristics analyzed in this CIL (J-joint insulator, capture feature O-ring, tang/clevis interference fit, V-2 filler, and tang/clevis metal interface gap) form a redundant thermal protection system. Failure of all components could result in a burn through.

2. Insulation in the case field joint is designed with a J-leg configuration that improved flight safety and reliability over the previous design. The unvented configuration incorporates a deflected J-leg that performs two primary functions:

   a. This deflected J-leg provides a method of accommodating manufacturing tolerances, thermal expansion

and contraction, and propellant slump while ensuring contact of mating surfaces during assembly and launch. This is accomplished by fabricating the interference leg in the open or undeflected position.

b. The deflected J-leg provides a stress-relief mechanism for joint movement due to thermal expansion or contraction of the propellant grain after assembly and pressurization deflections during motor operation. Joint mating surfaces are bonded together at assembly in the inboard portion of the insulation joint with the base region (adjacent to capture feature) being released. This forms the bonded J-joint. A pressure-sensitive adhesive is used to bond the deflected leg of the tang insulation to the clevis insulation during assembly of two adjacent case segments. Adhesive allows for mating and demating of segments without damage to the acrylonitrile butadiene rubber (NBR) insulation. The adhesive has the ability to allow any entrapped air to escape, and to reseal itself during assembly. It will also flow into deformed areas on the mating surface, thus functioning as a gasket/filler.

3. The capture feature O-ring groove is specially designed to allow extrusion of the capture feature O-ring toward the insulation during the leak check test. The O-ring seals against the insulation and O-ring groove.

4. The capture feature design, with applicable interference, reduces clevis seal extrusion gap opening while precluding opening of the capture feature sealing surfaces during pressurization.

5. The interference fit between the capture feature O-ring and the V-2 filler, along with the metal interface gap between the V-2 filler and the seals, contributes to thermal protection in the joint. If hot gases pass the J-joint and capture feature O-ring, the metal provides a heat sink to reduce temperature of hot gases.

6. V-2 filler is designed to take up excess volume in the joint between the capture feature O-ring and primary O-ring. There are eight sections of V-2 filler with approximately 1.5 inch gap 3-4 places in the full circumference. V-2 filler, and the subsequent reduced volume, contributes to thermal protection of the joint by providing the hot gases with less volume to fill.

7. Nonsolvent dispersed PSA was incorporated into the CIL per DCN-507 because of a material obsolescence issue. The new PSA did not perform under flight conditions as expected. The DCN-507 change was limited to a one flight effectivity (RSRM-55). The previously base lined solvent dispersed PSA was reinstated for all subsequent flights.

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

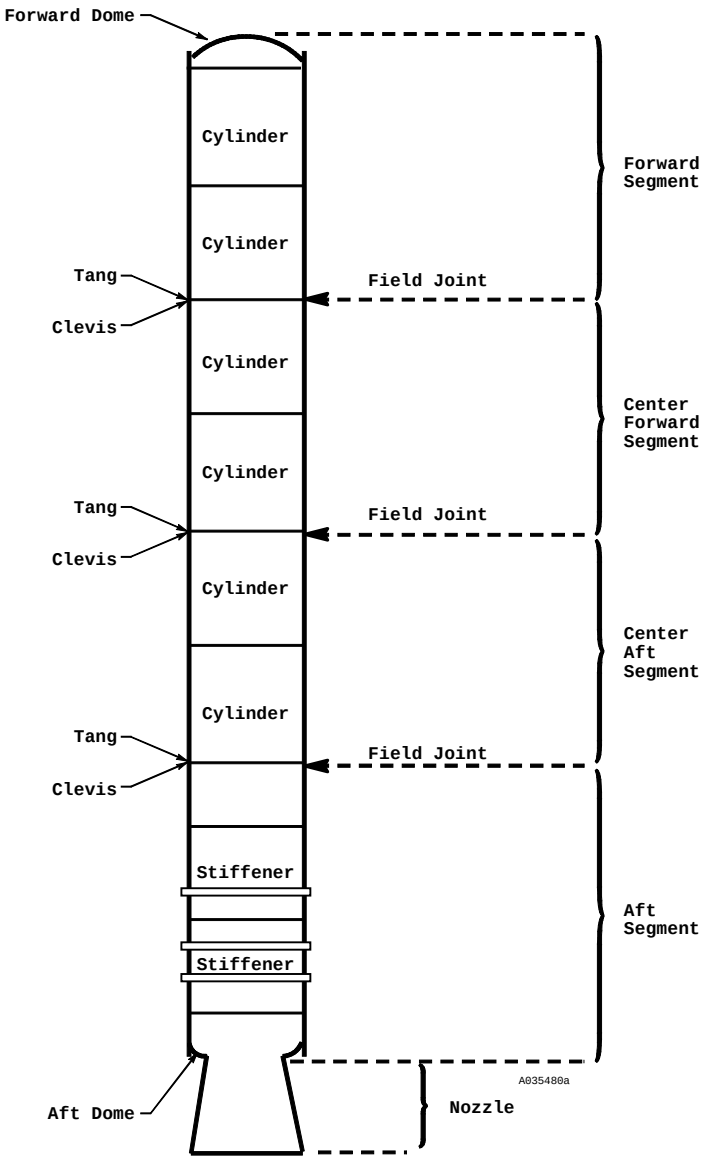
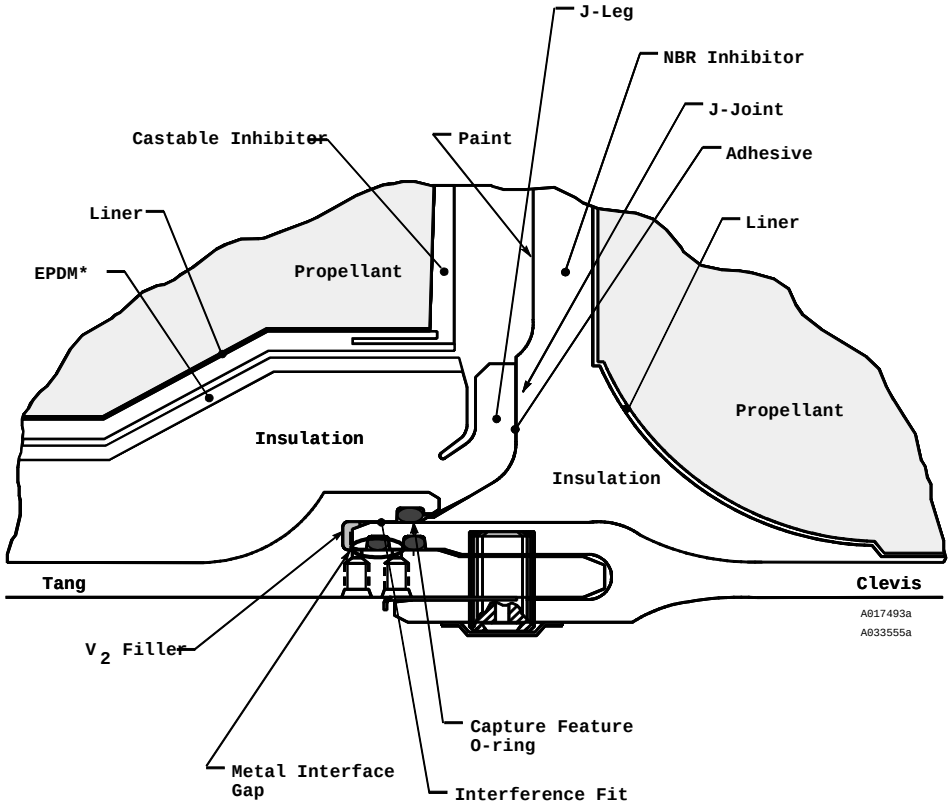


