ATK ALLIANT TECHSYSTEMS
THIOKOL PROPULSION

CRITICAL ITEMS LIST (CIL)

No. 10-04-01-03/01

SYSTEM:	Space Shuttle RSRM 10	CRITICALITY CATEGORY:	1R
SUBSYSTEM:	Lightning Protection, ESD, and Instrumentation 10-04	PART NAME:	Nozzle Grounding Strap (2)
		PART NO.:	(See Section 6.0)
ASSEMBLY:	Lightning and ESD Protection 10-04-01	PHASE(S):	Boost (BT)
FMEA ITEM NO.:	10-04-01-03 Rev N	QUANTITY:	(See Section 6.0)
CIL REV NO.:	N	EFFECTIVITY:	(See Table 101-6)
DATE:	27 Jul 2001	HAZARD REF.:	BC-01, BC-02, BC-11, BN-01
SUPERSEDES PAGE:	506-1ff.		
DATED:	31 Jul 2000		
CIL ANALYST:	D. F. Bartelt		
APPROVED BY:		DATE:	

RELIABILITY ENGINEERING: K. G. Sanofsky 27 Jul 2001

ENGINEERING: V. B. Teller 27 Jul 2001

1.0 FAILURE CONDITIONS: Failure during operation (D)

2.0 FAILURE MODE: 2.0 Failure to provide required grounding

3.0 FAILURE EFFECT: Failure of the nozzle grounding system could cause a current arc due to lightning or ESD of sufficient magnitude to cause premature nozzle NSD ignition and/or nozzle damage leading to thrust imbalance 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	Defective crimping	A
2.1.2	Contaminated grounding surface	B
2.1.3	Loose terminal cap screws due to foreign material in screw hole, screws bottoming in hole, improper application of locking sealant	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: Pass--Twelve straps are individually bolted to the nozzle, making a single failure cause noncredible.

6.0 ITEM DESCRIPTION:

1. The Nozzle Grounding Strap provides grounding path for lightning and ESD (See Figure 1). Materials are listed in Table 1.

Table 1. MATERIALS

Drawing No.	Name	Material	Specification	Quantity
1U51058	Nozzle Grounding Strap	Rope Lay Tinned Copper cable		12 ea/Motor
1U76065	Nozzle Exit Cone Screw	Stainless Steel		12 ea/Motor
1U75756	Fixed Housing Screw	Alloy Steel, Cad Plate	STW3-1553	12 ea/Motor
1U52837	Nozzle Exit Cone Housing	D6AC Steel	STW4-2709	1 ea/Motor
1U77640	Segment, Rocket Motor, Aft			1 ea/motor
1U52945	Nozzle Fixed Housing	D6AC Steel	STW4-2709	1 ea/Motor
	Set Screw	AMS 5737 Steel	A-286	36 ea/Motor
1U76034	Bolt, Case/Nozzle	Inconel 718	AMS-5662	100 ea/Motor
	Exit Cone Liner	Carbon-Cloth Phenolic	STW5-3279	A/R/Motor
	Insulation	Glass-Cloth Phenolic	STW5-2651	A/R/Motor
	Conductive Adhesive	Organic Resin Having A Conductive Filler and Curing Agent	STW4-2874	A/R/Motor
	Sealant, Polysulfide	Synthetic Rubber, Polysulfide	STW5-9072	A/R/Motor

6.1 CHARACTERISTICS:

1. The nozzle grounding system provides a grounding path from the aft dome segment through 100 bolts, metal-to-metal contact to the fixed housing through 12 grounding straps, and to the nozzle exit cone through 12 screws to the carbon phenolic exit cone liner. In addition, 36 set screws used as shear pins, provide grounding contact from the nozzle exit cone to the carbon phenolic exit cone liner. Conductive adhesive is applied to 36 set screws and 12 cap screws to meet the resistance requirement.

