



CRITICAL ITEMS LIST (CIL)

No. 10-01-01-08R/02

SYSTEM:	Space Shuttle RSRM 10	CRITICALITY CATEGORY:	1
SUBSYSTEM:	Case Subsystem 10-01	PART NAME:	Factory Joint, Insulator (1)
ASSEMBLY:	Case 10-01-01	PART NO.:	(See Section 6.0)
FMEA ITEM NO.:	10-01-01-08R Rev M	PHASE(S):	Boost (BT)
CIL REV NO.:	M	QUANTITY:	(See Section 6.0)
DATE:	17 Jun 2002	EFFECTIVITY:	(See Table 101-6)
SUPERSEDES PAGE:	208-1ff.	HAZARD REF.:	BC-02
DATED:	31 Jul 2000		
CIL ANALYST:	S. E. Rodgers		
APPROVED BY:		DATE:	

RELIABILITY ENGINEERING: K. G. Sanofsky 17 Jun 2002

ENGINEERING: P. M. McCluskey 17 Jun 2002

- 1.0 FAILURE CONDITION: Failure during operation (D)
- 2.0 FAILURE MODE: 2.0 Leakage through the insulator
- 3.0 FAILURE EFFECTS: Failure of the insulator as a pressure seal could result in hot gas flowing through the joint resulting in burn through causing loss of RSRM, SRB, crew, and vehicle

4.0 FAILURE CAUSES (FC):

FC NO.	DESCRIPTION	FAILURE CAUSE KEY
2.1	Age degradation, storage, transportation, and handling	A
2.2	Nonconforming material properties	B
2.3	Thin spot or insufficient material thickness	C
2.4	Inclusions and presence of non-insulation material	D
2.5	Ply separations and voids	E
2.6	Insulation-to-case debonds	F
2.7	Hole or gouge in insulator	G
2.8	Improper handling, application, or cure cycle	H

CRITICAL ITEMS LIST (CIL)

No. 10-01-01-08R/02

DATE: 17 Jun 2002  
 SUPERSEDES PAGE: 208-1ff.  
 DATED: 31 Jul 2000

5.0 REDUNDANCY SCREENS:

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

6.0 ITEM DESCRIPTION:

1. Factory joint insulators are shown as the primary insulation over the seven factory joints (See Figure1). Materials are listed in Table 1.

TABLE 1. MATERIALS

Drawing No.	Name	Material	Specification	Quantity
1U77502	FEP	Plastic Film	ASTM D 3368-81	25 LB/Motor
	Forward Segment/Dome	Filler Extrusion (NBR)	STW4-2535	7 LB/Motor
	Insulation	Acrylonitrile Butadiene Rubber, Asbestos Silica-Filled (NBR)	STW4-2621 TP VI	(ALTERNATE)
			STW4-2621	17,100 lb/Motor
	Insulation	Carbon Fiber-Filled Ethylene Propylene Diene Monomer (EPDM)	STW4-2621 TP I	(ALTERNATE)
			STW4-2868	98 lb/Motor
	Primer, Bonding agent	Chemlok 205	STW5-2664	8 gl/Motor
			STW5-2712	12 gl/Motor
	Teflon Tape	Chemlok 233	MIL-I-25594, TP I	8 rl/Motor
				1 ea/Motor
Barrel Assembly, Coated				

6.1 CHARACTERISTICS:

1. Insulation used on the RSRM protects internal case surfaces from the heat of combustion gases during motor burn time. Insulation over the factory joint serves as the primary seal for internal pressure throughout motor burn and provides multiple-ply coverage of the factory joint after worst-case design maximum erosion was experienced. The design consistently demonstrated seal function throughout RSRM operation even after loss of one ply of insulation due to normal erosion. All insulation safety factors are maintained after loss of one ply.
2. Acrylonitrile butadiene rubber (NBR) is used as the primary internal insulating material throughout the RSRM case.
3. RSRM internal insulation over the factory joints was increased in thickness and number of plies. A continuous first ply over the joint replaced the butt joint method on previous configurations, precluding a leak path along a ply into a joint. Insulation minimum safety factor for each of the seven factory joints increased from 1.5 to 2.0.
4. Factory joints demonstrated reliable performance and the insulation was successfully used for many years in numerous rocket motor programs, i.e., Minuteman and Poseidon (First-Stage) motors, Trident, Peacekeeper, Titan IIIC, and some 156-inch experimental motors.

