

CRITICAL ITEMS LIST (CIL)

No. 10-03-02-01/03

SYSTEM:	Space Shuttle RSRM 10	CRITICALITY CATEGORY:	1
SUBSYSTEM:	Ignition Subsystem 10-03	PART NAME:	Pyrotechnic Basket Assembly (1)
ASSEMBLY:	Safety and Arming Device 10-03-02	PART NO.:	(See Table A-3)
FMEA ITEM NO.:	10-03-02-01 Rev M	PHASE(S):	Boost (BT)
CIL REV NO.:	M	QUANTITY:	(See Table A-3)
DATE:	17 Jun 2002	EFFECTIVITY:	(See Table 101-6)
SUPERSEDES PAGE:	414-1ff.	HAZARD REF.:	BI-01
DATED:	31 Jul 2000		
CIL ANALYST:	D. J. McGough		
APPROVED BY:		DATE:	

RELIABILITY ENGINEERING: K. G. Sanofsky 17 Jun 2002

ENGINEERING: P. M. McCluskey 17 Jun 2002

- 1.0 FAILURE CONDITION: Failure during operation (D)
- 2.0 FAILURE MODE: 1.0 Structural failure of Pyrotechnic Basket Assembly
- 3.0 FAILURE EFFECTS: Pyrotechnic Basket debris causes initiator damage resulting in thrust imbalance 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	Nonconforming dimensions	B
1.3	Cracks or other material defects	C
1.4	Improperly-installed screws and bolts	
1.4.1	Improper torque	D
1.4.2	Improper locking	E
1.4.3	Galling/seizure	F
1.4.4	Contamination	G
1.5	Excessive pressure	
1.5.1	Improper charge	H
1.5.2	Fragmented (broken) B-KNO ₃	I
1.5.3	Nonconforming dimensions of B-KNO ₃ pellets/granules	J
1.5.4	Inadequate number/size holes in Pyrotechnic Basket Cover	K

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5.0 REDUNDANCY SCREENS:

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

6.0 ITEM DESCRIPTION:

1. The Pyrotechnic Basket Assembly (Figures 1 and 2) is part of the Safety and Arming (S&A) device that initiates the ignition train for the RSRM. The Pyrotechnic Basket Assembly is loaded with Boron-Potassium-Nitrate (B-KNO₃) granules and pellets that are ignited by the output from the RSRM Ignition Initiators (SIIs). The output from the Pyrotechnic Basket Assembly ignites the igniter initiator propellant grain that in turn ignites the igniter propellant grain. Primary components of the Pyrotechnic Basket Assembly include (Figure 3) a "Booster-Basket" Housing, perforated Booster Tube Assembly and two tube fittings with plugs and frangible seals (together called the cross-over tube) containing B-KNO₃ granules, B-KNO₃ pellets, an open-cell foam cushion placed against the pellets, and perforated retainer plate or Booster Cover. The Booster Cover is fastened to the basket housing using six pan head cap screws. The Pyrotechnic Basket Assembly is mounted on the inner surface of the Barrier-Booster Assembly using six socket head cap screws and faces toward the igniter initiator grain. Only structural failure of the Booster-Basket, basket cover, basket cover mount screws and Pyrotechnic Basket Assembly mount screws are considered credible for causing the effects of this mode. All components of the Pyrotechnic Basket Assembly are one-time-use items. Materials are listed in Table 1.

NOTE: Only structural failure of the Booster-Basket, Basket Cover, and assembly screws are considered credible for causing the effects of this mode. The following components are used to assemble a Pyrotechnic Basket Assembly that mates with the Barrier-Booster housing of the loaded Barrier-Booster Assembly indexed with a pin located on the Barrier-Booster Assembly.