Figure 1. Field Joint Locations



*Not used on forward segment

Figure 2. Field Joint J-Joint Thermal Protection System Components

9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN		FAILURE CAUSES
A	1.	Adhesive used to bond the J-joint is a solvent-dispersed, pressure-sensitive adhesive formulated by mixing rubber-based adhesive and methyl chloroform.
A,B	2.	Mixed pressure sensitive adhesive physical properties conform to engineering.
A	3.	Pressure-Sensitive Adhesive (Unmixed) is designed to have a storage life of 12 months from date of acceptance at Thiokol when stored at warehouse ambient temperature. The storage life expiration date of an individual lot may be extended for additional 6-month periods if, after retest, the adhesive conforms to requirements per engineering.
A	4.	Pressure sensitive adhesive, after mixing, is designed to have a storage life per engineering when stored at warehouse ambient temperature in airtight containers. Pressure-sensitive adhesive, after opening the airtight container, has a maximum useful life per engineering.
A	5.	Methyl chloroform physical and chemical properties are per MIL-T-81533.
A,B	6.	Laboratory testing was conducted to characterize adequate bonding mechanical and thermal properties of J-joint adhesive per TWR-31719.
A	7.	Thermal properties of NBR insulation were evaluated and a thermal analysis performed to verify adequate insulation performance per TWR-17039 and TWR-17009.
B,C	8.	The J-joint deflection and pressurization gap assures that compressive contact always occurs between tang and clevis joint insulation at assembly and during motor operation per TWR-16188.
B	9.	Application of adhesive on prepared clevis and tang insulation is per engineering drawings.
B,F,G	10.	KSC performs a visual inspection of aft and center J-joints following mating and after leak testing of Flight 1 motors by lowering an inspector into the bore to verify no gaps or separations exist in the J-joint bondline.
D	11.	Insulated surfaces of tang deflected leg and clevis mating surfaces are cleaned prior to application of pressure-sensitive adhesive per engineering drawings.
D	12.	Black light inspection of J-joint adhesive and bonding areas was performed for STS-26 to gather information to determine accept or reject criteria for future flights and develop processing guidelines per OMRSD requirements.
E,V	13.	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 RSRM and case segments must be handled by or near a joint to avoid damage. All lifting hooks and slings are fitted with safety hooks. Proof testing is required for all lifting and handling equipment per TWR-13880.
E,M,V	14.	Positive cradling or support devices and tie downs that conform to shape, size, weight, and contour of the component 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.

