CRITICAL ITEMS LIST (CIL)

No. 10-03-03-01/01

SYSTEM:	Space Shuttle RSRM 10	CRITICALITY CATEGORY:	1
SUBSYSTEM:	Ignition Subsystem 10-03	PART NAME:	Initiator Chamber (1)
ASSEMBLY:	Igniter Assembly 10-03-03	PART NO.:	(See Table A-3)
FMEA ITEM NO.:	10-03-03-01 Rev N	PHASE(S):	Boost (BT)
CIL REV NO.:	N	QUANTITY:	(See Table A-3)
DATE:	27 Jul 2001	EFFECTIVITY:	(See Table 101-6)
SUPERSEDES PAGE:	421-1ff.	HAZARD REF.:	BI-01
DATED:	31 Jul 2000		
CIL ANALYST:	F. Duersch		
APPROVED BY:		DATE:	

RELIABILITY ENGINEERING: K. G. Sanofsky 27 July 2001

ENGINEERING: V. B. Teller 27 July 2001

1.0 FAILURE CONDITION: Failure during operation (D)

2.0 FAILURE MODE: 2.0 Structural failure of Initiator Chamber

3.0 FAILURE EFFECTS: Failure of the Initiator Chamber could result in delayed ignition of the RSRM or sections of the chamber exiting the RSRM motor and damaging the nozzle assembly causing loss of the RSRM, SRB, crew, and vehicle

4.0 FAILURE CAUSES (FC):

FC NO.	DESCRIPTION	FAILURE CAUSE KEY
1.1	Nonconforming materials or heat treatment	A
1.2	Corrosion of Igniter Initiator	B
1.3	Nonconforming dimensions	C
1.4	Cracks or other material defects	D
1.5	Improper assembly of Initiator-to-Adapter	
1.5.1	Damaged threads	E
1.5.2	Improper torque	F
1.5.3	Improper thread engagement	G
1.6	Shock and vibration	H
1.7	Improper proof testing	I
1.8	Nonconforming sealant materials	J
1.9	Improper sealant application (Ignition Initiator-to-Igniter Adapter interface)	K

5.0 REDUNDANCY SCREENS:

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

6.0 ITEM DESCRIPTION:

1. There is one Initiator Chamber per RSRM, being a component of the ignition system that is attached through the ignition port on the forward motor segment.

2. The assembled igniter is detailed per engineering drawings that show an Insulated Initiator Chamber threaded and installed to the Insulated Ignition Adapter.

3. Assembly at Thiokol requires the following items:

   Igniter Initiator Chamber Assembly
   Insulated Adapter
   Sealant

Table 1. MATERIALS

Drawing No.	Name	Material	Specification	Quantity
1U77858	Initiator Chamber Assembly			1/Motor
1U50154	Initiator Chamber	4130 Steel	MIL-S-6758 Condition D	1/Motor
1U77450	Adapter	D6AC Steel	STW4-2706	1/Motor
1U77451	Adapter Assembly, Igniter, Insulated			1/Motor
1U77499	New Igniter Assembly			1/Motor
	Initiator Insulation	NBR	STW4-2621	A/R
	Initiator Liner		STW5-3224	A/R
	Adapter Insulation	NBR	STW4-2621	A/R
	Sealant	Sealant, Liquid Epoxy Sealant Asbestos Float Filled	STW5-2678	A/R
	Lubricant	Heavy Duty Calcium Grease	STW5-2942	A/R

6.1 CHARACTERISTICS:

1. The Igniter Initiator is a small multi-nozzle, steel-cased solid propellant igniter with a 30-point star grain cast from the same propellant formulation as the main igniter. The Initiator Chamber, made from high-strength steel, is insulated internally in thread areas and externally with insulation to prevent the chamber from melting and exposing the Safety and Arming (S&A) device and Adapter to direct heating during ignition and boost phases. The Insulated Adapter and Initiator Chamber are not reusable (Figure 1).

2. The Igniter Adapter provides the mounting surface between the other ignition system components and the forward dome.

3. The Igniter Initiator screw threads and mating threads of the Adapter are cleaned and sealant is applied. The Igniter Initiator is threaded into the Adapter, torqued per engineering drawing requirements and any extruded joint sealant is removed.