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TABLE 1. MATERIALS

Drawing No.	Name	Material	Specification	Quantity
1U50691	Cover	301 CRES Half Hard	MIL-S-5059	1/Motor
1U50694	Cushion	Polyurethane Foam	STW4-3240	1/Motor
1U50796	Tube Assembly Fitting	304 CRES	QQ-S-763	2/Motor
1U50797	Alignment Pin	Nylon	L-P-410	1/Motor
1U50798	Plug, Tube Assembly	303 CRES	ASTM-A-582	2/Motor
1U51701	Basket, Booster	304 CRES	QQ-S-763 Cond A	1/Motor
1U51702	Basket Assembly, Booster			1/Motor
1U51703	Basket Assembly, Pyrotechnic			1/Motor
1U77383	Housing, Barrier-Booster	A286 CRES	AMS-5737	1/Motor
1U77385	Barrier-Booster Assembly S/A Device			1/Motor
1U77386	Barrier-Booster Assembly, S/A Device, Loaded			1/Motor
1U77461	Index Pin	A286 CRES	AMS-5737	1/Motor
NAS1190E06P8L	Screw, Self-Locking	A286 CRES	AMS-5737	6/Motor
NAS1352C08LL20	Screw, Self-Locking	CRES Passivated	FF-S-86	6/Motor
	Ignition Granules		STW5-2702	A/R
	Potassium Nitrate		STW4-3812	A/R
	Boron Powder		STW4-2887	A/R
	Polyamide Plastic Binder		STW4-2886	A/R
	B-KNO ₃ Pellets		STW5-2885	A/R
	Potassium Nitrate		STW4-3812	A/R
	Boron Powder		STW4-2887	A/R
	Polyamide Plastic Binder		STW4-2886	A/R
	Graphite Lubricant		MIL-G-155	A/R
	Lubricant	Heavy-Duty Calcium Grease	STW5-2942	A/R
	Torque Seal	Special Purpose Lacquer	STW5-2984	A/R
	Coating, Clear	Lacquer	TT-L-50G, Type II	A/R
	Polyester Tape	Pressure-Sensitive	MIL-T-26317 or L-T-100, Type I	A/R
	Adhesive, Epoxy	Epoxy Resin, Metal-to-Metal Structural Bonding	MMM-A-134, Type I	A/R

6.1 CHARACTERISTICS:

1. The RSRM Safety and Arming (S&A) device meets established requirements for performance, design, development, test, manufacture, and acceptance for a two-part electromechanical Safety and Arming device.
2. The Pyrotechnic Basket Assembly contains an explosive mixture of B-KNO₃ granules (confined in the Booster-Tube Assembly) B-KNO₃ pellets cushioned by an open-cell foam disk placed against the pellets. The B-KNO₃ pellets and granules function as two steps in the ignition train of the RSRM. First, the SIs burst the frangible seals in the Pyrotechnic Basket Assembly and ignite the B-KNO₃ ignition granules that ignite the B-KNO₃ pellets. Then, output from the Pyrotechnic Basket Assembly ignites the igniter initiator, which in turn ignites the main igniter. Main igniter output ignites the SRM propellant grain (main motor). The Pyrotechnic Basket Assembly is not refurbished.