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

CRITICAL ITEMS LIST (CIL)

No. 10-01-01-08R/02

DATE: 17 Jun 2002  
SUPERSEDES PAGE: 208-1ff.  
DATED: 31 Jul 2000

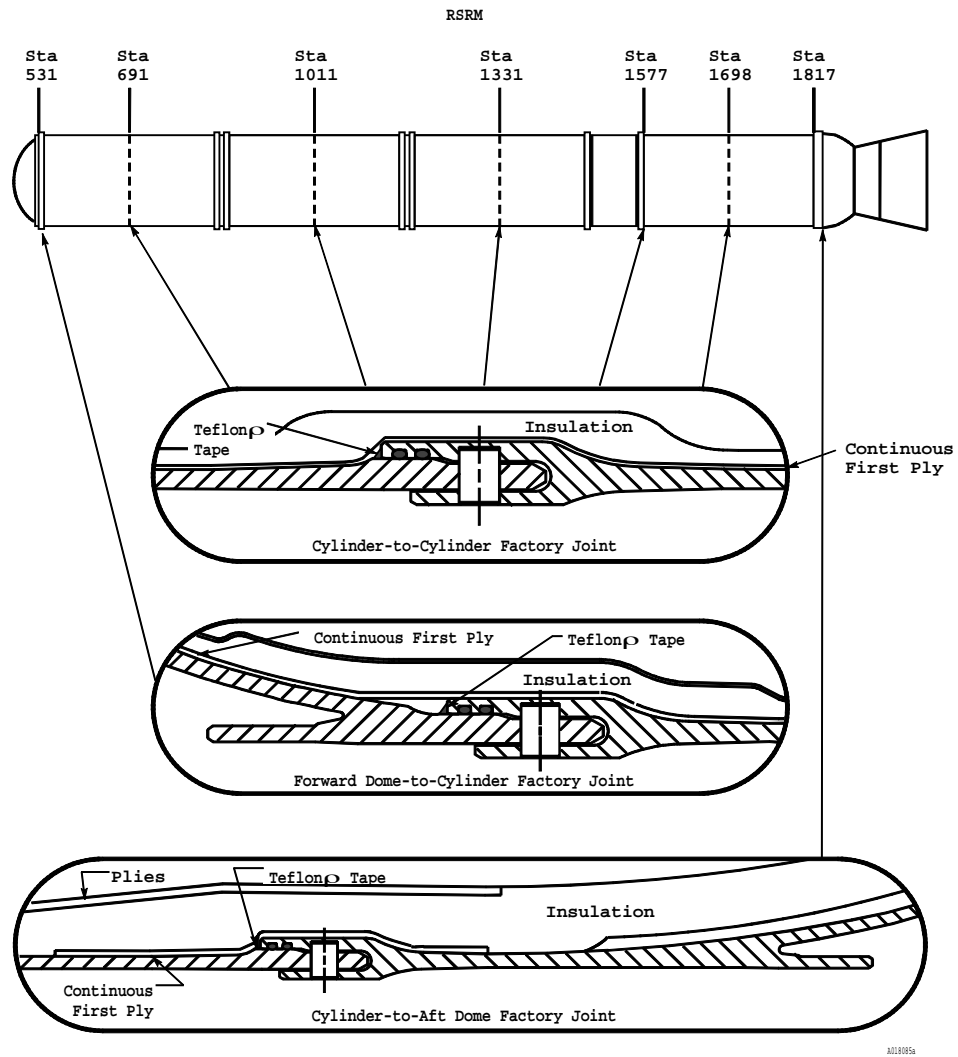


Figure 1. Factory Joints Internal Insulation

CRITICAL ITEMS LIST (CIL)

