

CRITICAL ITEMS LIST (CIL)

No. 10-01-03-01/01

SYSTEM:	Space Shuttle RSRM 10	CRITICALITY CATEGORY:	1
SUBSYSTEM:	Case Subsystem 10-01	PART NAME:	Systems Tunnel Floor Plate Assembly (1)
ASSEMBLY:	Case 10-01-01	PART NO.:	(See Section 6.0)
FMEA ITEM NO.:	10-01-03-01 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:	220-1ff.	HAZARD REF.:	BC-11
DATED:	31 Jul 2000		
CIL ANALYST:	D. F. Bartelt		
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: 1.0 Structural failure
- 3.0 FAILURE EFFECTS: Loss of range safety device and TVC. Debris damage to the External Tank and Orbiter would cause the loss of SRB, crew, and vehicle

4.0 FAILURE CAUSES (FC):

FC NO.	DESCRIPTION	FAILURE CAUSE KEY
1.1	Acoustic vibration and aeroshear	A
1.2	Failure of EPDM rubber	
1.2.1	Nonconforming physical properties	B
1.2.2	Age degradation	C
1.2.3	Moisture or fungus degradation	D
1.3	Failure of the EPDM-to-case bond	
1.3.1	Bonding surfaces not properly prepared or adequately cleaned	E
1.3.2	Bonding material not properly mixed, applied, or cured	F
1.3.3	Contamination during processing	G
1.3.4	Process environments detrimental to bond strength	H
1.3.5	Nonconforming adhesive material properties	I
1.3.6	Bond strength degradation during storage, handling, or transportation	J
1.3.7	Improper adhesive thickness	K
1.4	Failure of the EPDM-to-floor plate vulcanization bond	
1.4.1	Nonconforming bond enhancement material	L

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- 1.4.2 Bonding surfaces not adequately cleaned M
- 1.4.3 Bonding enhancement material not properly mixed, applied, or cured N

5.0 REDUNDANCY SCREENS:

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

6.0 ITEM DESCRIPTION:

- 1. Assembly of the systems tunnel floor plate to the case (Figures 1 and 2) is accomplished per engineering drawings. Materials are listed in Table 1.

Table 1. MATERIALS

Drawing No.	Name	Material	Specification	Quantity
1U82856	Floor Plate Assembly	Various		34/motor
(various)	Case Segments	D6AC Steel	STW7-2744	11/motor
(various)	Tunnel Floor Plate	Aluminum Alloy 2219-T87	QQ-A-250/30	34
	Thermal Insulation	Silica-Filled EPDM Rubber	STW4-2736	195 lb
	Adhesive Paste & Curing Agent	Epoxy Resin EA934NA	STW4-3218	A/R
	Rubber-to-Metal Primer	Adhesive Primer	STW5-2664	6.4 lb
	High Temp Primer	Adhesive Primer	STW5-3215	A/R
	Rubber-to-Metal Adhesive	Adhesive	STW5-2798	8.5 lb
1U82854	Tunnel Splice Plate Assembly	Aluminum Alloy 2219-T87	QQ-A-250/30	6
1U77610	Segment, Rocket Motor, Forward	Various		1/motor
1U77620	Segment, Rocket Motor, Fwd/Center	Various		1/motor
1U77630	Segment, Rocket Motor, Aft/Center	Various		1/motor
1U77640	Segment, Rocket Motor, Aft	Various		1/motor

6.1 CHARACTERISTICS:

- 1. EPDM rubber is vulcanized to the floor plate assembly that is bonded to the steel case. The floor plate assembly protects and holds instrumentation cables, Linear-Shaped Charge (LSC), and other ordnance lines.