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

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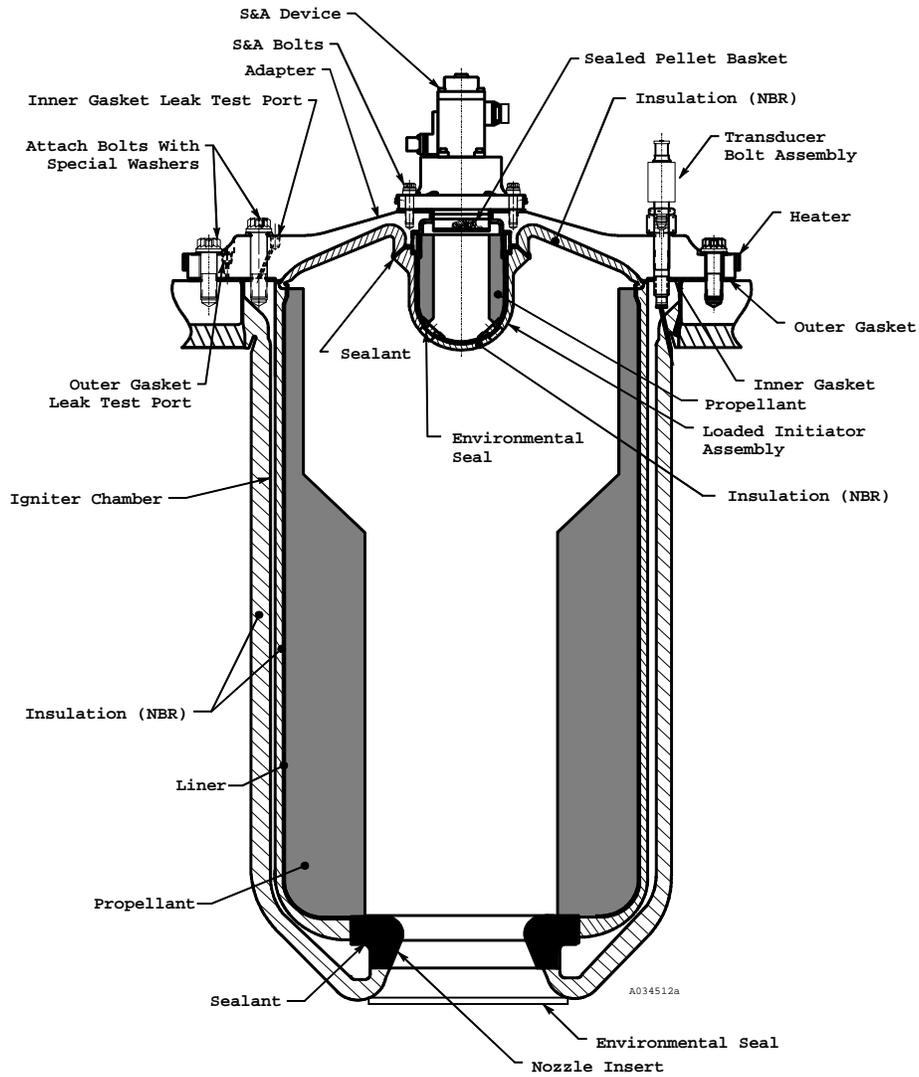


Figure 1. RSRM Ignition System

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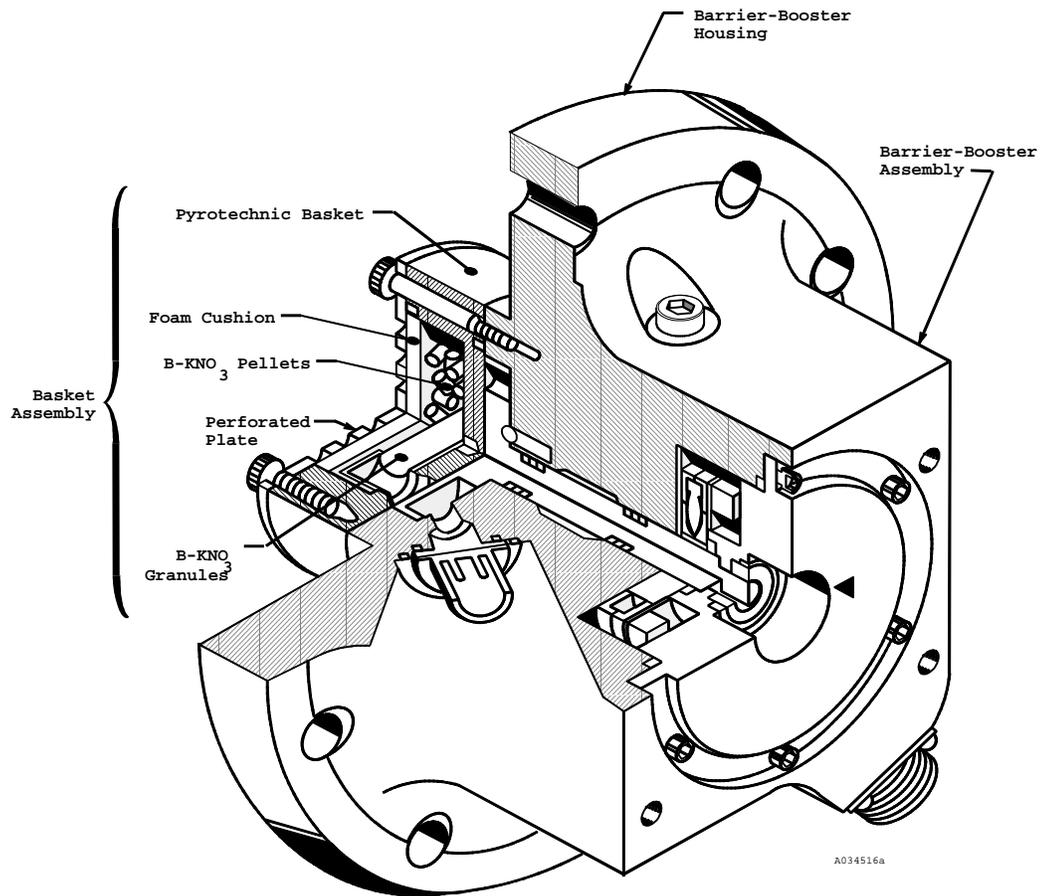


