CRITICAL ITEMS LIST (CIL)

No. 10-03-04-06/01

SYSTEM:	Space Shuttle RSRM 10	CRITICALITY CATEGORY:	1
SUBSYSTEM:	Ignition Subsystem 10-03	PART NAME:	Igniter Propellant (1)
ASSEMBLY:	Igniter Assembly 10-03-04	PART NO.:	(See Table A-3)
FMEA ITEM NO.:	10-03-04-06 Rev M	PHASE(S):	Pre-launch (PL)
CIL REV NO.:	M	QUANTITY:	(See Table A-3)
DATE:	31 Jul 2000	EFFECTIVITY:	(See Table 101-6)
SUPERSEDES PAGE:	434-1ff.	HAZARD REF.:	FI-01
DATED:	30 Jul 1999		
CIL ANALYST:	F. Duersch		
APPROVED BY:		DATE:	

RELIABILITY ENGINEERING: K. G. Sanofsky 31 Jul 2000

ENGINEERING: S. R. Graves 31 Jul 2000

1.0 FAILURE CONDITION: Premature operation (A)

2.0 FAILURE MODE: 1.0 Premature propellant ignition

3.0 FAILURE EFFECTS: Premature ignition results in loss of RSRM, causing loss of SRB, crew, and vehicle

4.0 FAILURE CAUSES (FC):

FC NO.	DESCRIPTION	FAILURE CAUSE KEY
1.1	Thermal energy causes premature ignition	A
1.2	Static discharge	B
1.3	Lightning strike	C

5.0 REDUNDANCY SCREENS:

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

6.0 ITEM DESCRIPTION:

1. Igniter propellant is designated TP-H1178 and is composed of bimodal ammonium perchlorate oxidizer, spherical aluminum powder, ferric oxide, poly butadiene acrylic acid acrylonitrile liquid terpolymer HB binder, and epoxy curing agent.

2. The igniter casting process ensures the propellant grain configuration is free of foreign material and objects. The igniter propellant grain configuration is a 40-point star web grain design. Star peaks and valleys are rounded to reduce the likelihood of stress discontinuities (Figure 1). After the casting process is completed and core removed, the igniter is inspected for cracks or voids.

3. The igniter reaches 90 percent of its peak output within 0.045 seconds from time zero. The flame from the igniter exhausts onto the forward star of the forward segment and thus ignites this surface initially. Ignition of the rest of the propellant surface occurs very rapidly. RSRM internal pressure increases rapidly and achieves lift-off thrust in less than 0.3 seconds.

4. Igniter propellant after cure is protected from atmospheric exposure by installation of an igniter environmental seal. The igniter environmental seal is a disc of cured asbestos and silicon dioxide filled acrylonitrile butadiene rubber (NBR). The disc is bonded over the igniter nozzle opening with an asbestos and thixotropic agent-filled epoxy sealant. The seal protects loaded igniter propellant from degradation due to moisture or humidity. The igniter is further protected from moisture and humidity by the inner gasket, packing with retainers, initiator nozzle port environmental seals, and Barrier-Booster seals. An igniter protective cover is required to seal the Safety and Arming (S&A) attachment flange on the igniter adapter. The protective cover is temporary until the S&A device is installed at KSC. The cover is made of aluminum and has an O-ring seal. Each lot of propellant raw materials is standardized per engineering to meet burn rate and mechanical property requirements. Materials are listed in Table 1.

TABLE 1. MATERIALS

Drawing No.	Name	Material	Specification	Quantity
	Propellant	TP-H1178	STW5-2833	A/R
		Terpolymer (PBAN)	STW4-2600	A/R
		Liquid Epoxy Resin	STW4-2601	A/R
		Ammonium Perchlorate with Conditioner	STW4-2602	A/R
		Ferric Oxide	STW4-2604	A/R
		Aluminum, Spherical	STW4-2832	A/R

The above materials make up TP-H1178 propellant which is used in the following parts:

1U77858	Igniter Initiator Chamber, Loaded	Various	1/motor
1U77372	Igniter Chamber, Loaded	Various	1/motor
1U76674	Forward Segment, Loaded	Various	1/motor

6.1 CHARACTERISTICS:

1. Igniter propellant is composed of bimodal ammonium perchlorate oxidizer, spherical aluminum, ferric oxide, polybutadiene acrylic acid- acrylonitrile (HB) polymer binder, and Epoxy Curing Agent (ECA). The propellant grain configuration in the igniter is a 40-point star and web grain design. Star peaks and valleys are rounded to reduce the likelihood of stress discontinuities (Figure 1). The igniter is up to 90 percent of peak thrust output by 0.045 seconds from time zero. The flame from the igniter exhausts onto the forward star of the forward segment and thus ignites this surface initially. Ignition of the remaining

propellant surface occurs very rapidly. RSRM internal pressure increases rapidly and achieves lift-off thrust in less than 0.3 seconds.

