ATK ALLIANT TECHSYSTEMS
THIOKOL PROPULSION

CRITICAL ITEMS LIST (CIL)

No. 10-02-01-03R/02

SYSTEM:	Space Shuttle RSRM 10	CRITICALITY CATEGORY:	1
SUBSYSTEM:	Nozzle Subsystem 10-02	PART NAME:	Nose Inlet Assembly (1)
ASSEMBLY:	Nozzle and Aft Exit Cone 10-02-01	PART NO:	(See Section 6.0)
FMEA ITEM NO.:	10-02-01-03R Rev M	PHASE(S):	Boost (BT)
CIL REV NO.:	M (DCN-533)	QUANTITY:	(See Section 6.0)
DATE:	10 Apr 2002	EFFECTIVITY:	(See Table 101-6)
SUPERSEDES PAGE:	311-1ff.	HAZARD REF.:	BN-04
DATED:	31 Jul 2000		
CIL ANALYST:	B. A. Frandsen		
APPROVED BY:		DATE:	

RELIABILITY ENGINEERING: K. G. Sanofsky 10 Apr 2002

ENGINEERING: B. H. Prescott 10 Apr 2002

1.0 FAILURE CONDITION: Failure during operation (D)

2.0 FAILURE MODE: 2.0 Structural failure of the metal housing

3.0 FAILURE EFFECTS: Breakup causing loss of nozzle, RSRM, SRB, crew, and vehicle

4.0 FAILURE CAUSES (FC):

FC NO.	DESCRIPTION	FAILURE CAUSE KEY
2.1	Nonconforming dimensions	
2.1.1	Initial manufacturing dimensions	A
2.1.2	Metal dimensions reduced by corrosion and/or refurbishment	B
2.2	Nonconforming material	
2.2.1	Improper heat treatment	C
2.2.2	Nonconforming voids, inclusions, or other material defects	D
2.3	Fatigue	E
2.4	Stress-corrosion cracking	F
2.5	Transportation, handling, and assembly damage	G

5.0 REDUNDANCY SCREENS:

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

6.0 ITEM DESCRIPTION:

1. Nose Inlet Assembly, Nozzle consists of metal components (Figures 1 and 2). Materials are listed in Table 1.

TABLE 1. MATERIALS

Drawing No.	Name	Material	Specification	Quantity
1U75398	Housing Assembly-Nose	7075-T73 Aluminum	STW3-3155	1/motor
1U79324	Bearing Assembly, Nozzle Flexible			1/motor
1U77640	Segment, Rocket Motor, Aft			1/motor
	Corrosion-Preventive Compound and O-Ring Lubricant	Heavy-Duty Calcium Grease	STW5-2942	A/R
	Primer Coating, Corrosion-Resistant, Epoxy Resin	Epoxy Resin, Corrosion-Resistant	STW5-2914	A/R
	Enamel Protective Coating, Epoxy Resin	Epoxy Resin, Enamel	STW5-2922	A/R
	Chemical Coating	Alodine 1200 Chemical Coating	MIL-C-5541, Class 1A	A/R

6.1 CHARACTERISTICS:

1. The nose inlet housing is a component of the nozzle assembly. It is an aluminum forging attached to the throat support housing on the forward end, and the forward end ring on the aft end.