Figure 2. Pyrotechnic-Basket Assembly Mounted to Barrier-Booster Assembly Housing

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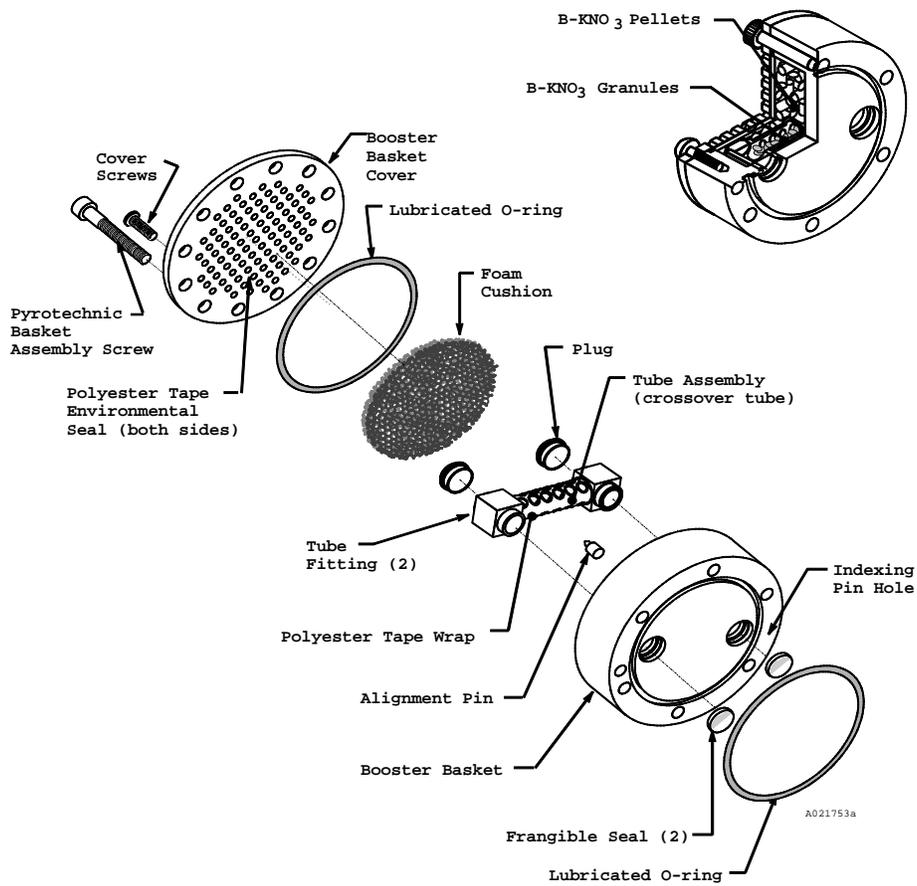


