ATK ALLIANT TECHSYSTEMS
THIOKOL PROPULSION

CRITICAL ITEMS LIST (CIL)

No. 10-03-03-02/01

SYSTEM:	Space Shuttle RSRM 10	CRITICALITY CATEGORY:	1
SUBSYSTEM:	Ignition Subsystem 10-03	PART NAME:	Initiator Insulation (1)
ASSEMBLY:	Igniter Assembly	PART NO.:	(See Table A-3)
FMEA ITEM NO.:	10-03-03-02 Rev N	PHASE(S):	Boost (BT)
CIL REV NO.:	N	QUANTITY:	(See Table A-3)
DATE:	5 Aug 2002	EFFECTIVITY:	(See Table 101-6)
SUPERSEDES PAGE:	422-1ff.	HAZARD REF.:	BI-05
DATED:	27 Jul 2001		
CIL ANALYST:	S. E. Rodgers		
APPROVED BY:		DATE:	

RELIABILITY ENGINEERING: K. G. Sanofsky 5 Aug 2002

ENGINEERING: L. D. Allred 5 Aug 2002

1.0 FAILURE CONDITION: Failure during operation (D)

2.0 FAILURE MODES: 1.0 Fails to provide thermal protection

3.0 FAILURE EFFECT: Insulation failure would expose the Initiator Chamber to operating temperatures causing breakup of Initiator Chamber. Exiting metal components would damage the nozzle, and/or the igniter insert causing loss of RSRM, SRB, crew, and vehicle

4.0 FAILURE CAUSES (FC):

FC NO.	DESCRIPTION	FAILURE CAUSE KEY
1.1	Nonconforming insulation or adhesive materials	A
1.2	Improper cure	B
1.3	Bondline failure of Insulation-to-Chamber	
1.3.1	Contamination of bonding material or bond surface	C
1.3.2	Nonconforming material application or insulation layup	D
1.3.3	Improper surface preparation	E
1.4	Improper insulation layup thickness	F
1.5	Storage degradation (insulation/adhesive)	G

5.0 REDUNDANCY SCREENS:

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

6.0 ITEM DESCRIPTION: Initiator insulation (provides thermal protection) (Figure 1). Materials are listed in Table 1.

TABLE 1. MATERIALS

Drawing No.	Name	Material	Specification	Quantity
1U77610	Segment, Rocket Motor, Forward	Composite of Various Components		1/motor
1U77499	Igniter Assembly	Composite of Various Components		1/motor
1U77858	Chamber Assembly, Igniter Initiator-Loaded	Composite of Various Components		1/motor
1U50154	Chamber, Igniter Initiator	4130 Steel	MIL-S-6758	1/motor
1U50046	Insulation, Initiator	Acrylonitrile Butadiene	STW4-2621	1/motor
			STW4-2621 TP I	(ALTERNATE)
	Pre-molded-External Insulation	Rubber (NBR), Asbestos and Silicon Dioxided-Filled Acrylonitrile Butadiene	STW4-2621	A/R
		Rubber (NBR), Asbestos and Silicon Dioxide-Filled	STW4-2621 TP I	(ALTERNATE)
	Sealant	Liquid Epoxy Resin, Asbestos Float-Filled	STW5-2678	A/R
	Floats	Pulp, Asbestos	STW4-2636	A/R
	Curing Agent	Polyamide Liquid Resin	STW4-2680	A/R
	Silicon Dioxide	Microfine Silicon Dioxide	STW4-2679	A/R
	Epoxy Resin	Liquid Epoxy Resin	STW4-2601	A/R
	Film, Polyethylene	Film, Polyethylene, Corrosion Inhibitor Treated	STW5-3610	A/R
	Adhesive Primer, Rubber-to-Metal Bonding Agent	Chlorinated Rubber-to-Metal Adhesive Primer	STW5-2664	A/R
	Rubber-to-Metal (Chemlok 233)	Bonding Agent, Rubber-to-Metal	STW5-2712	A/R

6.1 CHARACTERISTICS:

1. The function of the insulation used on the Initiator is to protect the Initiator Chamber during initiator and igniter firing and from motor temperature both during RSRM firing and subsequent heat soak during descent and recovery.

2. Acrylonitrile butadiene rubber (NBR), that is asbestos and silicon dioxide filled, is the primary material used to make up insulation used on and in the Initiator Chamber.