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

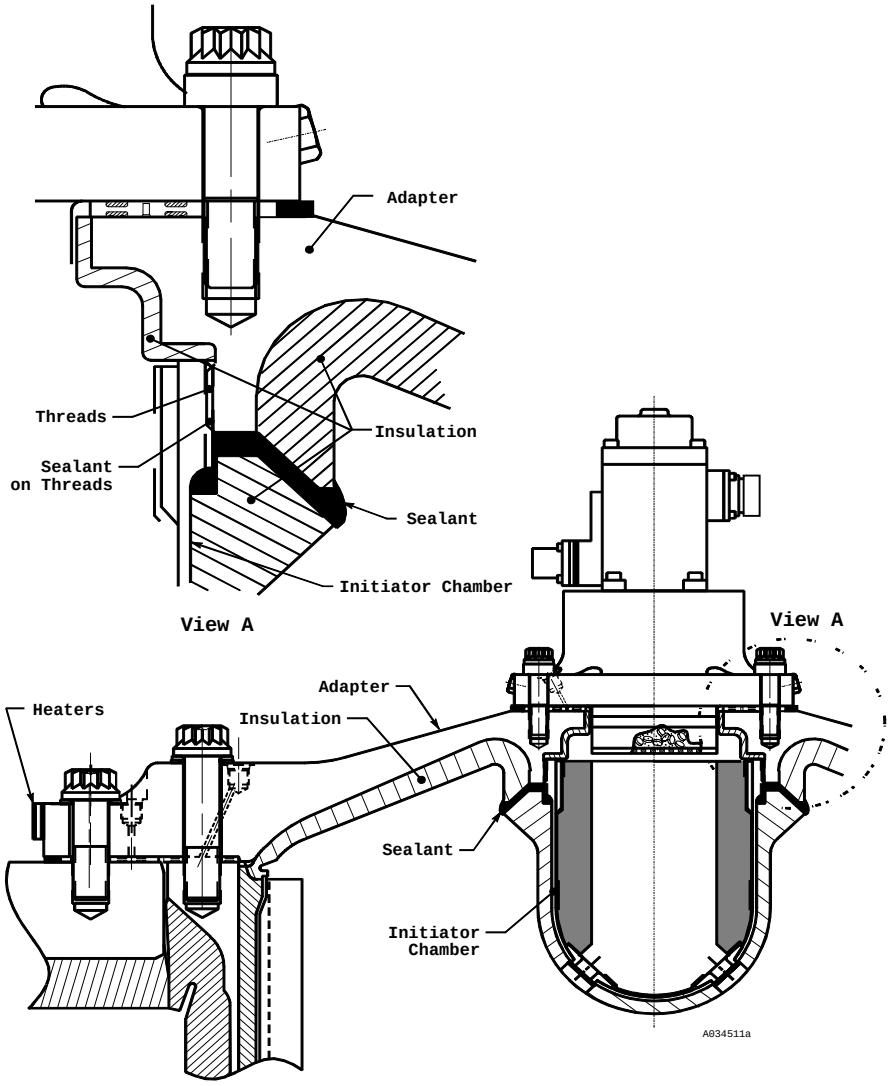

Figure 1. Insulated Adapter and Initiator Chamber

9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN	FAILURE CAUSES	
A,B,D	1.	The Igniter Initiator Chamber is fabricated of 4130 steel and heat-treated per engineering drawings.
A,D	2.	The Igniter Adapter is fabricated of D6AC steel and heat-treated per engineering drawings.
A,B	3.	Corrosion preventive compound is controlled per the Igniter Adapter and Igniter Initiator Chamber drawings.
A,C	4.	A three-dimensional structural analysis of the modified ignition system was performed per TWR-17265 and TWR-61222. Analysis shows that under worst-case pressure loading the Adapter area and Initiator Chamber have a positive margin of safety.
A	5.	Results of evaluation of the first production forging of the initiator Chamber are reported in TWR-10733. The report concluded that forgings produced per engineering were suitable for future production.
A,C	6.	Three Igniter Initiator Chambers were subjected to hydrostatic pressure and bursting as reported in TWR-10874. Based on initiator maximum expected operating pressure (MEOP) and a factor of safety of 1.4 to ultimate, the result demonstrated actual positive margins of safety.
A,J	7.	Development Motors DM-8 and DM-9 were static test fired to evaluate performance of accepted baseline RSRM hardware. The Igniter Adapter and Igniter Initiator Chamber are certified per Qualification Motors QM-6 and QM-7 static tests as reported in TWR-18764-03.
A,D	8.	The Igniter Adapter is reusable per engineering.
B	9.	The Igniter Initiator Chamber is defined as being susceptible to corrosion per MSFC specifications and the material use agreement. Bare metal surfaces of the Igniter Initiator Chamber are coated with a corrosion-preventive compound for preservation.
B	10.	Surface areas are cleaned before insulating, loading, and assembly per shop planning.
B	11.	Removal of surface corrosion is a standard shop practice used whenever corrosion is noted per shop planning.
B	12.	Corrosion-preventive compound is filtered to control contamination.
B	13.	Contamination control requirements and procedures are per TWR-16564.
C	14.	The Igniter Initiator Chamber is per engineering drawings that establish geometric dimensions and fabrication details.
C	15.	Igniter Adapter dimensions are per engineering drawings.
C	16.	Acceptable dimensions for the Refurbished Igniter Adapter are per engineering.