E,M	15.	Clevis and tang sealing interfaces are protected during shipping by an end grain cover. Shipping segments are shipped to KSC by flatbed railroad cars. The segments are installed in series on handling rings and a shipping cover is placed over the whole assembly per TWR-11869.
E	16.	Before mating the field joint, visual inspection of sealing surfaces is required per TWA-1177.
E,Y	17.	A Field Joint Assembly Fixture (FJAF) is used to assure proper mating of the segments at KSC.
E,M,V	18.	Railcar transportation shock and vibration levels for the segments are monitored as required by engineering with J-joint loads derived per analysis. Monitoring records are evaluated by Thiokol to verify that shock and vibration levels defined per MSFC specifications were not exceeded.
F,R,T,U,W	19.	Internal case segment and aft dome insulation, including application, thickness, and number of plies, is controlled per engineering drawings.
F,R,T,U,W	20.	Engineering drawings specify lay up, number of plies, and correct dimensions of the insulation application.
F	21.	Mold ring qualification tests are performed and statistically analyzed to assure adequate insulation dimensions and results reported in TWR-17543.
F,G	22.	A series of static tests and live firings qualify the RSRM Insulator System as reported in TWR-18764-06.
G	23.	Following propellant cure, a complete dimensional inspection is made of the joint insulation on the tang and clevis to determine if any propellant slump effects occurred that could result in problems during segment assembly per engineering drawings.
G	24.	Profile measuring tools to check dimensions and J-joint profile were developed to ensure insulation surface integrity prior to assembly per engineering drawings.
H,I,P	25.	The capture feature O-ring sealing surface (clevis leg surface) and capture feature O-ring gland conform to machining and surface finish requirements as determined by squeeze and fill per TWR-15771.
H	26.	Criteria to determine O-ring and gland size are found in TWR-15771.
H,L	27.	The O-ring gland is designed to provide stretch and squeeze which maintains a constant contact between the O-ring and both mating surfaces allowing easy installation without over-stretching per TWR-15771.
P	28.	Quality of case segment field joint sealing surfaces during refurbishment is per engineering.
J	29.	Criteria determining O-ring dimensions are outlined in TWR-15771.
J	30.	O-ring design provides constant contact between O-ring and mating segment sealing surfaces per TWR-15771.
J,K	31.	Large O-rings conform to engineering that establishes geometric dimensions and fabrication details.

J	32.	Large O-rings conform to engineering that covers process controls for fabrication of spliced joints and repairs.
J	33.	Splice joints are cut on an angle and bonded together in a mold (using 100 percent of the scarf area) using an adhesive with the same physical and chemical properties as the parent stock.
K	34.	Design requirements for large O-rings are established per engineering.
K	35.	Criteria for voids, inclusions, and subsurface indications are per engineering for large O-rings.
L	36.	Large O-rings are individually packaged per engineering.
L	37.	O-rings per TWR-15771 are designed for ease of installation without over-stretching.
L	38.	Capture feature O-ring design provides constant contact between the O-ring and mating segment sealing surfaces per engineering and TWR-15771.
L	39.	The O-ring is installed at KSC per engineering drawings.
L	40.	Material selection is based in part on resistance to damage as documented in TWR-17082.
L	41.	O-ring installation is with a light coat of filtered grease per engineering drawings.
L	42.	Design development testing of O-ring twisting and its effect on performance was performed per ETP-0153 with results documented in TWR-17991.
M	43.	Support equipment used to test, handle, transport, and assemble or disassemble the RSRM is certified and verified per TWR-15723.
M	44.	Motor segments are protected during shipping by a segment shipping cover assembly per engineering.
M,V	45.	The cast segment shipping configuration includes end covers to provide protection against contamination during shipping and storage using Handling Kits defined by engineering drawings.
N,AA	46.	Sealing surfaces are inspected for contamination, and cleaned as necessary. a. During processing, Thiokol takes steps to protect case segment exposed bare metal surfaces 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. b. During local transportation, Thiokol uses environmentally controlled shipping containers, which allow case segments to be shipped without grease. This was demonstrated to be acceptable per TWR-65920. c. Filtered grease is applied to sealing surfaces prior to assembly.
N,Z	47.	Grease is filtered to remove particulate contamination per engineering.
N,R,W,AA	48.	Cleanliness of sealing surfaces to prevent contamination is controlled as follows: a. Shop planning b. Contamination control requirements and procedures are described in TWR-16564.