3. External insulation is a pre-molded piece that is bonded on external surfaces of the Initiator Chamber. Internal insulation is made from a one-ply strip of 0.050-inch thick cured insulation stock bonded to the internal surface.

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

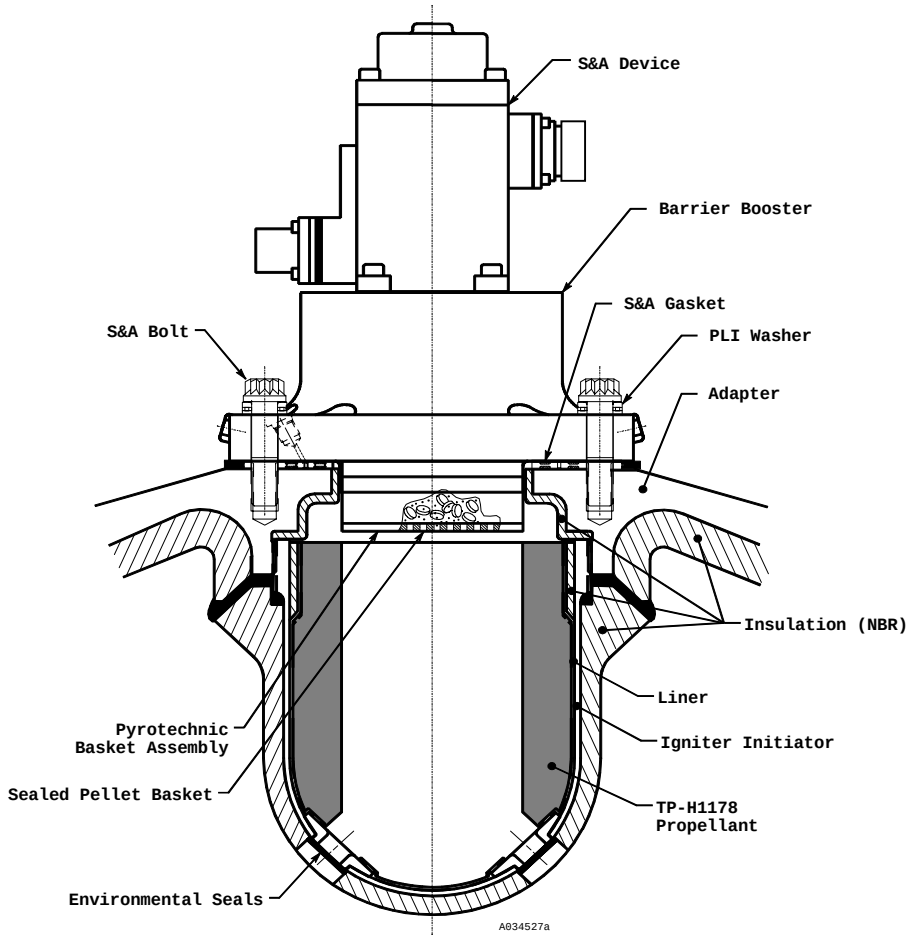

Figure 1. Loaded Igniter Initiator

9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN	FAILURE CAUSES	
A,B,F	1.	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. Using correct NBR thickness, there is a positive margin of safety for erosion based on a safety factor of 1.5 per TWR-12969.
A,C,D,E	2.	Sealant, as specified on the initiator drawing, is an asbestos float filled, liquid epoxy resin sealant containing a polyamide curing agent and a thixotropic agent per engineering.
A	3.	Sealant raw material specifications are per engineering for the following materials: a. Asbestos float b. Liquid epoxy resin c. Polyamide curing agent d. Microfine silicon dioxide
A	4.	Sealant preparation is per shop planning.
A	5.	Acceptability of the combination of raw material lots used to manufacture sealant is demonstrated by the raw material lot combination test per engineering.
A,C,D,E	6.	Sealant pot life is per shop planning.
A	7.	Specific criteria for nonmetallic material properties are per TWR-17039.
A,F	8.	NBR insulation was qualified and tested using static test igniters. A complete study of the insulation used on the ignition system is described in TWR-63419.
B	9.	Internal insulation is made from a one-ply strip of 0.050-inch thick cured insulation stock cut from a sheet of NBR per engineering drawings.
B	10.	Initiator insulation cure requirements (time, temperature, and pressure) are per shop planning.
B	11.	External insulation is pre-molded and cured per engineering drawings prior to bonding to the initiator chamber.
C,D,E	12.	Igniter Initiator Chamber insulation is bonded per engineering drawings and shop planning. Sealant is applied during this assembly process.
C,D,E	13.	NBR insulation storage, handling, and layup are per engineering and shop planning.
C,D,E	14.	Approved solvent is used to clean the NBR and metal bonding surfaces prior to insulation installation. Solvent is allowed to completely evaporate before the NBR is used per shop planning.
C,D,E	15.	The Initiator Chamber is grit blasted and degreased per shop planning.
C,D,E	16.	Steps related to contamination control for surface preparation, primer and adhesive application, and NBR installation are per shop planning.