D	17.	A fracture mechanics analysis of the Igniter Adapter is per TWR-16104. The analysis verified that there is no potential crack propagation problem in the Igniter Adapter and that the Igniter Adapter complies with the requirement of ensuring a minimum of four missions after hydroproof test.
E,F,G	18.	External threads on the Igniter Initiator Chamber and matching internal threads on the Igniter Adapter are per engineering drawings.
E,F,G	19.	Thread protectors are used to prevent thread damage during transportation and handling per shop planning.
E	20.	The Igniter Initiator Chamber is hydroproof tested with the external threads being loaded in the test.
E,F,G	21.	The Igniter Adapter and Igniter Initiator Chamber are mated per engineering drawings.
H	22.	Transportation and handling of the igniter system is per Thiokol IHM 29.
H	23.	Three igniters were subjected to transportation vibration, shock, and flight random vibration tests per CTP-0011. One igniter was subjected to transportation vibration, shock, and flight random vibration; and one igniter was subjected to transportation vibration and shock. Post-test examination, including radiographic inspection, revealed no detrimental effects per TWR-17872.
H	24.	The Igniter Initiator Chamber is transported to KSC as an integral part of the RSRM forward segment.
H	25.	Railcar transportation monitoring records are evaluated by Thiokol to verify that shock and vibration levels per MSFC Specifications were not exceeded.
I	26.	Thiokol determines that the supplier has available and uses correctly, gauging, measuring, and test equipment of the required accuracy and precision. Instruments are of the proper type and range to make measurements within the desired accuracy. Thiokol furnishes the hydrostatic fixture.
I	27.	TWR-16874 was prepared for the Igniter Adapter to ensure compliance with the requirement for multiple use.
I	28.	Hydroproof requirements are per engineering drawings for the Igniter Initiator Chamber.
I	29.	Hydroproof requirements for the Igniter Adapter are per engineering drawings.
J,K	30.	Sealant is an asbestos float-filled, liquid epoxy resin sealant containing polyamide curing agent and a thixotropic agent per engineering.
J	31.	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
J	32.	Storage life of sealant raw materials is per engineering. Storage life of liquid epoxy resin and asbestos floats may be extended after retest per engineering.
J	33.	Preparation of the sealant is per shop planning.

J	34. Acceptability of the combination of raw material lots used to manufacture the sealant is demonstrated by the raw material lot combination test per engineering.
J,K	35. Sealant pot life is per shop planning.
K	36. The Igniter Adapter and Igniter Initiator Chamber are assembled per the igniter assembly drawing and shop planning. Sealant is applied during this assembly process.