N	49.	Capture feature O-ring sealing surface quality is per engineering.
O	50.	Fluorocarbon rubber O-rings are suitable for periods of storage of up to 20 years (O-ring Handbook, ORD 5700, Copyright 1982, by Parker Seal Group, Lexington, KY). Environment and age is significant to seal useful life, both in storage and actual service.
O	51.	Large O-rings are packaged and stored to preclude deterioration caused by ozone, grease, ultraviolet light, and excessive temperature.
O	52.	Large O-ring time duration of supplier storage and total shelf life prior to installation is limited per engineering.
O	53.	Aging studies of O-rings after 5 years installation life were performed. Test results are applicable to all RSRM fluorocarbon seals. Fluorocarbon maintained its tracking ability and resiliency. Fluorocarbon was certified to maintain its sealing capability over 5 years per TWR-65546.
O	54.	The O-ring is a one-time-use item.
O	55.	Grease is stored at warehouse-ambient condition which is any condition of temperature and relative humidity experienced by the material when stored in an enclosed warehouse, in unopened containers, or containers which were resealed after each use. Storage life under these conditions is per engineering.
O	56.	Aging studies to demonstrate characteristics of grease after 5 years installation life were performed on TEM-9. Results showed that grease provided adequate corrosion protection for D6AC steel, and that chemical properties of grease remained intact per TWR-61408 and TWR-64397.
Q	57.	Large O-rings are high-temperature, low-compression set, fluid-resistant, black fluorocarbon rubber.
Q	58.	Corrosion-preventive compound conforms to material requirements per engineering drawings and specifications.
R	59.	Insulation materials are subject to handling, storage, and use as described by engineering.
R	60.	Application of insulating material to case segments was designated a critical process per shop planning. This provides for stricter controls during fabrication and inspection.
R	61.	The cure cycle is per shop planning.
R	62.	Primer and adhesive application is per engineering drawings.
R,S	63.	Witness panels are cured in the autoclave with the insulated segments during the cure cycle. These panels are then tested to assure bondline integrity for primer, adhesive, insulation, liner and propellant properties was achieved at the end of the cure cycle per engineering, TWR-17123, TWR-64433, and TWR-64923.
S	64.	Cured NBR properties are per engineering. Margins of safety limits for erosion are defined in engineering drawings for the case and nozzle and TWR-12969 and TWR-16742 for the Igniter.
S	65.	Insulation material (EPDM) properties conform to engineering drawings.

S	66.	Insulation adhesive primer and bonding agent material properties conform to and are qualified to engineering requirements.
S	67.	Methyl chloroform conforms to engineering requirements
S	68.	Teflon tape conforms to engineering requirements.
S	69.	Plastic film conforms to engineering requirements.
T	70.	Acceptance criteria for insulation anomalies are per engineering.
U	71.	Acceptance criteria for insulation voids, inclusions, ply separations, and pin holes, are per engineering drawings.
V	72.	Unvulcanized insulation material storage life and temperature limits, prior to lay up on the component, are per engineering. Storage life may be extended if, after retest, the material conforms to engineering.
V	73.	The RSRM and its components are protected by passive means against natural environments during transportation and handling per engineering drawings.
V	74.	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.
V	75.	Preservation and packaging of thermal insulation is used to prevent exposure to direct sunlight, ultraviolet radiation, or ozone as established by engineering drawings.
V	76.	Thermal analyses were performed for RSRM components during in-plant transportation and storage to determine acceptable temperature and ambient environment exposure limits per TWR-50083. Component temperatures and exposure to ambient environments during in-plant transportation or storage are controlled per engineering.
V	77.	Evaluation of TEM-09 insulation performance and post-fire bondline integrity demonstrated that thermal safety factors and material decomposition met the requirements of the HPM CEI specification. Structural testing indicated that post-fired TEM-09 internal insulation was comparable to recently fired RSRM materials per TWR-63479.
V	78.	Testing of real time aged propellant/liner/insulation (PLI) samples indicated that TP-H1148 propellant and PLI bond properties were not affected by aging for up to five years per TWR-63837.
W	79.	To enhance the effectiveness of insulation, the number of plies and insulation thickness was increased where needed to meet a minimum factor of safety of 2.0 per TWR-16623.
X	80.	Engineering drawings specify critical dimensions that effect field joint interference fit and metal interface gap. They include attach segments, capture feature cylinder segments, and light weight cylinder segments.
X,Y,Z,AA,AB	81.	Metal interface gap between V-2 filler and seals was added to the CIL as a contributor to the thermal protection of the joint per TWR-66503. Metal in the joint (interference fit and metal interface gap) provides a heat sink which reduces the temperature of hot gases if the gases pass the J-joint and capture feature O-ring per TWR-17015. Analyses cover pressurization and heating within the joint due to the entrance of chamber gases by way of postulated single or double leak paths through the joint's adhesive. Maximum steel surface temperature is below the melting point, but slightly

above the design/reuse temperature. O-ring temperatures were well below the ablation temperature, resulting in no seal erosion. Also, an interference fit between the capture feature and inner clevis leg insures that the primary O-ring will not experience contact with high temperature gas per TWR-17910. The metal interface gap ahead of the primary and secondary O-rings is per engineering drawings and held within 0.021 inches.

X	82.	Corrosion protection is provided as required by engineering.
X	83.	Case segment refurbishment criteria is defined per engineering.
X	84.	Dimensions of the pin retainer (shims) are controlled per engineering.
X	85.	Requirements for the RSRM field joint interference fit, as determined by profile measuring device data, under temperature-controlled conditions are per engineering.
Y	86.	Critical areas of assembly are performed in the vehicle assembly building at KSC. Operational Maintenance Instruction stacking and alignment operations is the primary document that governs assembly practices.
Y	87.	During assembly of the segments (field joint mating) at KSC, crane travel is restricted to 0.050 inch per 60 second period.
Y	88.	Field joint assembly is performed at KSC using customized pin retainer shims and selection and installation of these shims is per engineering drawings and specifications.
AA	89.	Tang and clevis field joints are an integral part of the case and are made from high-strength, low-alloy steel (D6AC) per engineering.
Z,AA	90.	At Thiokol, removal of surface contamination and corrosion is a standard shop practice used whenever contamination and corrosion is noted.
AA	91.	Sealing surface contamination is controlled at KSC by use of an environmental enclosure.
AA	92.	Filtered grease is included in RSRM Segment life verification.
AB	93.	Case segments are controlled per engineering.
AB	94.	Heat treatment provides for high strength and high toughness with reduced internal and surface stresses per engineering.
AC	95.	Dimensions for V-2 filler are established per engineering.
AD	96.	Capture feature V-2 filler material requirements are established per engineering.
AE,AF	97.	Cleaning and installation of V-2 filler is per engineering and TWA-1177.
X,Z,AA,AB	98.	All new RSRM case segments are hydroproof tested three times followed by magnetic particle inspection per engineering. Final hydroproof and magnetic particle inspections 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.