C,D,E

17. Preparation of bonding surfaces and their cleanliness is per the following:

    a. Bonding surface preparation for the NBR and liner is per engineering drawings.
    b. Contamination control requirements and procedures are described in TWR-16564.

C,D,E

18. Structural analyses determined that the Initiator Chamber-to-Insulation bondline demonstrates a positive margin of safety based on a safety factor of 2.0 per TWR-17195.

F

19. Thickness of internal insulation is defined by engineering drawings. Cured NBR is dry-fit to the Initiator Chamber to assure proper layup per shop planning.

A,F

20. Static test motors demonstrated that NBR insulation remained strongly bonded to the igniter Initiator Chamber and that erosion was within acceptable limits. A series of igniters and RSRM static test motors qualify the insulated igniter adapter per TWR-18764-03.

F

21. Internal insulation thickness is per engineering drawings.

G

22. The RSRM igniter, including igniter initiator insulation, is required to have a 5 year storage life after KSC acceptance. A 64-month old igniter was fired in DM-6, performing satisfactorily in all aspects. It was concluded that an igniter aged up to 64 months would have no detectable performance change from aging per TWR-13003. This igniter demonstrates 5 year life requirements for igniters.

G

23. Unvulcanized insulation material storage life and temperature limits prior to lay up are per engineering. Storage life may be extended if, after retest, the material is per engineering.

G

24. Initiator adhesive is made up of the following raw materials, each having a specified storage life:

    a. Asbestos floats
    b. Liquid epoxy resin
    c. Polyamide liquid curing agent
    d. Silicon dioxide

G

25. Storage life of liquid epoxy resin and asbestos floats may be extended after retest per engineering.

G

26. The initiator is protected from aging. Inserts are installed in the port at the aft end of the initiator and a protective cover is placed over the Safety and Arming device opening. Also, the igniter chamber has a nozzle environmental seal over its aft end.

G

27. 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 per engineering.

G

28. 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.

	G	29. 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.
	G	30. The Flight Igniter is included in the RSRM Forward Segment life verification.
	E	31. A Spray-in-Air cleaning system is used to clean metal components as part of the bonding surface preparation processing sequence.
	A,B,C,D,E,F	32. As a result of the RSRM Performance Enhancement (PE) Program, load factors for ignition system PLI (Propellant, Liner, and Insulation) components were updated. Structural responses to both the original and PE loads cases were analytically compared. For all conditions, there were insignificant changes in induced stresses and therefore none of the ignition system PLI structural safety factors were changed as a result of the RSRM PE program per TWR-73983.
600	A,C,D,E	33. Insulation anomalies are process-finalized in accordance with engineering. Process finalization procedures and criteria are substantiated by design engineering per TR12961.