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

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Floor Plate Assembly

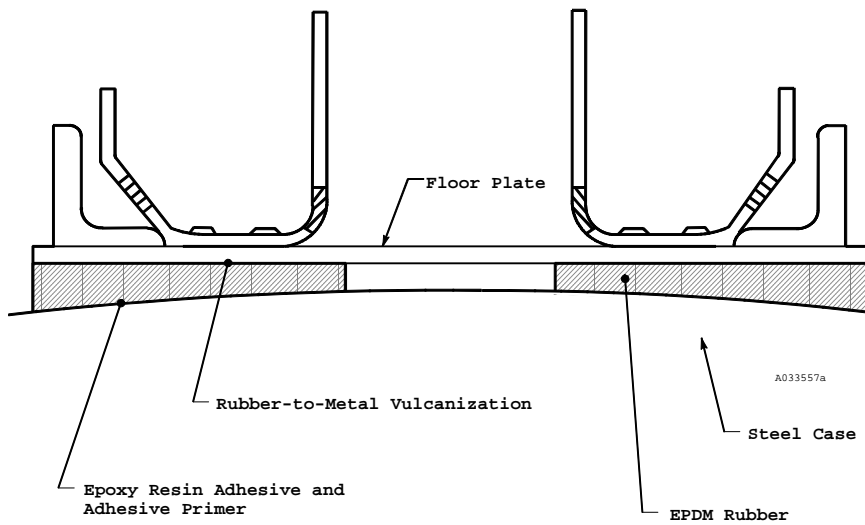
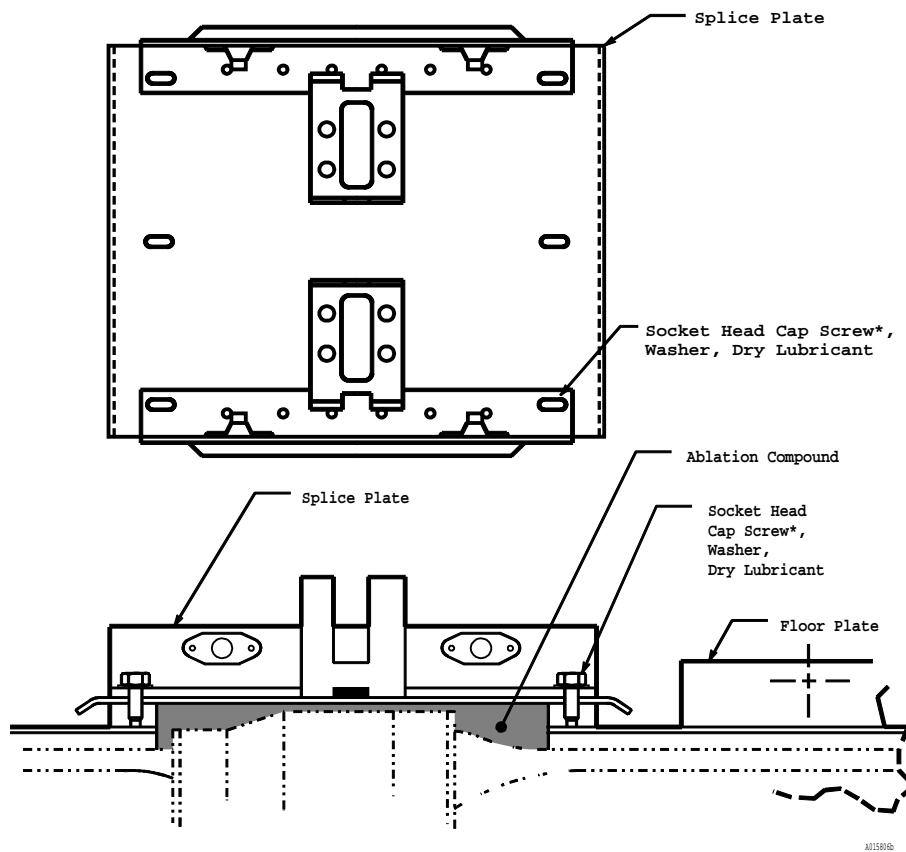


Figure 1. Tunnel Floor Plate Assembly

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*Socket head cap screw on forward segment and 2 center segments at field joints. Hex head cap screws only on aft segment

Figure 2. Tunnel Splice Plate Joint Section

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9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN FAILURE CAUSES