9.2 TEST AND INSPECTION:

DCN	FAILURE CAUSES and TESTS (T)			CIL CODE
	1.	For New Case Segment, Cylinder, Forging, verify:		
AB		a.	Ultrasonic test	ADW178
	2.	For New Case Segment, Attach, Forging, verify:		
AB		a.	Ultrasonic test	ABL168
	3.	For New Case Segment, Capture Cylinder, Standard Weight, verify:		
H,I,P,X		a.	Capture feature gap	ADX011,ADX094
H,P		b.	Depth of capture feature O-ring groove	ADX013,ADX044B
H,P		c.	Width of capture feature O-ring groove	ADX014,ADX044C
P		d.	Distance from Datum -A- to capture feature inner diameter	MKL013
H,P		e.	Capture feature O-ring groove corner radius (two places)	ADX016,ADX016A
P,X		f.	Sealing surface diameter at tang	ADX015,ADX052
P,X		g.	Capture feature outer diameter	FAC012
P		h.	Sealing surface finish of capture feature O-ring groove	FAC016,FAC017
AB		i.	Magnetic particle inspection after hydroproof test	ADX105
	4.	For Refurbished Case Segment, Capture Cylinder, Standard Weight, verify:		
H,I,P,X		a.	Capture feature gap	ADX141
H,P		b.	Depth of capture feature O-ring groove	ADX147A
H,P		c.	Width of capture feature O-ring groove	ADX147
P,X		d.	Sealing surface diameter at tang	FAC014
P,X		e.	Capture feature outer diameter	FAC015
P		f.	Sealing surface finish of capture feature O-ring groove	FAC018
N		g.	Field joint sealing surfaces for defects	AOJ003C
AB		h.	Magnetic particle inspection after hydroproof test	ADX113
	5.	For New Case Segment, Capture Cylinder, Light Weight, verify:		
H,I,P,X		a.	Capture feature gap	ADW012,ADW098
H,P		b.	Depth of capture feature O-ring groove	ADW018,ADW152
H,P		c.	Width of capture feature O-ring groove	ADW015,ADW016
P		d.	Distance from Datum -A- to capture feature inner diameter	MKL012
H,P		e.	Capture feature O-ring groove corner radius (two places)	ADW017,ADW017A
P,X		f.	Sealing surface diameter at tang	ADW149,ADW053
P,X		g.	Capture feature outer diameter	FAC203
P		h.	Sealing surface finish of capture feature O-ring groove	FAC207,FAC208
AB		i.	Magnetic particle inspection after hydroproof test	ADW107
	6.	For Refurbished Case Segment, Capture Cylinder, Light Weight, verify:		
H,I,P,X		a.	Capture feature gap	ADW145
H,P		b.	Depth of capture feature O-ring groove	ADW151
H,P		c.	Width of capture feature O-ring groove	FAB236
P,X		d.	Sealing surface diameter at tang	FAC205
P,X		e.	Capture feature outer diameter	ADW051
P		f.	Sealing surface finish of capture feature O-ring groove	FAC209
N		g.	Field joint sealing surfaces for defects	AOJ003B
AB		h.	Magnetic particle inspection after hydroproof test	ADW117

	7.	For New Case Segment, Cylinder, Light Weight, verify:	
AB	a.	Magnetic-particle inspection after hydroproof test	ABM110A
	8.	For Refurbished Case Segment, Cylinder, Light Weight, verify:	
H,I,P,X	a.	Inner clevis leg wall thickness	ABM083
H,I,P	b.	Sealing surface finish on inner clevis leg inner surface	ABM131
P,X	c.	Inner clevis leg inner diameter	FAC602
N	d.	Field joint sealing surfaces for defects	AOJ003A
AB	e.	Magnetic particle inspection after hydroproof test	ABM107
	9.	For Refurbished Case Segment, Attach, Standard Weight, verify:	
P,X	a.	Inner clevis leg inner diameter	FAC702
H,I,P	b.	Sealing surface finish on inner clevis leg inner surface	FAC705
H,I,P,X	c.	Inner clevis leg wall thickness	MAA104
N	d.	Field joint sealing surfaces for defects	RAA231
AB	e.	Magnetic particle inspection after hydroproof test	FAB921
	10.	For New Case Segment, Attach, Light Weight, verify:	
P,X	a.	Inner clevis leg inner diameter	FAC302
P	b.	Inner clevis leg outer diameter (Datum -C-)	ABL075
H,I,P,X	c.	Inner clevis leg wall thickness	ABL078,ABL081
H,I,P	d.	Sealing surface finish on inner clevis leg inner surface	ABL135,ABL136
AB	e.	Magnetic particle inspection after hydroproof test	ABL094
	11.	For Refurbished Case Segment, Attach, Light Weight, verify:	
H,I,P,X	a.	Inner clevis leg wall thickness	ABL077
H,I,P	b.	Sealing surface finish on inner clevis leg inner surface	ABL134
P,X	c.	Inner clevis leg inner diameter	FAC306
N	d.	Field joint sealing surfaces for defects	AOJ002A
AB	e.	Magnetic particle inspection after hydroproof test	ABL112
	12.	For New Case Assembly, Painted Segment (Forward, Center, and Aft) verify:	
M	a.	Weight test, NDT, and proper hookup of handling equipment used for mating	AEY009,AEZ008,AFB008
	13.	For New Case Assembly, Painted Forward Segment, verify:	
R	a.	Air dry of adhesive primer	RAA220
R	b.	Air dry of bonding agent	RAA221
R,U	c.	Black light inspection is performed to verify all contamination that fluoresces is removed	RAA222
R	d.	Full coverage of adhesive primer	RAA225
R	e.	Full coverage of bonding agent	RAA226
V	f.	Storage life is acceptable for adhesive primer	RAA214
V	g.	Storage life is acceptable for bonding agent	RAA215
V	h.	Adhesive primer is properly mixed and acceptable for application	RAA216
V	i.	Bonding agent is properly mixed and acceptable for application	RAA217
	14.	For New Barrel Assembly, Coated verify:	
R	a.	Full coverage of adhesive primer	AFK022A

