ATK ALLIANT TECHSYSTEMS
THIOKOL PROPULSION

CRITICAL ITEMS LIST (CIL)

No. 10-02-04-01/01

SYSTEM:	Space Shuttle RSRM 10	CRITICALITY CATEGORY:	1
SUBSYSTEM:	Nozzle Subsystem 10-02	PART NAME:	NASA Standard Detonator (GFE) (1)
ASSEMBLY:	NASA Standard Detonator (NSD) 10-02-04		
FMEA ITEM NO.:	10-02-04-01 Rev N	PART NO.:	(See Section 6.0)
CIL REV NO.:	N	PHASE(S):	Boost (BT)
DATE:	27 Jul 2001	QUANTITY:	(See Section 6.0)
SUPERSEDES PAGE:	348-1ff.	EFFECTIVITY:	(See Table 101-6)
DATED:	31 Jul 2000	HAZARD REF.:	BN-01
CIL ANALYST:	R. E. L. Hamilton		
APPROVED BY:		DATE:	

RELIABILITY ENGINEERING: K. G. Sanofsky 27 July 2001

ENGINEERING: G. A. Ricks 27 July 2001

1.0 FAILURE CONDITION: Premature operation (A)

2.0 FAILURE MODE: 1.0 Premature or inadvertent operation

3.0 FAILURE EFFECTS: Initiation of LSC causing loss of aft portion of Aft Exit Cone, RSRM, SRB, crew, and vehicle

4.0 FAILURE CAUSES (FC):

FC NO.	DESCRIPTION	FAILURE CAUSE KEY
1.1	Lightning	A
1.2	Stray electromagnetic interference	B
1.3	Electrostatic discharge	C
1.4	Increased sensitivity due to contamination during assembly, handling transportation, storage, and installation	D
1.5	High temperature	E
1.6	Shock/vibration	F

5.0 REDUNDANCY SCREENS:

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

6.0 ITEM DESCRIPTION:

1. NASA Standard Detonator (NSD) (Figure 1) is used to initiate the severance of the aft portion of the Aft Exit Cone after completion of the boost phase and before water impact of the SRB. The NSD is assembled to the Aft Exit Cone per engineering drawings. Materials are listed in Table 1.

TABLE 1. MATERIALS

Drawing No.	Name	Material	Specification	Quantity
1U77653	Exit Cone Assembly-Nozzle, Aft			1/motor
SEB26100094	NASA Standard Detonator			1/motor
	Epoxy Resin Adhesive, Non-Asbestos, Structural Bonding	Epoxy Resin And Amine Curing Agent	STW4-3218	A/R

6.1 CHARACTERISTICS:

1. The NASA Standard Detonator (NSD) is located on the Aft Exit Cone just aft of the compliance ring. The NSD consists of the NASA Standard Initiator (NSI) that is threaded and welded into a housing containing a primary and secondary explosive train. The electrical bridge wire of the NSI ignites the NSI output charge that is amplified by a lead azide column detonating the final cyclonite (RDX) output charge. Detonation of RDX causes detonation of the Linear-Shaped Charge (LSC). The LSC is used to sever the Aft Exit Cone following completion of the boost phase and prior to SRB water impact.