No. 10-01-01-08R/02

DATE: 17 Jun 2002  
 SUPERSEDES PAGE: 208-1ff.  
 DATED: 31 Jul 2000

9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN FAILURE CAUSES

- |       |  |
|-------|--|
| A     | 1. 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 is per engineering.  |
| A     | 2. 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. Proof testing is required for all lifting and handling equipment per TWR-13880. |
| A     | 3. Cradling or support devices and tie-downs that conform to the shape, size, weight, and contour of the component to be transported are provided for supporting RSRM segments and other components. Shock mounting and other protective devices are used on trucks and dollies for moving sensitive loads per TWR-13880.  |
| A     | 4. Support equipment used to test, handle, transport, and assemble or disassemble the RSRM is certified and verified per IHM 29.   |
| A     | 5. 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.   |
| A     | 6. Railcar transportation shock and vibration levels for the segments are monitored per engineering with loads derived by analysis. Monitoring records are evaluated by Thiokol to verify that shock and vibration levels per MSFC specifications were not exceeded.   |
| A     | 7. The RSRM and its components are protected by passive means against natural environments during transportation and handling per engineering drawings.  |
| A     | 8. Qualification Motor QM-6 certifies that factory joint insulation meets the erosion safety factor after a full-scale motor burn per TWR-17372.   |
| A     | 9. Preservation and packaging of thermal insulation is to prevent exposure to direct sunlight, ultraviolet radiation, or ozone per engineering drawings.   |
| A     | 10. 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 the ambient environment during in-plant transportation or storage are per engineering.  |
| A     | 11. Evaluation of TEM-09 insulation performance and post-fire bondline integrity demonstrated that thermal safety factors and material decomposition are per the HPM CEI specification. Structural testing indicated that post-fired TEM-09 internal insulation was comparable to recently fired RSRM materials per TWR-63479.   |
| A     | 12. Testing of real time aged propellant/liner/insulation (PLI) samples indicated TP-H1148 propellant and PLI bond properties were not affected by aging for up to five years per TWR-63837.   |
| B,F,H | 13. 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,   |

CRITICAL ITEMS LIST (CIL)

No. 10-01-01-08R/02

DATE: 17 Jun 2002  
 SUPERSEDES PAGE: 208-1ff.  
 DATED: 31 Jul 2000

adhesive, insulation, liner, and propellant properties were achieved at the end of the cure cycle per engineering, TWR-17123, TWR-64433, and TWR-64923.

- |           |     |   |
|-----------|-----|---|
| B         | 14. | Cured NBR properties are per engineering. Margins of safety limits for erosion are per engineering drawings for the case and nozzle, and TWR-12969 and TWR-16742 for the Igniter.   |
| B         | 15. | Insulation adhesive primer and bonding agent material properties are per engineering.   |
| B         | 16. | Teflon tape is per engineering requirements.  |
| B         | 17. | Development Motors DM-8 and DM-9 and Qualification Motors QM-6 and QM-7 were static fired to evaluate the performance of accepted insulation as documented per TWR-18764-06.  |
| 585 B     | 18. | Approved solvent use is per engineering.  |
| C,E,F,G,H | 19. | Internal case segment and aft dome insulation, including application, thickness, and number of plies, is per engineering drawings.  |
| C         | 20. | To enhance the effectiveness of factory joint insulation as a seal, the number of plies and insulation thickness over the joints were increased to meet a minimum factor of safety per TWR-16623.   |
| C,E,F     | 21. | Integrity of the factory joint insulation as a primary pressure seal is per TWR-16190.  |
| C,D,E,F,H | 22. | Post-test inspection measurements of the insulation over the factory joints were performed for DM-9 per TWR-16472, Vol III. Similar inspections are performed for each flight motor per TWR-16473.  |
| D         | 23. | To control contamination of bonding materials or bonding surfaces, primer and adhesive are stored in sealed containers. Methyl Ethyl Keytone is used to clean insulation and metal bonding surfaces. Clean felt is placed over metal bonding surfaces. NBR is covered with black polyethylene during process delays. Components are handled with clean, lint-free gloves. These procedures are per shop planning. |
| D         | 24. | During insulation lay up, all personnel inside the segment are required to wear clean cotton gloves, clean coveralls, and polyethylene foot covers per shop planning.   |
| D         | 25. | All personnel inside the segment during insulation layup are required to adhere to Hair Containment Guidelines per GS & HM 4.9 to prevent contamination of the insulation and/or bonding agents from loose hair or hair oils.   |
| D         | 26. | Tool accountability is per shop planning.   |
| E,F,G     | 27. | The NBR insulation material specification specifies tests performed to certify the quality of material procured and qualification tested for use on both case wall and forward inhibitor per TWR-12646.   |
| E,F,G     | 28. | Engineering specifies tests performed to certify material quality for bonding agents and adhesive primers.  |
| E         | 29. | Acceptance criteria for insulation anomalies are per engineering.   |
| H         | 30. | Design requirements and processing characteristics of NBR Insulation are per  |