R		b.	Full coverage of bonding agent	AFK024A
R		c.	Air dry of adhesive primer	AFK068
R		d.	Air dry of bonding agent	AFK072A
R,U		e.	Black light inspection to verify all contamination that fluoresces is removed	AFK033B
V		f.	Adhesive primer is properly mixed and acceptable for application	AFK185FM
V		g.	Bonding agent is properly mixed and acceptable for application	AFK185FH
W		h.	Primed surfaces meet requirements	AFK120
W		i.	Adhesive surfaces meet requirements	AFK120A

15. For New Insulated Segment Assembly (Forward, Center, Aft) verify:

F		a.	Proper installation of tang mold ring	AGC001,AGC001B
F		b.	Proper installation of clevis mold ring	AGC001C,AGC001D
R,W	(T)	c.	Insulation thickness by ultrasonics	AFG171,AFI186,AFK214
R		d.	Full coverage of adhesive primer	AFG075,AFI018,AFK022
R		e.	Full coverage of bonding agent	AFI024,AFI024A,AFK024
R		f.	Full coverage of rubber-to-metal adhesive	AFI024B
R		g.	Air dry of adhesive primer	AFG057,AFI063,AFI063A
R		h.	Air dry of bonding agent	AFG058,AFI067,AFI067B
R		i.	Air dry of rubber-to-metal adhesive	AFI067A
R		j.	MEK tackifier is applied in the stress-relief flap area	AFG014,AFI015,AFK015
R,U		k.	Black light inspection is performed to verify all contamination which fluoresces is removed	AFG034,AFI036,AFK033
R,S	(T)	l.	Results of Chemlok-to-Case Insulation bondline integrity tests with witness panels per engineering	AOX014,AOX015,AOX016
T,U		m.	No unacceptable surface defects in cured NBR	AFG067,AFI211,AFK078
T,U		n.	5U NBR insulation lay up is complete	AFK145B,AHP000,AHQ001
U		o.	Insulation is uniform in appearance and free of surface contamination per specifications	AFG052, AFI084, AFK062
U		p.	All tools and in-process materials are accounted for after insulation lay up	AFG006,AFI114,AFK206
U		q.	Contamination is removed from case prior to insulation lay up	AFG051,AFI057,AFK061B
V		r.	Environmental history for insulation	AFK068A,AFK086,AFK086A,AFK086B, AKZ006C,AKZ006D,AKZ006E,ALH022B, ALH022C,ALH022D,ALH022E,ALH022F
V		s.	Storage life is acceptable for adhesive primer	AFK185B,AMR048D,AMX019
V		t.	Storage life is acceptable for bonding agent	AFE082S,AFI162,AMX018
V		u.	Storage life is acceptable for insulation	AFG135H,ALH097C,AFI118,AFI118A, AFI118B,AFI118C,AFI118D,AFK185, AFK185A,AKZ038C,AKZ038D,AKZ038E
V		v.	Storage life is acceptable for rubber-to-metal adhesive	AFE082U
V		w.	Adhesive primer is properly mixed and acceptable for application	AFK185FA,AFK185FD,AFK185FG
V		x.	Bonding agent is properly mixed and acceptable for application	AFK185FB,AFK185FE,AFK185FI
V		y.	Rubber-to-metal adhesive is properly mixed and acceptable for application	AFK185FF
V		z.	Component temperatures and exposure to ambient environments during in-plant transportation or storage are acceptable	BAA018,BAA019,BAA020
W		aa.	Primed surfaces meet requirements	AFG038,AFI110C,AFK120F
W		ab.	Adhesive surfaces meet requirements	AFG038A,AFI110A,AFK120E

