CRITICAL ITEMS LIST (CIL)

No. 10-04-01-01R/01

SYSTEM:	Space Shuttle RSRM 10	CRITICALITY CATEGORY:	1R
SUBSYSTEM:	Lightning Protection, ESD, and Instrumentation 10-04	PART NAME:	Grounding Strip, Systems Tunnel (2)
ASSEMBLY:	Lightning and ESD Protection 10-04-01	PART NO.:	(See Section 6.0)
FMEA ITEM NO.:	10-04-01-01R Rev M	PHASE(S):	Prelaunch, Boost (PL, BT)
CIL REV NO.:	M	QUANTITY:	(See Section 6.0)
DATE:	31 Jul 2000	EFFECTIVITY:	(See Table 101-6)
SUPERSEDES PAGE:	505-1ff.	HAZARD REF.:	BC-11
DATED:	30 Jul 1999		
CIL ANALYST:	D. F. Bartelt		
APPROVED BY:		DATE:	

RELIABILITY ENGINEERING: K. G. Sanofsky 31 Jul 2000

ENGINEERING: S. R. Graves 31 Jul 2000

1.0 FAILURE CONDITION: Failure during operation (D)

2.0 FAILURE MODE: 2.0 Failure to provide grounding for a lightning strike or for a case static charge buildup

3.0 FAILURE EFFECT: Failure of the Systems Tunnel Grounding System to dissipate a lightning strike or Electro Static Discharge (ESD) could cause premature severance of the nozzle exit cone, premature ignition, and separation of the RSRM causing loss of RSRM, SRB, crew, and vehicle

4.0 FAILURE CAUSES (FC):

FC NO.	DESCRIPTION	FAILURE CAUSE KEY
2.1	Open circuit due to:	
2.1.1	Bondline failure of grounding strip due to:	
2.1.1.1	Improperly installed due to contamination, improper mixing, cure, pot life, quantity, surface preparation, or shelf life	A
2.1.1.2	Nonconforming adhesive properties	B
2.1.2	Broken or damaged grounding strip	C

5.0 REDUNDANCY SCREENS:

SCREEN A: Pass--Testing and inspection provide verification of the grounding system integrity.
SCREEN B: Fail--No provision is made for failure detection by the crew.
SCREEN C: Fail--Contamination of the electrically-conductive adhesive could result in a grounding failure.

6.0 ITEM DESCRIPTION:

1. The systems tunnel grounding strip provides a grounding path for Systems Tunnel to case segments; 23 grounding strips are required per RSRM (See Figures 1 and 2). Materials are listed in Table 1.

TABLE 1. MATERIALS

Drawing No.	Name	Material	Specification	Quantity
10182-0391-001	Grounding strip	Aluminum Alloy 1100-0	QQ-A-250/1	23 ea/Motor
1U77610	Segment, Rocket Motor, Forward	Composite of Components		1 ea/Motor
1U77620	Segment, Rocket Motor, Fwd Center	Composite of Components		1 ea/Motor
1U77630	Segment, Rocket Motor, Aft Center	Composite of Components		1 ea/Motor
	Conductive Adhesive	Org Resin with Conductive Filler and a Curing Agent	STW4-2874	A/R/Motor
1U77640	Segment, Rocket Motor, Aft			1/motor

6.1 CHARACTERISTICS:

1. Grounding strips provide grounding of the systems tunnel to the case segments. The strips provide electrical dissipation of voltage from a lightning strike down the case to the nozzle area for exit to the Mobile Launch Platform ground system during prelaunch, or to the plume (which acts as part of the grounding medium) during boost (Figures 1 and 2).

2. Lightning Environment is per NASA specification NSTS 07636. Currents in a lightning flash are separated into three categories: (a) Return stroke surges, (b) Intermediate currents, and (c) Continuing currents. Return stroke currents mainly produce explosive effects and indirect effects. Intermediate and Continuing currents are primarily responsible for damage such as hole burning. These three categories are represented by idealized waveforms described in NSTS 07636.