CRITICAL ITEMS LIST (CIL)

No. 10-01-01-08R/02

DATE: 17 Jun 2002  
SUPERSEDES PAGE: 208-1ff.  
DATED: 31 Jul 2000

engineering drawings and shop planning for material ingredients, mixing, and cure requirements.

- H 31. To assure 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. 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-10212.
- H 32. Contamination control requirements and procedures are per TWR-16564.
- B,C 33. 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.

CRITICAL ITEMS LIST (CIL)

No. 10-01-01-08R/02

DATE: 17 Jun 2002  
 SUPERSEDES PAGE: 208-1ff.  
 DATED: 31 Jul 2000

9.2 TEST AND INSPECTION:

FAILURE CAUSES and  
DCN TESTS (T) CIL CODES

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

C,D,H	a.	5U NBR insulation layup is complete and acceptable	AHP000,AHQ001,AFK145B
D	b.	All tools and in-process materials are accounted for after insulation layup	AFG006,AFI114,AFK206
A	c.	Environmental history for insulation	AKZ006C,ALH022B,AFK068A,AFK086
H	d.	Black discoloration or darkening of cured NBR is acceptable	AFG002,AFI002,AFK002
B,F,H	(T) e.	Results of Chemlok-to-Case Insulation bondline integrity tests with witness panels per engineering	AOX014,AOX015,AOX016
A	f.	Bonding agent is used	AMX016,AMX016D,AFE082N
A	g.	Storage life is acceptable for bonding agent	AMX018,AFE082S,AFI162
A	h.	Component temperatures and exposure to ambient environments during in-plant transportation or storage are acceptable	BAA018,BAA019,BAA020
A	i.	Storage life is acceptable for adhesive primer	AMX019,AMR048D,AFK185B
A	j.	Stock number is recorded for insulation	AKZ025B,ALH068B,ALH068C,ALH068AH
E,F	k.	Blacklight inspection is performed to verify all contamination which fluoresces is removed	AFK033,AFG034,AFI036
C,E,F,H	l.	Primed surfaces meet requirements	AFG038,AFI110C,AFK120F
C,E,F,H	m.	Adhesive surfaces meet requirements	AFG038A,AFI110A,AFK120E
A	n.	Storage life is acceptable for insulation	AKZ038C,ALH097C,AFI118,AFG135H
A	o.	Adhesive primer is used	AMR045,AMR045D,AMR045E
D,E,F,G,H	p.	Contamination is removed from case prior to insulation layup	AFG051,AFI057,AFK061B
D,E,F,G,H	q.	Insulation is uniform in appearance and free of surface contamination per specifications	AFG052,AFI084,AFK062
D	(T) r.	No unacceptable surface defects in cured NBR	AFG067,AFK078,AFI211
A	s.	Lot number is recorded for insulation	ALH067A,ALH067AB,ALH067B,ALH067C
H	t.	Insulation cure cycle is complete	AFG086,AFI099,AFK110
E,H	u.	Trapped air bubbles in the insulation do not exceed specification requirements	AFG102,AFI155,AFK172
A	v.	Adhesive primer is properly mixed and acceptable for application	AFK185FA,AFK185FD,AFK185FG
E,F,H	(T) w.	Insulation-to-case bond by ultrasonics in the factory joint region is acceptable	AFI107,AFI107A,AFK117
H	x.	Proper application of teflon tape	AFG144,AFI173,AFK194
H	y.	Solid core thermocouple leads are installed through the putty	AFG147,AFI178,AFK199
H	z.	Thermocouple leads are working throughout the cure cycle	AFG149,AFI180,AFK201
H	aa.	Vacuum bags evacuated and checked for leaks	AFI160,AFG177,AFK181
C,E,H	(T) ab.	Insulation thickness by ultrasonics	AFG171,AFI186,AFK214
A	ac.	Bonding agent is properly mixed and acceptable for application	AFK185FB,AFK185FE,AFK185FI
2. For New Barrel Assembly, Coated verify:
 