2. Ground Strap: No. 6 (0.214 diameter) (12 straps required per RSRM)

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

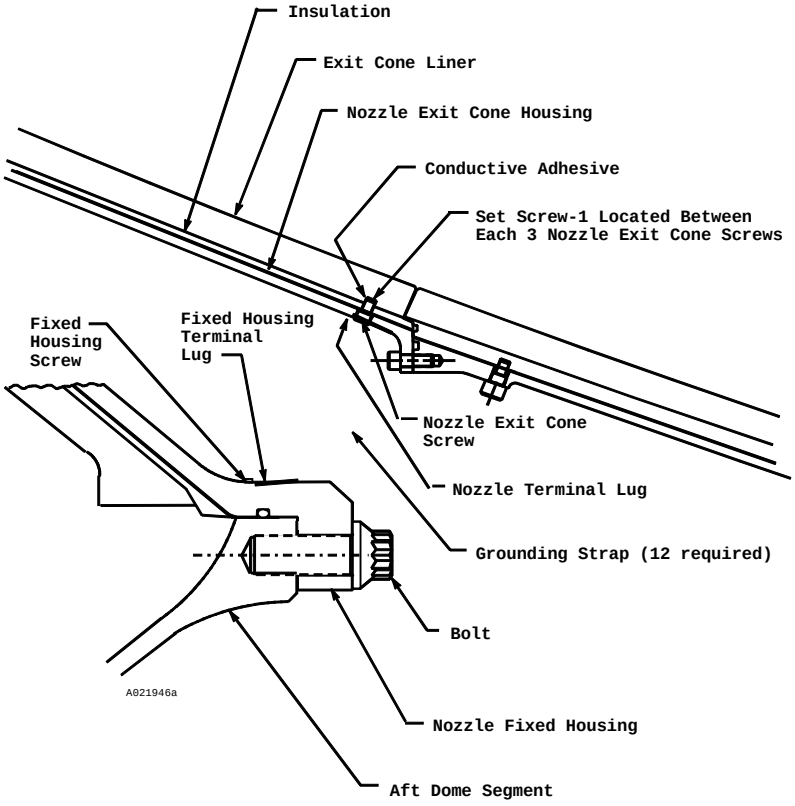

Figure 1. Nozzle Grounding Strap

9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN		FAILURE CAUSES
A	1.	Crimping is per engineering.
B	2.	Fastener heads and adjacent surfaces are cleaned prior to installation and application of polysulfide sealant.
C	3.	Conductive adhesive is applied to the aft holes of the forward exit cone prior to installation of the vented cap screw on the nozzle forward exit cone assembly.
C	4.	Nozzle exit cone screws and fixed housing screws are torqued per engineering and shop planning.
C	5.	Polysulfide sealant is applied around fastener heads during aft segment assembly.
C	6.	Tapped holes are inspected to verify no adhesive buildup. Threads may be cleaned with a flat-bottom tap per shop planning.
C	7.	Conductive adhesive is applied to all 36 set screws and 12 vented capscrews per engineering drawings.
C	8.	Design requirements for bond resistance measurements are per engineering drawings.

9.2 TEST AND INSPECTION:

DCN	FAILURE CAUSES and TESTS (T)				CIL CODE
			1.	For New Cable, Lightning Bypass verify:	
	A		a.	Certificate of Conformance for crimping per MIL specification	ABS000
			2.	For New Segment Assembly, Rocket Motor, verify:	
	A,B,C	(T)	a.	Direct current resistance between cable grommet and forward exit cone housing	RAA042
	A,B,C	(T)	b.	Direct current resistance between cable grommet and fixed housing	RAA043
	B		c.	Cleanliness of electrical grounding surfaces during assembly	ADR052B
	A,B,C	(T)	d.	Grounding bond resistance for each grounding strap	ADR090
	C		e.	Cleanliness of threaded holes in fixed housing	ADR260
	C		f.	Torque of nozzle fixed housing screws	ADR270
	C		g.	Sealant is applied around bolt heads	AGJ215
			3.	For New Exit Cone Assembly, Forward Section verify:	
	C		a.	Cap screw installed with adhesive	ADI037
	B		b.	Cleanliness of electrical grounding surfaces during assembly	ADR052
	B		c.	Cleanliness of threads of holes for mounting cap screw fasteners during assembly	ADR053
569	C		d.	Adhesive (Conductive Adhesive) for cap screw holes is mixed per planning requirements	ADR132
	C		e.	Cap screws are properly torqued	ADI191
	C		f.	Conductive adhesive is acceptable	ALW001