9.2 TEST AND INSPECTION:

DCN	FAILURE CAUSES and TEST (T)			CIL CODE
		1.	For New Igniter Adapter, verify:	
A,D	(T)	a.	Chemical analysis	AAS029,AAS323
A,D	(T)	b.	Mechanical properties	AAS404,RAA044
A,D	(T)	c.	Metallurgical characteristics	AAS404C,RAA045
A,D	(T)	d.	Heat treatment	AAS175,AAS177
A,C,D,H,I	(T)	e.	Proof test	AAS198A
A,D,H,I	(T)	f.	Magnetic-particle inspection after proof test is complete and acceptable	AAS313A
A,D		g.	Material is D6AC steel	AAS029A
A,C,D,H		h.	Supplier records are complete and acceptable	AAS550
C,E,F,G		i.	The 4.750 -12UN-3B thread for initiator	AAS023
C,E,F,G		j.	Diameter of undercut immediately forward of threads for mounting initiator	AAS080
C		k.	Profile thickness from flange to Safety and Arming device mounting boss	AAS385
D,F,G		l.	No obvious shipping or handling damage	AAS343
D,H	(T)	m.	Ultrasonic testing complete and acceptable	AAS541,RAA001
		2.	For Refurbished Igniter Adapter, verify:	
A,C,D,H,I	(T)	a.	Hydroproof successful	AAN008
A,C,D,H,I	(T)	b.	Magnetic-particle after hydroproof test	AAS301
C		c.	Threaded holes conform to gauging requirements after hydroproof testing	AAS491
		3.	For New Igniter Initiator Chamber, verify:	
A,D		a.	Material is 4130 steel	AAN000
A,D		b.	Heat treatment per MIL-H-6875	AAN004
A,B,D,E, F,G,H,I	(T)	c.	Hydroproof test	AAN010
A,B,D,E, F,G,H,I	(T)	d.	Magnetic-particle inspection after hydroproof test is complete and acceptable	AAN017
A,C,D,H		e.	Certificate of Conformance is complete and acceptable	AAN028
B,D		f.	Grease is applied to bare metal surfaces	AAN002
C		g.	Overall length	AAN022
C,E,F,G		h.	Thread length	AAN026
C,E,F,G		i.	Threads	AAN027
C,E,F		j.	Wall thickness	AAN029
D,E,F,G		k.	No obvious shipping damage	AAN021
		4.	For New Adapter Assembly, Igniter Insulated verify:	
E,F,G		a.	Initiator installation length after insulation application	AAL015
		5.	For New Chamber Assembly, Igniter Initiator-Loaded verify:	
B		a.	No corrosion exists on initiator chamber interior surface prior to liner application	AAN003
B		b.	No corrosion exists on initiator chamber interior after hand cleaning, prior to application of sealant and insulation	AAM011
B		c.	No corrosion exists on initiator chamber exterior after hand	

					cleaning, prior to application of sealant and insulation	AAM009
	B			d.	Tooling and initiator chamber surfaces are clean and dry prior to liner application	AAM014
	E,F,G			e.	External insulation meets drawing dimensional requirements after bonding	AAM058
569	J			f.	Sealant is acceptable and within pot life per planning requirements	AMU017
	J			g.	Pot life between liner mixing and application not exceeded	AOA044
	J		(T)	h.	Shore A hardness tests of sealant	AAM077

6. For New Igniter Assembly verify:

	F,K			a.	Proper application of sealant prior to installation of initiator	AEF035
	E,F,G,K			b.	Adapter threads for Initiator Chamber are clean and free from contamination prior to assembly	AEF054
	B,E,F,G,K			c.	Initiator Chamber threads are clean and free of contamination and surface defects per igniter process finalization specification	AEF055
	E,F,G			d.	Initiator Chamber is installed and torqued correctly into Adapter	AEF275
	K			e.	Sealant within pot life at time of application	AMU001A
	K			f.	Excess sealant wiped off after torquing initiator	AEF007
	K			g.	Gap between two mating surfaces (Adapter and Initiator) is totally filled after torquing	AEF103

7. For New Liquid Epoxy Resin verify:

J		(T)	a.	Specific gravity	ALD063,ALD061
J		(T)	b.	Viscosity	ALD085,ALD082
J		(T)	c.	Weight per epoxy	ALD101,ALD098
J		(T)	d.	Hydrolyzable chlorine percent	ALD009,ALD006
J		(T)	e.	Moisture percent	ALD038,ALD035
J		(T)	f.	Infrared spectrum	ALD030

8. For Retest Liquid Epoxy Resin verify:

J		(T)	a.	Hydrolyzable chlorine percent	ALD011
J		(T)	b.	Viscosity	ALD083
J		(T)	c.	Weight per epoxy	ALD103
J		(T)	d.	Moisture	ALD989

9. For New Curing Agent, Polyamide Liquid Resin, verify:

J		(T)	a.	Amine value	ALQ001, AMQ006
J		(T)	b.	Ash content	AMQ015
J		(T)	c.	Color	ALQ026, AMQ028
J		(T)	d.	Specific gravity	AMQ033
J		(T)	e.	Viscosity	ALQ049, AMQ050

10. For New Floats, Asbestos verify:

J		(T)	a.	Volatile matter	ALI051
J		(T)	b.	pH (Aqueous extract)	ALI023
J		(T)	c.	Calcination loss	ALI002
J		(T)	d.	Fiber size distribution	ALI011
J		(T)	e.	Wet volume	ALI053

11. For Retest Floats, Asbestos, verify:

J		(T)	a.	volatile matter for storage life extension	ALI051A

12. For New Silicon Dioxide, verify:

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

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

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