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

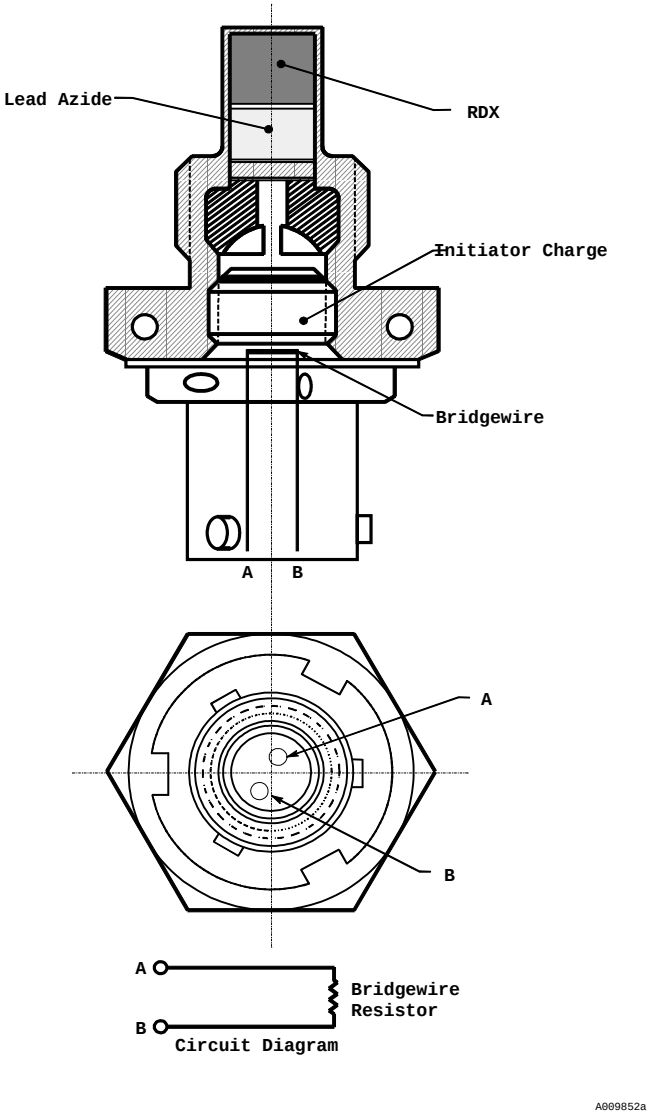

Figure 1. NASA Standard Detonator

9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN	FAILURE CAUSES		
	A,B,C,E,F	1.	The NSD is GFE supplied by JSC and controlled per JSC specifications and drawings.
	A,B,C,D,E,F	2.	NSD qualification is controlled by JSC and qualification testing and/or analysis related to listed failure causes is addressed in the JSC Critical Items List.
	A,B,C	3.	Each NSD is torqued into the initiator assembly clamp to create a path of low resistance per engineering drawings and specifications.
	A,B,C	4.	Dielectric strength and no-fire current tests were completed on the NSD and met or exceeded requirements per Qualification Report SOS-TR-6068.
595	A,B,C	5.	Two failure tolerances against erroneous signals were performed. There was no fire when subjected to one amp for five minutes at ambient temperature or when subjected to power dissipation of one watt for five minutes at 165 degrees F. per JSC specification.
	A,B,C	6.	The NSD when installed into the nozzle severance subsystem or nose cap separation subsystem proved insensitive to lightning and EMI per SRM Electromagnetics Effects Control Plan 16A00100.
	A,B,C	7.	The NSI will fire at 3.5 amps; however a firing current of 5 amps is recommended per JSC Qualification Report SOS-TR-6068.
	A,B,C	8.	The NSD is shielded from EMI and was qualified per NSTS-08060.
	A	9.	To assure proper electrical bond, a test is performed to measure resistance between the nozzle severance cable and the NSD per engineering drawings.
	C	10.	Each detonator of the lot is subject to an electrostatic discharge of voltage per JSC specifications.
	D	11.	The detonator has a storage life of 10 years when temperatures are maintained per JSC specifications.
	D	12.	The NSD is hermetically sealed by design and processing to prevent contamination per JSC specifications.
	D	13.	Each detonator is X-rayed and N-rayed twice in position 90 degrees apart along the longitudinal axis. This helps assure the assembly was performed properly and to determine there are no foreign objects or materials present per JSC specifications.
	D,F	14.	The NSD will withstand a drop test of eight feet and forty feet, which exceeds g-loads experienced in transportation and handling per NSTS 08060.
	D,F	15.	The nozzle assembly is shipped in the aft segment. Railcar transportation shock and vibration levels are monitored per engineering and applicable loads are derived by analysis. Monitoring records are evaluated by Thiokol to verify shock and vibration levels per MSFC Specification SE-019-049-2H were not exceeded. TWR-16975 documents compliance of the nozzle with environments per MSFC specifications.

D,F 16. Analysis is conducted by Thiokol engineering to assess vibration and shock load response of the RSRM nozzle during transportation and handling to assembly and launch sites per TWR-16975.

E 17. The NSD does not auto ignite when exposed to temperatures of 400°F for one hour per JSC specifications.

E 18. The nozzle severance system is designed with flight internal and external thermal protection. The maximum predicted temperatures of the NSD at severance are less than NSD auto ignition temperatures per TWR-17221.

F 19. A random vibration can be experienced in each of three mutually perpendicular axes to levels per JSC specifications without causing any degradation.

F 20. The total nozzle severance system is capable of surviving two shocks in each axis per TWR-13230.

F 21. The NSD was qualified for and successfully used on the Apollo, Command Module, and Shuttle Program. Eight-foot and forty-foot drop tests were performed, completed, and met or exceeded engineering specification requirements per Qualification Report SOS-TR-6068.

22. The NSD was verified for use on the RSRM in the following ways per JSC specifications:

F a. Vibration and high-temperature test
F b. Vibration and low-temperature test
F c. Eight-foot and forty-foot drop test
F d. Shock test

23. Supplier testing of this GFE item minimizes failure related to the listed causes and is controlled by JSC and should be addressed in the JSC Critical Items List. The NSD is tested by the supplier in the following ways per JSC specifications. Documentation of acceptability is per certificate.

D a. Internal static pressure leak test
D b. Hermetic seal test
D c. Examination of product
D d. Bridge wire resistance test
D e. Radiograph

595 E 24. Acceptance testing by the supplier consists of a number of NSDs from the lot that is test fired at a high temperature per JSC specification. Documentation is per certificate.

9.2 TEST AND INSPECTION:

DCN	FAILURE CAUSES and TESTS (T)			CIL CODES
		1.	For New NASA Standard Detonator verify:	
A,B,C,E	(T)	a.	NASA approved lot certification for flight	AKD006
D	(T)	b.	Certificate of conformance for the product	AKO006
		2.	For New Exit Cone Assembly--Nozzle, Aft verify:	
A,B,C,D	(T)	a.	Bridge wire resistance test on the NASA Standard Detonator	AGH005
A,B,C	(T)	b.	Electrical resistance and an open circuit between the cable assembly and the NASA Standard Detonator	CIC008
A,B,C,D		c.	Contamination of NSD just prior to installation	AGH007
A,B,C,D		d.	NASA approved lot certification for flight for the NASA Standard Detonator is complete and acceptable	AKD006A
D		e.	Detonator has at least one year of shelf life remaining at the time of installation	AKO001
D		f.	Measured resistance reading is within set limit of lot certification value	AGH016
D		g.	Damage to NSD just prior to installation	AGH010
E		h.	A complete uniform covering of insulation cork	AGH009D
E		i.	All foam standoffs are installed over the LSC and detonator	AGH009B
E		j.	Flap and blast shield are installed correctly	AGH009C
E		k.	Blast shield is bonded to aft exit cone assembly using adhesive	AGH004
E		l.	Blast shield scarf joint bond is acceptable	AGH002
E		m.	Blast shield screws are torqued as required	AGH001
F		n.	NSD torqued into initiation assembly clamp	AGH019
F		o.	Detonator and LSC cable connection are potted	AGH011