16. For New Loaded Segment Assembly (Forward and Center) verify:

M		a.	Current certification of handling and lifting equipment	AFF021,AFH023

17. For New Loaded Segment Assembly (Forward, Center, Aft) verify:

T	(T)	a.	Insulation to case bond by ultrasonics in the field joint region is acceptable	MKL007,MKL008,MKL009
T,U	(T)	b.	Results of radiographic inspections per engineering	AFF058,AFH060,AFJ046
V		c.	Proper installation of segment end covers prior to shipping from casting pits.	AID001,AID002,AID003
V		d.	Component temperatures and exposure to ambient environments during in-plant transportation or storage are acceptable	BAA008,BAA009,BAA010

18. For Refurbished Pin Retainer, verify

AB		a.	No bends, cracks, or scratches	RAA213

19. For New Large O-ring verify:

J		a.	Diameter	AEB014,AEB015,AEB018,AEB023,AEB026,AEB027
J		b.	Correct identification	AEB087,AEB100
J		c.	Splice is bonded over 100 percent of the scarf area	AEB133,AEB134
J		d.	No more than five splices	AEB167,AEB169
J		e.	Repairs	AEB265,AEB266
J		f.	Adhesive is made from fluorocarbon rubber	AEB308, AEB311
J		g.	Splice bond integrity	AEB317,AEB319
J,K	(T)	h.	Subsurface indications	AEB354
J,K,L		i.	Surface quality	AEB388,AEB389
J,Q	(T)	j.	Tensile strength	AEB394,AEB401,AEB402
J	(T)	k.	Ultimate elongation	AEB442,AEB443
Q		l.	Material is fluorocarbon rubber	AEB141,AEB151
Q	(T)	m.	Shore A hardness	AGM304,AGM312
Q	(T)	n.	Ultimate elongation	AGM408,AGW075
Q	(T)	o.	Compression set	AKW006,AKW011

20. For New Handling Kit, Center Segment, verify:

M	a.	Clevis joint area free from damage prior to shipping segments	AGR001
V	b.	End covers are in place on the segments to protect the propellant grain and insulation from ultra violet degradation prior to shipping	AID000A
M	c.	Tang joint area is free from damage prior to shipping segments	AFS046
Z,AA	d.	Grease applied to clevis joint area prior to shipping	AGR005
Z,AA	e.	Grease applied to tang joint area prior to shipping	AGR005A

21. For New Handling Kit, Aft Segment, verify:

M	a.	Clevis joint area free from damage prior to shipping segments	AGT001
V	b.	End covers are in place on the segments to protect the propellant grain and insulation from ultra violet degradation prior to shipping	AID000B
Z,AA	c.	Grease applied to clevis joint area prior to shipping	AGT005

22. For New Handling Kit, Forward Segment, verify:

M	a.	Tang joint area free from damage prior to shipping segments	AGN001
V	b.	End cover is in place on the segment to protect the propellant grain and insulation from ultra violet degradation prior to shipping	AID000
Z,AA	c.	Grease applied to tang joint area prior to shipping	AGN005

23. For New Pressure-Sensitive Adhesive, verify:

A	(T)	a.	Solids content	AMJ001
A	(T)	b.	T-peel adhesion strength	AMJ003
A	(T)	c.	Tensile adhesion strength	AMJ005
A	(T)	d.	Viscosity	AMJ007

24. For New Methyl Chloroform, verify:

A		a.	Certificate of Conformance is complete and acceptable	AJJ007

25. For New Pressure-Sensitive Adhesive (Solvent-Dispersed), verify:

D		a.	Mixed adhesive is free from visible contamination prior to kitting	AOH001
D		b.	Premixed adhesive is uniform in appearance and free of visible contamination	CAA004
D		c.	Methyl chloroform is free of visible contamination prior to mixing	RAA141
A,B		d.	Viscosity of mixed adhesive	AOH002

26. For New Filtered Grease verify:

N,Q,Z	(T)	a.	Contamination	ANO064

27. For New Grease verify:

N,Q,Z,AA	(T)	a.	Penetration	LAA037
N,Q,Z,AA	(T)	b.	Dropping point	ANO042
N,Q,Z,AA	(T)	c.	Zinc concentration	LAA038

28. For New NBR, verify:

S	(T)	a.	Shore A hardness (calendered only)	ALH098,ALH102,ALH109
S	(T)	b.	Elongation (calendered only)	ALH010,ALH062,ALH065
S	(T)	c.	Tensile strength (calendered only)	ALH147,ALH149,ALH154
S	(T)	d.	Specific gravity (calendered only)	ALH118,ALH121,ALH126
S	(T)	e.	Mooney viscosity (extrusions only)	ALH041,ALH046,ALH170
S	(T)	f.	Scorch characteristics (extrusions only)	ALH081,ALH086,ALH171
S		g.	Material workmanship including uniform appearance and free from contamination	ALH168

29. For New EPDM, Carbon Fiber-Filled verify:

S	(T)	a.	Elongation	AKZ019C,AKZ022C,ALV001
S	(T)	b.	Fiber content	ALV007
S	(T)	c.	Filler content	ALV028
S	(T)	d.	Mooney viscosity	MKL025
S		e.	Roll weight	ALV009
S	(T)	f.	Scorch characteristics	MKL024
S		g.	Shipping time and environment	ALV005
S	(T)	h.	Shore A hardness	AKZ040C,AKZ045C,ALV011
S	(T)	i.	Specific gravity	AKZ046C,AKZ050C,ALV014
S	(T)	j.	Tensile strength	AKZ055C,AKZ059C,ALV021
S	(T)	k.	Volatile content	ALV031
S	(T)	l.	Weight per square foot	ALV033
S		m.	Width of uncured stock	ALV038