9.2 TEST AND INSPECTION:

DCN	FAILURE CAUSES and TESTS	(T)			CIL CODE
			1.	For New NBR verify:	
A,G		(T)	a.	Elongation (calendered only)	ALH010,ALH062,ALH065
A,G		(T)	b.	Shore A hardness (calendered only)	ALH098,ALH102,ALH109
A,G		(T)	c.	Mooney viscosity (extrusions only)	ALH041,ALH046,ALH170
A,G		(T)	d.	Scorch characteristics (extrusions only)	ALH081,ALH086,ALH171
A,G		(T)	e.	Specific gravity (calendered only)	ALH118,ALH121,ALH126
A,G		(T)	f.	Tensile strength (calendered only)	ALH147,ALH149,ALH154
A,G			g.	Material workmanship including uniform appearance and free from contamination	ALH168
			2.	For Re-test NBR, verify:	
A,G		(T)	a.	Mooney viscosity	ALH049
A,G		(T)	b.	Scorch characteristics	ALH087
			3.	For New Liquid Epoxy Resin verify:	
A		(T)	a.	Hydrolyzable chlorine percent	ALD009,ALD006
A		(T)	b.	Infrared spectrum	ALD030
A		(T)	c.	Moisture percent	ALD038,ALD035
A		(T)	d.	Specific gravity	ALD063,ALD061
A		(T)	e.	Viscosity	ALD085,ALD082
A		(T)	f.	Weight per epoxy	ALD101,ALD098
			4.	For Retest Liquid Epoxy Resin verify:	
A		(T)	a.	Moisture	ALD989
A		(T)	b.	Hydrolyzable chlorine percent	ALD011
A		(T)	c.	Viscosity	ALD083
A		(T)	d.	Weight per epoxy	ALD103
			5.	For New Curing Agent, Polyamide Liquid Resin, verify:	
A		(T)	a.	Amine value	ALQ001,AMQ006
A		(T)	b.	Ash content	AMQ015
A		(T)	c.	Color	ALQ026,AMQ028
A		(T)	d.	Specific gravity	AMQ033
A		(T)	e.	Viscosity	ALQ049,AMQ050
			6.	For New Floats, Asbestos verify:	
A		(T)	a.	Calcination loss	ALI002
A		(T)	b.	Fiber size distribution	ALI011
A		(T)	c.	pH (aqueous extract)	ALI023
A		(T)	d.	Volatile matter	ALI051
A		(T)	e.	Wet volume	ALI053
			7.	For Re-test Floats, Asbestos, verify:	
G		(T)	a.	Volatile matter for storage life extension	ALI051A
			8.	For New Silicon Dioxide, verify:	

A	(T)	a.	Bulk density	ALP002,ALP008
A	(T)	b.	Loss on ignition	ALP040
A	(T)	c.	Moisture	ALP058,ALP064
A	(T)	d.	pH ALP097,ALP101	

9. For New Sealant, Liquid Epoxy Resin, Asbestos Float Filled verify:

A	(T)	a.	Tensile adhesion for each raw material lot combination evaluation	AMU013
A		b.	Shelf life of sealant components at time of production mix	AMU004
A		c.	Raw material weights are correct in accordance with the production planning requirements	AMU015

10. For New Chamber Assembly, Igniter Initiator-Loaded verify:

G	a.	Component temperatures and exposure to ambient environments during in-plant transportation or storage are per the in-plant exposure limit and transportation specification	BAA012
G	b.	Sealant is acceptable and within pot life per planning requirements	AMU017
F	c.	Thickness of internal insulation prior to bonding	AAM020
F	d.	Dry-fit of insulation to Initiator Chamber	AAM021
C,D,E	e.	Internal and external insulation conforms to the process finalization specification	AAM039
A	f.	Pot life between liner mixing and application not exceeded	AOA044
F	g.	External insulation meets drawing dimensional requirements after bonding	AAM058
C,D,E	h.	Proper sealant application for internal and external insulation	AAM067
C,D,E	i.	Bonding surface preparation for the chamber and internal and external insulation are complete and acceptable per shop planning	AAM072
A	j.	Shore A hardness tests of sealant	AAM077
C,D,E	k.	External insulation is buffed prior to dry fit	ALH164B

11. For New Insulation, Initiator, Pre-molded-External verify:

B	a.	VIP is complete and acceptable	AAD003
B	b.	Insulation cure is complete and acceptable	AAD004
F	c.	Thickness of insulation	AAD005

12. For New Film, Polyethylene verify:

C,D,E	a.	No visible contamination	AAM039A
C,D,E	b.	Uniform in appearance	AAM039B

13. For New Igniter Assembly verify:

G	a.	Component temperatures and exposure to ambient environments during in-plant transportation or storage are controlled in accordance with the temperature exposure limit specification	BAA015
C,D,E	b.	General condition and freedom from contamination of initiator prior to installation	AAM097

14. For New Segment, Rocket Motor, Forward, verify:

G	a.	Component environments during in-plant transportation or storage	BAA021

15. KSC verifies:

G	a.	Life requirements for the expected launch schedule are met per OMRSD, File II, Vol III, C00CA0.030	OMD019