- | | | |
|-----------|-----|---|
| A | 1. | A stress analysis of the systems tunnel bond lines for ascent loading, including aerodynamic and acoustic loads, was performed. This analysis showed positive margins of safety for the EPDM-to-case bond and the EPDM-to-tunnel bond per TWR-13694. |
| B | 2. | Physical properties of cured and uncured EPDM rubber are defined per engineering. |
| B | 3. | The formula for EPDM rubber to ensure proper physical properties is defined per engineering. |
| B | 4. | EPDM material properties and stress and strain values for the systems tunnel application were determined and reported in TWR-12856. |
| C | 5. | Age control requirements of EPDM material specifications limit the times allowed for mixing-to-shipment, shipment, storage, lay up-to-cure, and also specific temperature requirements. |
| D,E,G,H | 6. | Paint is removed to bare metal at floor plate pad bonding locations on the case. The clean, bare metal surface is completely covered with adhesive primer, and the primer is ambient dried. |
| D,E,G,H | 7. | Control of workmanship assures that epoxy resin adhesive and adhesive primer will be free from agglomeration, foreign matter, separation, dilution, and contamination. |
| D,E,G,H | 8. | EPDM will be free from surface contamination such as grease, oil, foreign materials, or other contaminants. |
| D,E,G,H | 9. | The factor of safety for the systems tunnel bond line for ascent is 2.0. An analysis was performed and showed a positive margin of safety per TWR-13694. |
| D,E,G,H | 10. | A fungus certification test was performed to ensure that materials used to attach the aluminum systems tunnel to the steel RSRM do not support fungal growth per TWR-16851. |
| D,E,G,H | 11. | EPDM for the systems tunnel is accepted for use per a material use agreement. |
| F,I,K | 12. | Adhesive primer and epoxy resin adhesive are mixed, applied, and cured per engineering drawings and specifications. |
| F,J,K | 13. | Epoxy adhesive resin has a minimum tensile strength as defined per engineering. |
| F,K | 14. | Thickness of the adhesive is controlled per engineering drawings and waviness of the case. Thickness of the adhesive is determined during application by the application tool, and therefore, improper thickness would only result from improper application. |
| F,K | 15. | A test was performed with a similar adhesive using a 0.25-thick coating compared to a thin coating. Analysis showed no strength problem per TWR-15173. |
| F,K,L,M,N | 16. | Contamination control requirements and procedures are described in TWR-16564. |

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- I 17. Epoxy resin adhesive is a two-part epoxy (part A) consisting of gray aluminum powder-filled, thixotropic epoxy resin in paste form, and (part B) consisting of amber, amine-type liquid curing agent.
- I 18. Epoxy resin adhesive and adhesive primer mechanical properties and selection criteria are established per TWR-18011.
- I 19. Epoxy resin adhesive and primer system material properties are certified per TWR-16671 and TWR-17735.
- I,J 20. Adhesive primer (Silane) has a controlled storage life from date of manufacture as required per engineering. Packaging of the primer is in air-tight glass bottles or containers.
- F,G,K 21. Epoxy resin adhesive storage life is per engineering.
- J 22. Loads induced as a result of transportation and handling were studied with respect to the structural integrity of RSRM loaded segment components. It was determined that all components within the loaded segments were structurally sound through transportation and handling prior to flight per TWR-13694.
- J 23. Rail car transportation shock and vibration levels for the segments are monitored per engineering and loads are derived per analysis. Monitoring records are evaluated by Thiokol to verify that shock and vibration levels defined per MSFC Specifications were not exceeded.
- J 24. 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 controlled per in-plant transportation and environment specifications.
- J 25. TEM motor floor plate pull tests were used to demonstrate that the Systems Tunnel Bond meets "useful life" requirements and demonstrates positive margins of safety for epoxy resin adhesive per TWR-64178.
- L,N 26. Adhesive primers and bonding agents are mixed and applied to metal surfaces for corrosion protection and insulation bonding per engineering and shop planning.
- L 27. Vulcanized metal adhesive and primer system material properties are established per TWR-16671.
- L,N 28. Rubber-to-metal adhesive is applied over primer per engineering and shop planning.
- M,N 29. Cleaning of bonding surfaces is controlled per shop planning.
- N 30. EPDM is cured (vulcanized) to the floor plate with rubber-to-metal adhesive and rubber-to-metal primer at controlled elevated temperature and pressure with controlled timing per shop planning.
- A,B,C,E,G,H,
I,J,K,L,M,N 31. TWR-66825-2 and -6 were updated to incorporate the Performance Enhancement (PE) Program. Predicted PE temperatures and aerodynamic loads for the Systems Tunnel, Systems Tunnel Cork, and GEI TPS remain essentially unchanged. Load factors were updated to include rigid body loads, but resulting effects were insignificant. Existing stresses and structural margins of safety quoted for the Generic Aero/Heating Certification are valid for PE per TWR-66825-2 & -6.