Figure 3. Pyrotechnic-Basket Assembly Section and Exploded Views

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9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN FAILURE CAUSES

- | | | |
|-------------|-----|--|
| A,C | 1. | Booster Basket Cover material is 301 CRES. |
| B | 2. | Booster Basket Cover dimensions are per engineering drawings. |
| K | 3. | The number and size of holes in the Booster Basket Cover are controlled per engineering drawings. |
| B | 4. | Booster Cover screw dimensions are per NAS specifications. |
| A,C,D,E,F | 5. | The Booster Basket Cover screws are self-locking using a nylon locking element, Type A286 CRES per Federal Specifications. |
| D,E,F | 6. | The Booster Basket Cover screws are torqued per engineering drawings and shop planning. |
| A,B | 7. | The factor of safety for the cover and screws is 1.4 for ultimate strength and 1.2 for yield strength. An analysis per TWR-11807 was performed using maximum stress that demonstrated a positive margin of safety for both the cover and screws. |
| E | 8. | The Booster Cover screws are discarded and replaced with new screws if the screws do not seat during run-down torque per shop planning. |
| A,C | 9. | Booster Basket material is 304 CRES per Federal Specifications. |
| B | 10. | Booster Basket dimensions are per engineering drawings. |
| A,B,C,D,E,F | 11. | Pyrotechnic Basket Assembly screws are self-locking and CRES per NAS specifications. |
| D,E,F | 12. | The Pyrotechnic Basket Assembly screws are torqued in an established pattern per shop planning. |
| D,F | 13. | All torque values conform to MSFC standards. |
| D,E,F | 14. | Torque seal is applied to cover plate screw heads and cover plate after the screws are torqued. |
| D,F | 15. | The Booster Basket Cover screws, Booster Basket, Pyrotechnic Basket Assembly screw and Barrier-Booster Housing are compatible against galling and seizure. |
| G | 16. | Contamination control of the Booster-Basket screw holes is per shop planning. |
| G | 17. | All booster basket screw holes are covered with tape to prevent any B-KNO ₃ granules or B-KNO ₃ dust from contaminating the threads. |
| H,I,J | 18. | Formulation, manufacture, and performance requirements of B-KNO ₃ pellets and B-KNO ₃ granules are controlled per engineering. |
| H | 19. | B-KNO ₃ pellet and granule load weights are per engineering drawings. |
| H | 20. | Structural integrity of the Pyrotechnic Basket Assembly was determined by static tests of live firings, measuring the delay times, pressure, and charge weights per |

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TWR-11093.

- H 21. Each lot of Pyrotechnic Basket Assemblies are loaded with B-KNO₃ pellets and B-KNO₃ granules manufactured using the same lots of raw materials in one unchanging and continuous manufacturing process per JSC Specification, NSTS-08060. A single lot of B-KNO₃ pellets and B-KNO₃ granules is used.
- I,J 22. A cushion is included in the Pyrotechnic Basket to prevent damage to the pellets during transportation and handling.
- K 23. Consolidated Controls Corp (CCC) performed design proof tests, Bruceton Reliability tests, firing shock tests, vibration tests, reliability firing tests, and safety firing tests to develop a design that would satisfy the engineering requirements of the Pyrotechnic Basket Assembly per supplier report 75060 DTR1.
- A,B,C,D,F,
H,I,J,K 24. A lot acceptance test is performed at Thiokol. Data is analyzed by Design Engineering and reported in a final report for each lot.

