ATK ALLIANT TECHSYSTEMS
THIOKOL PROPULSION

CRITICAL ITEMS LIST (CIL)

No. 10-03-04-04R/01

SYSTEM:	Space Shuttle RSRM 10	CRITICALITY CATEGORY:	1
SUBSYSTEM:	Ignition Subsystem 10-03	PART NAME:	Redesigned Igniter Insulation
ASSEMBLY:	Igniter Assembly 10-03-04	PART NO.:	(See Table A-3)
FMEA ITEM NO.:	10-03-04-04R Rev M	PHASE(S):	Boost (BT)
CIL REV NO.:	M	QUANTITY:	(See Table A-3)
DATE:	5 Aug 2002	EFFECTIVITY:	(See Table 101-6)
SUPERSEDES PAGE:	431-1ff.	HAZARD REF.:	BI-05
DATED:	31 Jul 2000		
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 MODE: 1.0 Fails to provide Igniter Chamber thermal protection

3.0 FAILURE EFFECTS: Insulation failure would expose the Igniter Chamber to operating temperatures, causing failure of Igniter Adapter seals or structural failure of Igniter Chamber resulting in 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 materials or bond surface	C
1.3.2	Nonconforming bond materials application or insulation lay up	D
1.3.3	Improper surface preparation	E
1.4	Improper insulation thickness	F
1.5	Storage degradation	G
1.6	Ply separations, voids, or inclusions	H

5.0 REDUNDANCY SCREENS:

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

6.0 ITEM DESCRIPTION:

1. Igniter Chamber Insulation (See Figure 1). This CIL analyzes internal and external insulation of the Igniter Chamber. CILs 10-03-04-26R/01 and 10-05-03-08R/01 analyze the J-joints. 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
1U77371	Chamber Assembly, Igniter, Insulated	Composite of Various Components		1/motor
	Insulation	Acrylonitrile Butadiene Rubber (NBR), Asbestos and Silicon Dioxide-Filled	STW4-2621	A/R
			STW4-2621 TP I	(ALTERNATE)
	Adhesive Primer, Rubber-to-Metal	Chlorinated Rubber-to-Metal Adhesive Primer	STW5-2664	A/R
	Bonding Agent, Rubber-to-Metal	Bonding Agent, Rubber-to-Metal (Chemlok 233)	STW5-2712	A/R

6.1 CHARACTERISTICS:

1. The ignition system pressure vessel consists of a main Igniter Chamber bolted to an Igniter Adapter. The Chamber is insulated both internally and externally with asbestos and silicon dioxide filled acrylonitrile butadiene rubber (NBR) to protect it during igniter firing and from temperature both during SRM firing and subsequent heat soak during descent and recovery.

2. The Igniter Chamber is coated with adhesive materials (Chemlok bonding agent and adhesive primer) and allowed to dry, after which plies of NBR are laid-up on internal and external surfaces of the chamber. A vacuum bag is placed on the inside and outside of the insulated chamber and then the chamber is placed in an autoclave for curing the NBR.