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9.2 TEST AND INSPECTION

FAILURE CAUSES and				
DCN	TESTS (T)		CIL CODE	
		1. For New Thermal Insulation, EPDM, Silica-Filled, verify:		
B	(T)	a. Specific gravity	ALT017,ALT020	
B	(T)	b. Tensile strength	ALT027,ALT031	
B	(T)	c. Ultimate elongation	ALT041,ALT042	
B	(T)	d. Hardness	ALT005,ALT006	
		2. For Retest, Thermal Insulation, EPDM, Silica-Filled, verify:		
C	(T)	a. Tensile strength	ALT034	
C	(T)	b. Ultimate elongation	ALT045	
C	(T)	c. Hardness	ALT009	
		3. For the New Floor Plate Assembly verify:		
585	M,N	a. Floor plate bonding surface was properly grit blasted and is clean	AHI010	
	M,N	b. Floor plate bonding surface is cleaned with approved solvent prior to applying primer and adhesive	AHI005	
	M,N	c. Application of primer	AHI001	
	M,N	d. Application of adhesive	AHI000	
	M,N	e. Insulation working area, table cutting surface, and cutting utensils are cleaned prior to cutting insulation, and gloves are worn during cutting operation	AHI006	
	M,N	f. Gloves are worn during lay up operation	AHI007	
	M,N	g. Bonding surface is protected to prevent surface contamination, after adhesive is applied and prior to vulcanization	AHI013	
	M,N	h. Floor plate assembly is wrapped with protective packing and tape	AHI016	
	B,N	i. Cure process	AHI014	
	C	j. Shelf life of uncured EPDM rubber	ALT010	
	N	k. Edge unbonds, if any, due to normal processing are within drawing requirements.	AHI012	
			4. For New Segment, Rocket Motor (Forward, Forward Center, Aft Center, and Aft), verify:	
	D,E,G,H		a. Floor plate bonding surfaces are cleaned prior to installation	AET018,AEU017,AGA017,AEW018
D,E,G,H		b. Paint removal for floor plate installation	AET023,AEU022,AGA022,AEW023	
D,E,G,H		c. Floor plate bonding surface of case is cleaned prior to bonding	AET003,AEU003,AGA003,AEW003	
B,C,D,E, F,G,H,I,J, K,L,M,N	(T)	d. Floor plate pull tests are acceptable	AET020,AEU019,AGA019,AEW020	
D,E,F,G, H,I,K	(T)	e. Floor plate witness panel results are acceptable for adhesive primer, silane, and epoxy resin adhesive	RAA233,RAA234,RAA235,RAA236	
F,K		f. Adhesive primer (silane) for floor plate bonding is properly applied	AET000,AEU000,AGA000,AEW000	
F,K		g. Adhesive primer (silane) for floor plate bonding is properly dried	AET001,AEU001,AGA001,AEW001	
F,K		h. Epoxy resin adhesive for floor plate bonding is properly mixed	AET015,AEU014,AGA014,AEW015	
F,K		i. Epoxy resin adhesive for floor plate bonding is		

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F,K	(T)	j.	properly applied Epoxy resin adhesive for floor plate bonding is cured to time and shore D requirements	AET013,AEU012,AGA012,AEW013 AET014,AEU013,AGA013,AEW014
J		k.	Component environments during in-plant transportation or storage	BAA021,BAA022,BAA024,BAA030
5. For New Primer, Adhesive - Silane verify:				
D,E,G,H,I		a.	Workmanship	ANY013
D,E,G,H,I		b.	Color	POG001
I	(T)	c.	Infrared identification	ANY022
I	(T)	d.	Bond strength and durability	ANY000
I	(T)	e.	Acidity	ANY001
F,K		f.	Adhesive primer is properly mixed	AET002
6. For New Adhesive Primer, verify:				
L	(T)	a.	Solids content	AMR059,AMR067
L	(T)	b.	Density	AMR006,AMR012
L	(T)	c.	Viscosity	AMR083,AMR092
L	(T)	d.	Peel adhesion	AMR026,AMR022
L		e.	Workmanship	AMR041
7. For New Adhesive, Rubber-to-Metal verify:				
L	(T)	a.	Solids content	AND028,AND026
L	(T)	b.	Specific gravity	AND033,AND036
L	(T)	c.	Viscosity	AND046,AND044
L	(T)	d.	Peel strength, rubber-to-steel	AND014,AND009
L		e.	Workmanship	FAA842
8. For New Epoxy Resin Adhesive, Non-Asbestos verify:				
I	(T)	a.	Filler content (Part A)	AMD009,AMD013
I	(T)	b.	Epoxide content (Part A)	AMD002,AMD006
I	(T)	c.	Titrateable nitrogen (Part B)	AMD035,AMD039
I		d.	Certificate of Conformance	FAA014
D,E,G,H,I		e.	Workmanship	AMD015
I	(T)	f.	Working life	AMD043
I	(T)	g.	Tensile adhesion steel-to-steel	AMD031
9. For Retest Epoxy Resin Adhesive, Non-Asbestos, verify:				
I	(T)	a.	Tensile adhesion steel-to-steel	AMD033