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9.2 TEST AND INSPECTION:

<u>FAILURE CAUSES and DCN TESTS</u> (T)			<u>CIL CODES</u>
		1. For New Plastic Polyamide Resin Binder, verify:	
I,J		a. Workmanship (includes visible contamination)	ALX002
I,J	(T)	b. Melting point	ALX003
I,J	(T)	c. Solution-cloud time	ALX008
		2. For New Boron Pellets, verify:	
H	(T)	a. Auto ignition temperature	ANI006
H,I,J	(T)	b. Average crush strength	ANI008
H	(T)	c. Boron content	ANI011
H,I,J		d. Diameter	ANI021
H	(T)	e. Heat of reaction	ANI026
H,I,J	(T)	f. Ignition pressure	ANI029
H	(T)	g. Ignition time	ANI033
H,I,J		h. Length	ANI035
H,I,J		i. Weight	ANI042
H	(T)	j. Potassium-Nitrate content	ANI044
		3. For New Ignition Granules, verify:	
H	(T)	a. Auto ignition temperature	AMW005
H	(T)	b. Boron content	AMW007
H	(T)	c. Heat of reaction	AMW018
H,I,J	(T)	d. Particle size	AMW026
H	(T)	e. Potassium-Nitrate content	AMW028
		4. For New Booster Basket Cover Screw, verify:	
A,C,D,F		a. Screw material A286 CRES	AKK000
B,D,F		b. Diameter "A" (lot-sample)	AKK001
B,D,F		c. Length (lot-sample)	AKK002
B,D,F		d. Threads (lot-sample)	AKK004
		5. For New Booster Basket Cover, verify:	
A,C		a. Booster Cover material conforms to specification	ABH001
A,C		b. Certificate of Conformance complete	ABH003
B		c. Fastener holes	ABH005
B		d. Mylar film tape dimensions acceptable	ABH006
B		e. Thickness	ABH012
I,J,K		f. Number of holes in Pyrotechnic Basket Cover within specified drawing dimensions	ANG007
		6. For New Booster Basket, verify:	
A,B,C		a. Booster Basket material is 304 CRES.	ACH003,ACH003A
B		b. Internal diameter	ACH012A
B		c. Height	ACH013A
B		d. Locations of ports in Booster-Basket	ACH014
B		e. Threaded holes	ACH018
B		f. Through hole diameter	ACH019A

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	7.	For New Booster Basket Assembly verify:	
A	a.	Certificate of Conformance complete	ACH005
	8.	For New Pyrotechnic Basket Assembly Screw, verify:	
A,C	a.	Screw material A286 CRES and heat treated	DAA038
B	b.	Length (lot-sample)	DAA034
B	c.	Threads (lot-sample)	DAA035
B	d.	Diameter (lot-sample)	DAA037
B	e.	Certificate of Conformance complete and acceptable	DAA041
	9.	For New Pyrotechnic Basket Assembly, verify:	
C	a.	Outside mating surfaces conform to requirements	ACJ021
E	b.	Proper screws used to assemble Booster Cover	ACJ025
H	c.	Proper weight of B-KNO ₃ granules in the cross over tube.	ACJ032
H	d.	Proper weight of B-KNO ₃ pellets loaded into Pyrotechnic Basket	ACJ034
D,E,F	e.	Torque seal applied between cover screw heads and cover plate	ACJ043
G	f.	All holes examined for contamination after tape is removed	ACY003
G	g.	All screw holes covered with Teflon tape	ACY004
585 G	h.	Holes cleaned with approved solvent prior to taping	ACY057
D,E,F	i.	Proper torque of Booster Basket Cover screws	ACY098
A,B,C,D,	j.	Lot Acceptance Testing of loaded Pyrotechnic Basket Assembly	AKS000
E,F,H,I,J (T)	k.	Single lot of pellets used in each lot of Pyrotechnic Basket Assemblies	ANI052
H,I,J,K	l.	Single lot of granules used in each lot of Pyrotechnic Basket Assemblies	AMW035
C	m.	Epoxy seal around cross-over tube for absence of cracks, unbonds or separations	DAA049
	10.	For New Barrier-Booster Assembly, Loaded, verify:	
G	a.	Cleanliness of screw holes prior to installing Pyrotechnic Basket Assembly	ACY021
E	b.	Proper screws used to assemble Pyrotechnic Basket Assembly-to-Barrier-Booster	ADA134
D,E,F	c.	Proper torque applied to Pyrotechnic Basket Assembly screws	ADA181