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

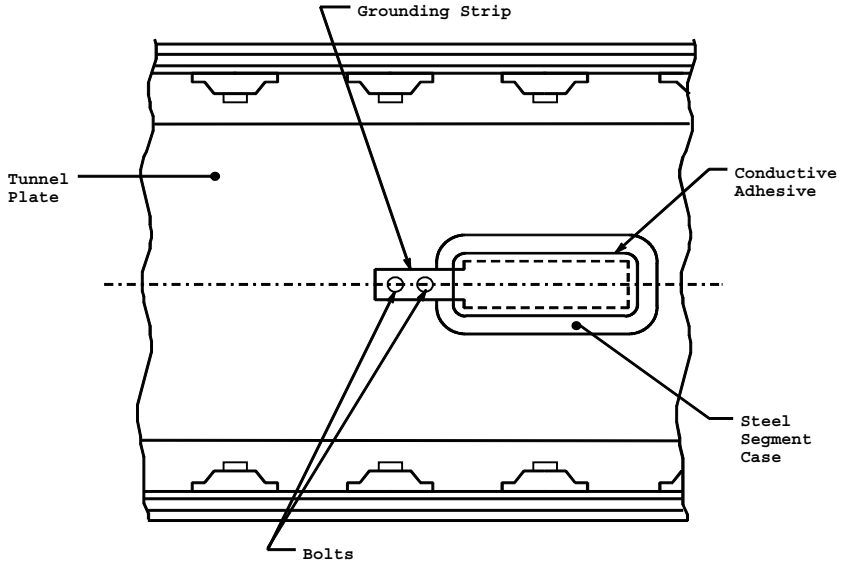

Figure 1. Grounding Strip

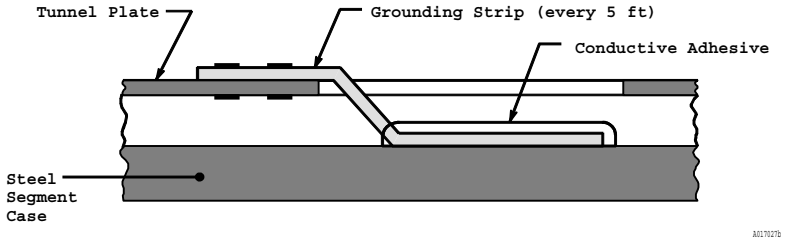

Figure 2. Grounding Strip Section

9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN	FAILURE CAUSES	
A	1.	Conductive adhesive has an extremely low electrical resistance bond when cured per engineering.
A	2.	Conductive adhesive tensile shear strength when cured is per engineering.
A	3.	A minimum amount of grounding strip is bonded to the steel case segment using conductive adhesive.
A	4.	Mating surfaces of the grounding strip and steel case segment are cleaned to bare metal per engineering.
A	5.	Adhesive cure time and temperature are per engineering.
A	6.	Mixed adhesive is uniform in appearance and free from visible contamination per engineering.
A,B	7.	The mix ratio of the components of the conductive adhesive is per engineering.
A	8.	Storage life of conductive adhesive is per engineering.
A,B	9.	Conductive adhesive physical and electrical properties are per engineering.
A	10.	The design requirement for electrical bonding is to verify the grounding strips connected to the systems tunnel floor plates are bonded to the RSRM Case and the electrical bond-resistance test is acceptable.
C	11.	The material, aluminum 1100-0, was selected for its malleable quality and ability to withstand high vibration, shock, and fatigue.

9.2 TEST AND INSPECTION:

DCN	FAILURE CAUSES and TESTS	(T)			CIL CODE
			1.	For New Segment, Rocket Motor (Forward, Forward Center, Aft Center, and Aft), verify:	
	A		a.	Ground strap and case bonding surfaces are cleaned	AET004,AEU004,AGA004,AEW004
	A		b.	Conductive adhesive for ground strap bonding did not exceed shelf life prior to use	AET006,AEU006,AEW006,AGA006
	A,B		c.	Cure of conductive adhesive for ground strap bonding	AET009,AEU009,AEW009,AGA009
	A,B,C	(T)	d.	Electrical bond resistance of each ground strap	AET010,AEU010,AEW010,AGA010
	C		e.	Grounding straps, for breaks and damage after installation	AEU020,AGA020,AET021,AEW021
	A		f.	Required amount of grounding straps are bonded to the case segment	AEU021,AGA021,AET022,AEW022
	A		g.	Weigh up and mixing of conductive adhesive for ground strap bonding	ALW032,ALW032A,ALW032B,ALW032C
			2.	For New Adhesive, Electrically-Conductive verify:	
	B	(T)	a.	Base resin density	ALW005,ALW006
	B	(T)	b.	Consistency	ALW010,ALW011
	B	(T)	c.	Cured material density	ALW016,ALW017
	A,B	(T)	d.	Tensile shear strength	ALW024,ALW025
	B	(T)	e.	Volume resistivity	ALW029,ALW030
	B		f.	Workmanship is uniform in appearance and free from visible contamination	ALW027
	B	(T)	g.	Work life	ALW034,ALW035
			3.	For Retest Adhesive, Electrically-Conductive verify:	
	B	(T)	a.	Base resin density	ALW004
	B	(T)	b.	Tensile shear strength	ALW023
			4.	For New Ground Strip, Systems Tunnel verify:	
	C		a.	No shipping or handling damage	AAA000
			5.	KSC verifies:	
	A,B,C	(T)	a.	Systems tunnel floor plate-to-case segment grounding strap is bonded in place on each motor prior to stacking per OMRSD, File V, Vol I, B47SG0.560	OMD113