30. For Retest NBR, verify:

S,V	(T)	a.	Mooney viscosity	ALH049

S,V	(T)	b.	Scorch characteristics	ALH087
		31.	For New Adhesive Primer, verify:	
S	(T)	a.	Solids content	AMR059,AMR067
S	(T)	b.	Density	AMR006,AMR012
S	(T)	c.	Viscosity	AMR083,AMR092
S	(T)	d.	Peel adhesion	AMR026,AMR022
S		e.	Workmanship	AMR041
		32.	For New Bonding Agent, Rubber-to-Metal verify:	
S	(T)	a.	Specific gravity	AMX027,AMX029
S	(T)	b.	Viscosity	AMX039,AMX040
S	(T)	c.	Peel adhesion strength	AMX006,AMX010
S	(T)	d.	Solids content	AMX021,AMX023
		33.	For New Adhesive, Rubber-to-Metal verify:	
S	(T)	a.	Solids content	AND028,AND026
S	(T)	b.	Specific gravity	AND033,AND036
S	(T)	c.	Viscosity	AND046,AND044
S	(T)	d.	Peel strength, rubber-to-steel	AND014,AND009
S		e.	Workmanship	FAA842
		34.	For New Teflon Tape, verify:	
S		a.	Certificate of Conformance is complete and acceptable	AJC001
		35.	For New Plastic Film, verify:	
S	(T)	a.	Tensile resistance	AIN011
S	(T)	b.	Tear strength	AIN007
S	(T)	c.	Dielectric strength	AIN002
		36.	For New Pin Retainer, verify:	
X		a.	Shim thickness	ACO007
		37.	For RSRM Acceptance Criteria for Interference Fit, verify:	
X		a.	Interference fit of the RSRM field joints for each flight set	FAE001
		38.	For New Volume Filler, Capture Feature verify:	
AC		a.	Length	AKY007
AD		b.	Specific gravity	AKH005
AD		c.	Filler is fluorocarbon rubber per specification	AGW029
		39.	KSC verifies:	
H,I,J,K,L, M,N,P	(T)	a.	Clevis Joint Leak Test results are acceptable for each segment per OMRSD, File V, Vol I, B47CJ0.011	OMD026
A,B,D,E		b.	Acceptable J-joint adhesive application on each segment per OMRSD, File V, Vol I, B47CJ0.020	OMD027
O,AA		c.	Expiration date is not exceeded for materials installed at KSC per OMRSD, File V, Vol I,B47GEN.160	OMD042

595	F,T	(T)	d.	Case-to-insulation bond lines are acceptable by probing full circumference with 0.020 inch thick shim stock on the clevis end and 0.005 inch thick shim stock on the tang end of each segment per OMRSD File V, Vol I, B47SG0.051.	OMD078
	H,M,N,P, Z,AA,AB		e.	Tang and Clevis Field Joint unpainted surfaces are free from surface defects or contamination per OMRSD, File V, Vol I, B47SG0.122	OMD085
	L		f.	No damage to shipping box, shipping bag or O-rings prior to installation per OMRSD, File V, Vol I, B47SG0.152	OMD087
	D,E,T,U		g.	All Field Joint J-Joint bonding surfaces are free of contamination and defects per OMRSD, File V, Vol I, B47SG0.160	OMD088
	Y		h.	RSRM field joint parallel alignment per OMRSD, File V, Vol I, B47SG0.180	OMD090
	Y		i.	Acceptable field joint engagement rate during segment mating per OMRSD, File V, Vol I, B47SG0.290	OMD095
	L		j.	Application of filtered grease to the field joints (O-ring grooves, sealing surfaces, pin holes) per OMRSD, File V, Vol I, B47SG0.370	OMD103
	L,N		k.	Application of filtered grease to Field Joint O-Rings and Thermal Barrier per OMRSD, File V, Vol I, B47SG0.380	OMD104
	Y		l.	Acceptable contact between FJAF and segment outer clevis leg during mating operations per OMRSD, File V, Vol I, B47SG0.390	OMD105
	AF		m.	V-2 volume filler is free of contamination per OMRSD, File V, Vol I, B47SG0.400	OMD106
	AC,AE		n.	Proper orientation and spacing of the V-2 volume filler per OMRSD, File V, Vol I, B47SG0.410	OMD107
	E		o.	Tang J-Joint (Forward, Center Forward and Center Aft segments) non-sealing surface (from J-joint bonding surface outboard) is free of contamination and damage prior to assembly per OMRSD, File V, Vol I, B47SG0.420	OMD108
	L,N		p.	Field joint interfaces are free of contamination prior to engagement into the FJAF per OMRSD, File V, Vol I, B47SG0.490	OMD109
	Y		q.	Correct field joint pin retainer clips (custom shims) are installed per OMRSD, File V, Vol I, B47SG0.510	OMD110
	E		r.	Clevis end (Center Forward, Center Aft and Aft segments) non-sealing surface (outboard of J-Joint bonding area) is free of contamination and damage prior to assembly per OMRSD, File V, Vol I, B47SG0.520	OMD111