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

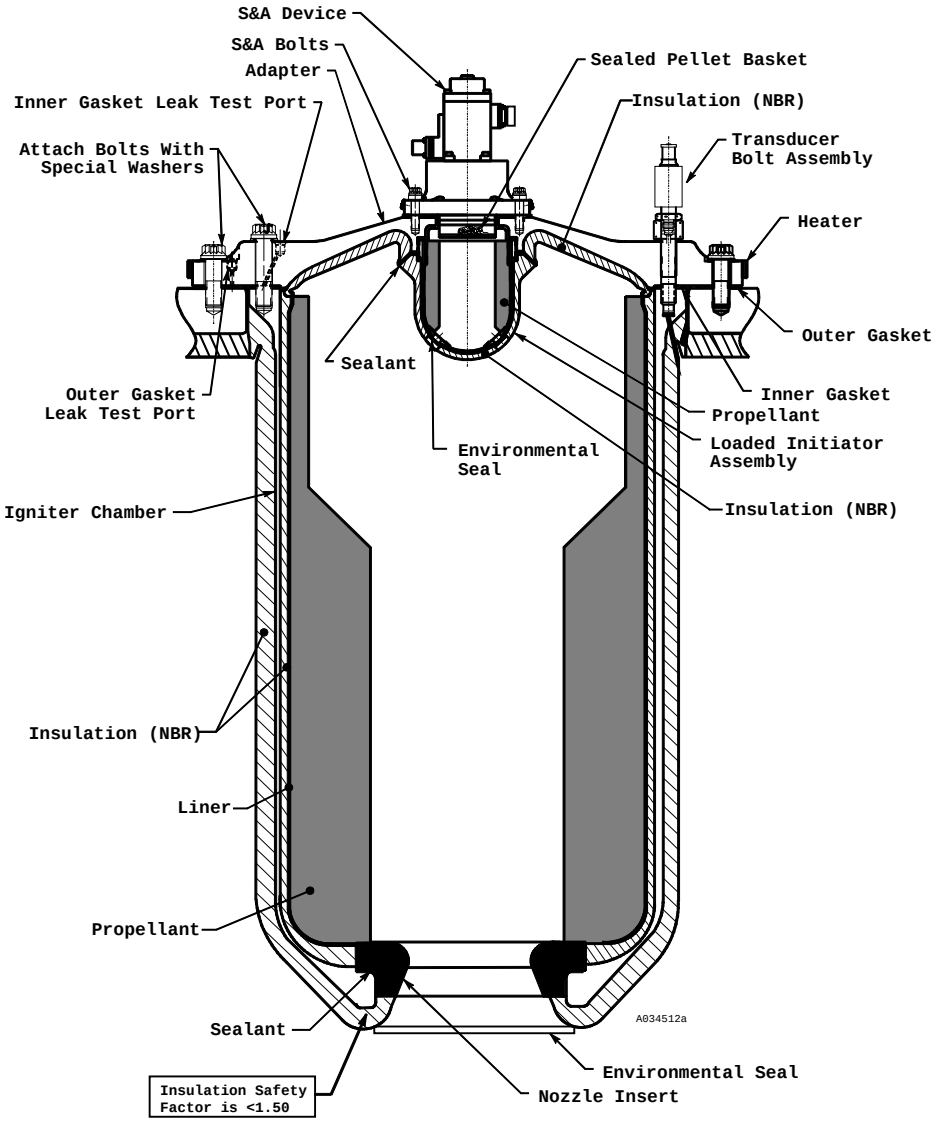

Figure 1. RSRM Ignition System

9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN	FAILURE CAUSES	
A,B,H	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.
A	2.	Structural analyses determined that the Igniter-to-Insulation bondline demonstrates a positive margin of safety based on a safety factor of 2.0 per TWR-17195.
A	3.	Insulation adhesive primer and bonding agent material properties are qualified per engineering.
A	4.	Criteria for nonmetallic material properties are per TWR-17039.
A,F	5.	Static test motors demonstrated that NBR insulation remained strongly bonded to the Igniter Chamber and that erosion was within acceptable limits. A series of igniters and RSRM static test motors qualified the insulated igniter per TWR-18764-03.
A,F	6.	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	7.	After insulation lay up, a vacuum bag is installed over the insulation and Igniter Chamber. The insulation and Igniter Chamber are then positioned in an autoclave and cured per shop planning. The process is described in TWR-10341.
B	8.	Insulation cure requirements (time, temperature, and pressure) are per shop planning.
C,D,E	9.	Adhesive primers and bonding agents are mixed and applied to metal surfaces for corrosion protection and insulation bonding per engineering and shop planning.
C,D,E	10.	NBR insulation storage, handling, and lay up are per engineering and shop planning.
C,D,E,H	11.	Methyl Ethyl Ketone (MEK) is used to clean and activate the NBR surface prior to insulation lay up. MEK is allowed to completely evaporate before the NBR is used per shop planning.
C,D,E	12.	The chamber is grit blasted and degreased per shop planning.
C,D,E	13.	Degreasing contamination controls are per engineering.
C,D,E	14.	Preparation of bonding surfaces and their cleanliness are per engineering as follows: a. Bonding surface preparation for the chamber and NBR is per engineering drawings. b. Blacklight and CONSCAN are used to verify chamber surface preparation and cleanliness prior to insulation bonding. c. Contamination control requirements and procedures are described in TWR-16564.
C,D,E	15.	Structural analyses determined that the Igniter Chamber-to-Insulation bondline demonstrates a positive margin of safety based on a safety factor of 2.0 per TWR-17195.
F	16.	Thickness of Igniter Chamber Insulation is per engineering drawings.