A	a.	Bonding agent is used	AMX016E
A	b.	Adhesive primer is used	AMR045F
A	c.	Storage life is acceptable for adhesive primer	AMR048
C,E,F,H	d.	Primed surfaces meet requirements	AFK120
C,E,F,H	e.	Adhesive surfaces meet requirements	AFK120A

CRITICAL ITEMS LIST (CIL)

No. 10-01-01-08R/02

DATE: 17 Jun 2002  
 SUPERSEDES PAGE: 208-1ff.  
 DATED: 31 Jul 2000

A		f.	Storage life is acceptable for bonding agent	AFK185F
A		g.	Bonding agent is properly mixed and acceptable for application	AFK185FH
A		h.	Adhesive primer is properly mixed and acceptable for application	AFK185FM
3. For Retest NBR, verify:				
A,B	(T)	a.	Mooney viscosity	ALH049
A,B	(T)	b.	Scorch characteristics	ALH087
4. For New Case Assembly, Painted Forward Segment, verify:				
A		a.	Storage life is acceptable for adhesive primer	RAA214
A		b.	Storage life is acceptable for bonding agent	RAA215
A		c.	Adhesive primer is properly mixed and acceptable for application	RAA216
A		d.	Bonding agent is properly mixed and acceptable for application	RAA217
A		e.	Adhesive primer is used	RAA218
A		f.	Bonding agent is used	RAA219
E,F		g.	Blacklight inspection is performed to verify all contamination that fluoresces is removed	RAA222
C,E,F,H		h.	Primed surfaces meet the requirements per engineering	RAA223
C,E,F,H		i.	Adhesive surfaces meet the requirements per engineering	RAA224
5. For New NBR, verify:				
B		a.	Elongation (calendered only)	ALH010
B	(T)	b.	Mooney viscosity	ALH041,ALH046
B	(T)	c.	Elongation	ALH062,ALH065
B	(T)	d.	Scorch characteristics	ALH081,ALH086
B	(T)	e.	Shore A hardness	ALH098,ALH109
B	(T)	f.	Shore A hardness (calendered only)	ALH102
B	(T)	g.	Specific gravity (calendered only)	ALH118
B	(T)	h.	Specific gravity	ALH121,ALH126
B	(T)	i.	Tensile strength (calendered only)	ALH147
B	(T)	j.	Tensile strength	ALH149,ALH154
B		k.	Material workmanship including uniform appearance and free from contamination	ALH168
B	(T)	l.	Mooney viscosity (extrusions only)	ALH170
B	(T)	m.	Scorch characteristics (extrusions only)	ALH171
6. For New Adhesive Primer, verify:				
B	(T)	a.	Density	AMR006,AMR012
B	(T)	b.	Peel adhesion	AMR022,AMR026
B		c.	Workmanship	AMR041
B	(T)	d.	Solids content	AMR059,AMR067
B	(T)	e.	Viscosity	AMR083,AMR092
7. For New Bonding Agent, Rubber-to-Metal verify:				
B	(T)	a.	Peel adhesion strength	AMX006,AMX010
B	(T)	b.	Solids content	AMX021,AMX023
B	(T)	c.	Specific gravity	AMX027,AMX029
B	(T)	d.	Viscosity	AMX039,AMX040
8. For New Teflon Tape, verify:				
B		a.	Certificate of Conformance is complete and acceptable	AJC001





CRITICAL ITEMS LIST (CIL)

No. 10-01-01-08R/02

DATE: 17 Jun 2002  
SUPERSEDES PAGE: 208-1ff.  
DATED: 31 Jul 2000

9. For New Plastic Film, verify:

B	(T)	a.	Dielectric strength	AIN002
B	(T)	b.	Tear strength	AIN007
B	(T)	c.	Tensile resistance	AIN011

| 585

10. For New Approved Solvent, verify:

	B	a.	Certificate of Conformance is complete and acceptable	AJJ007A
--	---	----	---	---------

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

D,E,F,H	(T)	a.	Results of radiographic inspections per engineering	AFF058,AFH060,AFJ046
---------	-----	----	---	----------------------