7.0 FAILURE HISTORY/RELATED EXPERIENCE:

1. Current data on test failures, flight failures, unexplained failures, and other failures experienced during RSRM ground processing activity can be found in the PRACA Database.

8.0 OPERATIONAL USE: N/A

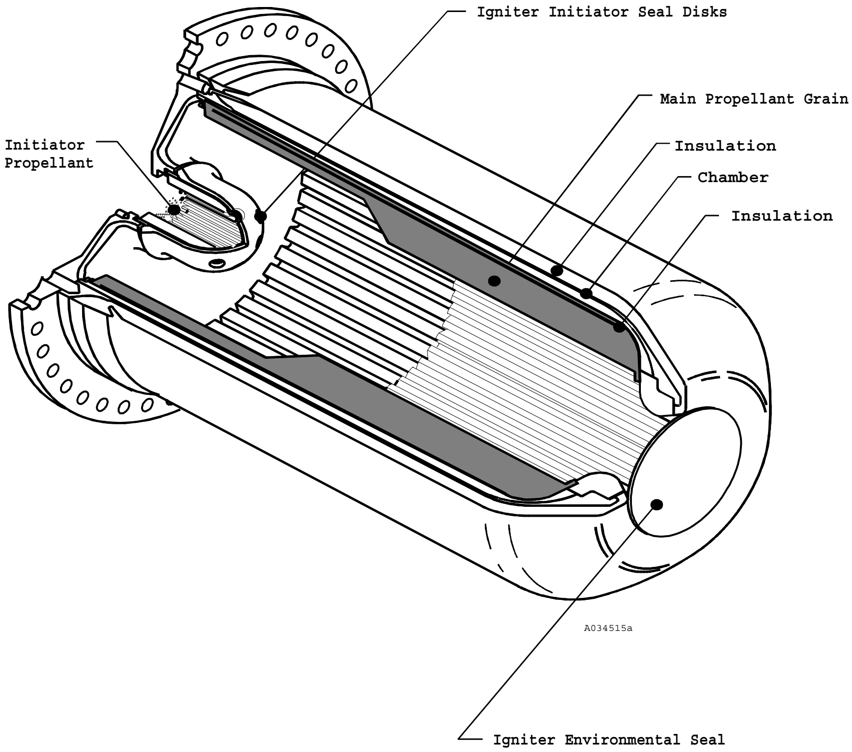

Figure 1. Igniter and Initiator Propellant Grain Configuration

9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN	FAILURE CAUSES		
	A	1.	Analysis of the effects of short-term exposure of TP-H1178 propellant to high temperature (300^{o}F for 24 hours) showed no premature ignition in the temperature range per TWR-11404.
	A	2.	Thermal analysis per TWR-16339 showed igniter case temperatures remain within temperature requirements thus ensuring igniter case functional integrity.
	A	3.	The igniter is housed in the forward segment of the RSRM, maximizing the distance between the ignition system and the Space Shuttle Main Engine (SSME) exhaust. The SRM nozzle protective plug prevents SSME exhaust gases from entering the motor.
	A	4.	Igniter insulation (internal and external), forward segment case insulation, and propellant provide isolation of the igniter propellant from ambient thermal environments.
	B	5.	A test per TWR-16512 was performed to determine the sensitivity of TP-H1178 propellant to ignite due to Electrostatic Discharge (ESD). It was determined that TP-H1178 is less sensitive to ESD than TP-H1148. Analyses showed no propellant ignition during the test.
	B	6.	The igniter is protected from static discharge by the grounding shield provided by the grounded forward case segment that is bonded to the igniter adapter. The S&A device is bonded to the adapter completing the ground path around the igniter per engineering drawings.
	B	7.	Igniter propellant is completely enclosed by the adapter, igniter environmental seal, igniter chamber, and the initiator after assembly of the ignition system per engineering drawings.
	B	8.	Testing reported in TWR-12866 showed no propellant ignition or noted degradation when subjected to voltage discharges up to 50,000 volts and showed the propellant static discharge sensitivity to be greater than 8 joules.
	B,C	9.	A continuous metallic path is provided by electrical bonding from the RSRM to the facility grounding system to ensure electrical resistance across mating surfaces is within limits per NSTS-07636.
	C	10.	RSRM grounding system design and RSRM component electrical bonding resistance requirements preclude premature propellant ignition caused by a lightning strike. The S&A device, initiator, and igniter are mounted in the center of the forward segment dome with bolts providing a metal-to-metal contact between the adapter and segment. The igniter is further protected from a lightning strike by the forward assembly.
	C	11.	Developmental lightning strike tests were performed to provide a technical basis for design and qualification tests per MSFC-16A00100.

C 12. Lightning protection requirements are per NSTS-07636.

9.2 TEST AND INSPECTION:

DCN	FAILURE CAUSES and TESTS (T)		CIL CODE
		1. KSC verifies:	
	B,C	a. S&A device to igniter adapter electrical bonding tests per OMRSD, File V, Vol I, B47SA0.100.	OMD071