	F	17. Insulation thickness provides a positive margin of safety for erosion based on a safety factor of 1.5 per TWR-12969 and TWR-16742. The area aft of the nozzle insert is not required to meet the 1.5 safety factor per TWR-16742.
	F	18. After curing, the insulated chamber is assembled into a fixture on a lathe and machined to proper thickness per engineering drawings.
	F	19. Inner diameter insulation thickness of the Igniter Chamber is controlled by shop planning and manufacturing processes.
	G	20. The RSRM igniter is required to have a 5-year storage life after KSC acceptance. A 64-month-old igniter was fired in Development Motor DM-6 performing satisfactorily in all aspects. It was concluded that an igniter aged up to 64 months would have no detectable performance change due to aging per TWR-13003. This igniter demonstrated the 5-year life requirement for igniters.
	G	21. Storage and retest requirements for adhesive primers and bonding agents are per engineering.
	G	22. 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.
	G	23. The Insulated Chamber is placed in a storage container per shop planning.
	G	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 ambient environments during in-plant transportation or storage are per engineering.
	G	25. Accelerated aging tests performed on the igniter PLI bond system per TWR-16106 indicate that the 90 degree peel strength of the PLI bond decreases with time, high temperature, and high humidity storage during liner cure in the test specimen. After liner cure, 90 degree peel strength stabilizes. Tensile adhesion strength of the PLI bond remains constant with time, high temperature, and high humidity storage. Accelerated aging tests indicated no degradation to the igniter PLI bond.
	G	26. The Flight Igniter is included in the RSRM Forward Segment life verification.
	H	27. Insulation lay up and cure processes are per shop planning.
600	A,C,D,E,H	28. Insulation anomalies, including voids, are process-finalized per engineering. Process finalization procedures and criteria are substantiated by design engineering per TR12961.
	E	29. 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	30. 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.

9.2 TEST AND INSPECTION:

DCN	FAILURE CAUSES and TESTS (T)			CIL CODE
		1.	For New NBR verify:	
A	(T)	a.	Elongation (calendered only)	ALH010,ALH062,ALH065
A	(T)	b.	Mooney viscosity (extrusions only)	ALH041,ALH046,ALH170
A	(T)	c.	Scorch characteristics (extrusions only)	ALH081,ALH086,ALH171
A,B	(T)	d.	Shore A hardness (calendered only)	ALH098,ALH102,ALH109
A	(T)	e.	Specific gravity (calendered only)	ALH118,ALH121,ALH126
A	(T)	f.	Tensile strength (calendered only)	ALH147,ALH149,ALH154
A		g.	Material workmanship including uniform appearance and free from contamination	ALH168
		2.	For Retest NBR, verify:	
A,G	(T)	a.	Mooney viscosity	ALH049
A,G	(T)	b.	Scorch characteristics	ALH087
		3.	For New Adhesive Primer, verify:	
C,D,E		a.	No damage to container or container seal	PDS001
A	(T)	b.	Density	AMR006,AMR012
A	(T)	c.	Peel adhesion	AMR022,AMR026
A		d.	Workmanship	AMR041
A	(T)	e.	Solids content	AMR059,AMR067
A	(T)	f.	Viscosity	AMR083,AMR092
		4.	For New Bonding Agent, Rubber-to-Metal verify:	
C,D,E		a.	No damage to container or container seal	PDS002
A	(T)	b.	Peel adhesion strength	AMX006,AMX010
A	(T)	c.	Solids content	AMX021,AMX023
A	(T)	d.	Specific gravity	AMX027,AMX029
A	(T)	e.	Viscosity	AMX039,AMX040
		5.	For New Chamber Assembly-Igniter, Insulation, verify:	
F		a.	Thickness of the insulation	AED001
C,D,E,F,H		b.	General workmanship and condition of the part	AED003
C,D,E,G		c.	Environmental history for insulation per engineering	PDS005
G		d.	Insulated Igniter Chamber is properly placed in the igniter storage container	AED006
C,D,E,G		e.	Storage life is acceptable for adhesive primer per engineering	PDS006
C,D,E,G		f.	Storage life is acceptable for bonding agent per engineering	PDS007
B,H		g.	Insulation cure time, temperature, and pressure are acceptable per shop planning	AED008
C,D,E,G		h.	Storage life is acceptable for insulation per engineering	PDS008
G		i.	Adhesive primer is properly mixed and acceptable for application	PDS009
C,D,E,H		j.	Insulation unbonds and edge separations are per engineering	AED010
G		k.	Bonding agent is properly mixed and acceptable for application	PDS010
F		l.	Insulation is flush with or higher than the igniter insert	AED011
C,D,E		m.	MEK is completely evaporated from the insulation surface prior to insulation lay up	AED013
G		n.	Component temperature and exposure to ambient environments during in-plant transportation or storage are per engineering	BAA013
C,D,E		o.	Proper bonding agent application	AED020

C,D,E		p.	Proper adhesive primer application	AED020A
C,D,E		q.	Bonding surface preparation for the chamber and NBR is complete and acceptable	AED021
D,F,H	(T)	r.	Radiographic results are complete and acceptable	AED030
C,D,E,H		s.	Tap test inspection of chamber insulation	AED036
A,D,H		t.	No unacceptable blisters or inclusions	WJB001

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

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

7. For New Igniter Assembly verify:

G		a.	Component temperatures and exposure to ambient environments during in-plant transportation or storage are controlled per temperature exposure limit specifications	BAA015

8. KSC verifies:

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