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

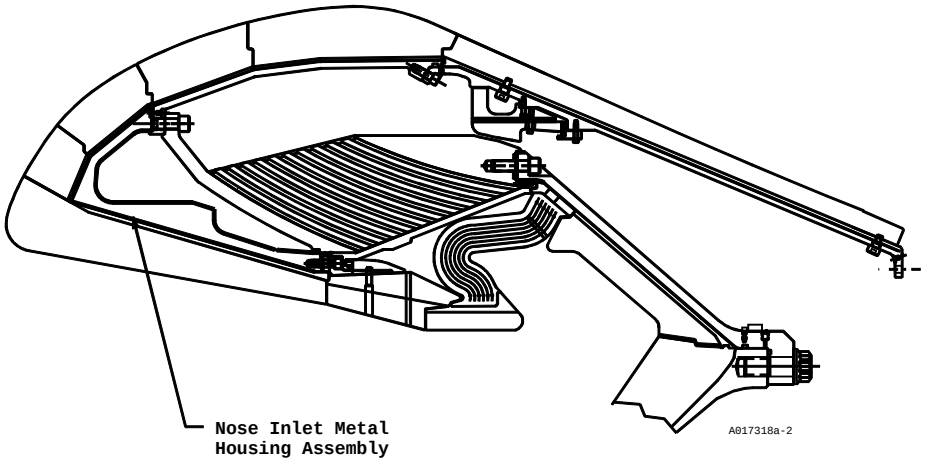

Figure 1. Nose Inlet Metal Housing Location

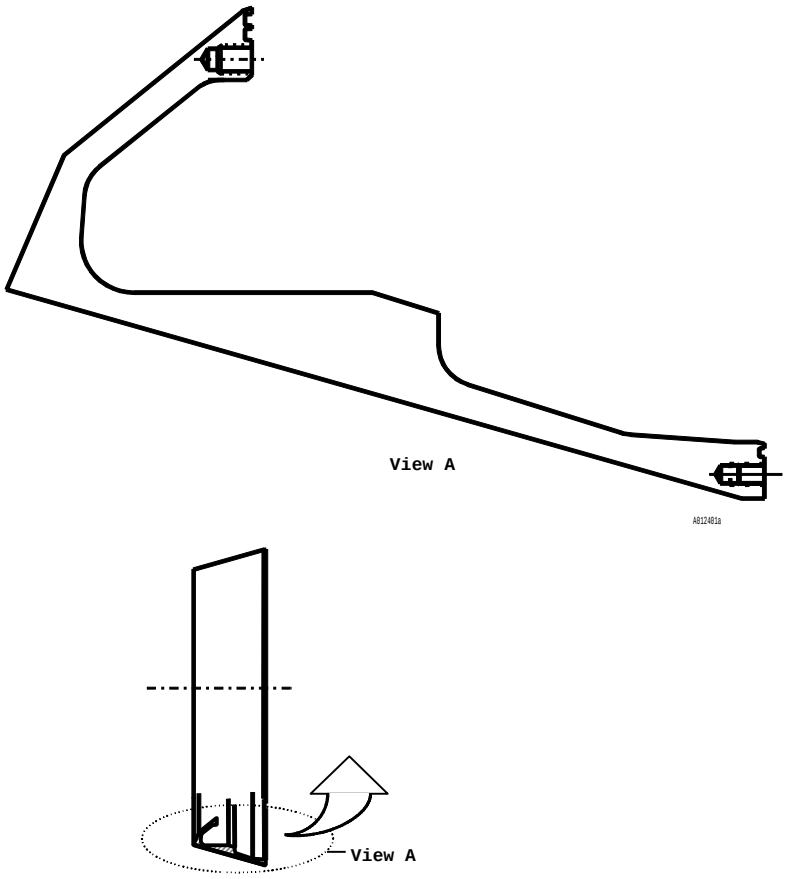

Figure 2. Nozzle Nose Inlet Metal Housing

9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN	FAILURE CAUSES	
A	1.	Nose inlet housing dimensions are per engineering drawings.
B	2.	Refurbished nose inlet housing dimensions are per engineering.
B	3.	Paint primer and paint coatings are applied to the nose inlet housing at designated surfaces per engineering to prevent corrosion.
B	4.	Alodine coating is applied to new and refurbished nose inlet housings.
A,B,C,D,E,F	5.	The nose inlet housing shows a positive margin of safety based on factors of safety of 1.4 ultimate and 1.1 on yield per TWR-16975.
A,B	6.	Assembly stresses are minimized as follows: a. Mating surface flatness is controlled by inspection of machining operations b. Threads are cleaned and lubricated prior to assembly c. Assembly bolts are torqued in a prearranged sequence to preload values
C,E,F	7.	The nose inlet housing is an aluminum forging. Composition and heat treatment are per engineering. This material is resistant to stress corrosion cracking per MSFC standards.
D,E,F	8.	The basic forging was analyzed per JSC specification SE-R-0006 and reported in TWR-10711. This report shows the forging to be free of re-entrant or sharply folded lines and that the principal grain flow is oriented parallel with the principal stresses expected.
C,D,E,F	9.	Analysis for useful life of the nose inlet housing is per TWR-16875.
C,D,E,F	10.	Refurbishment of the aluminum nose inlet housing is per engineering.
C,D,E,F	11.	Design verification analysis shows the materials and geometry of the nose inlet housing are acceptable for flight per TWR-18764-09.
C,E,F	12.	As part of the post-flight inspection plan, char and erosion of the nozzle insulation is inspected and analyzed. If char and erosion of the insulation are determined to be such that the supporting aluminum housing may have been exposed to high temperature, the suspect housing is analyzed. For Qualification and Production Verification motors, these char and eroding data were recorded per TWR-16473. For flight motors these data are recorded per TWR-50051.
G	13.	Transportation and handling of nozzle assembly items by Thiokol is per Thiokol IHM 29.
G	14.	The RSRM and its component parts, when protected per TWR-10299 and TWR-11325, are capable of being handled and transported by rail or other suitable means to and from fabrication, test, operational launch, recovery, retrieval, and refurbishment sites.
G	15.	Positive cradling or support devices and tie downs that conform to shape, size, weight, and contour of components to be transported are provided to support RSRM segments and other components. Shock mounting and other protective

devices are used on trucks and dollies to move sensitive loads per TWR-13880.

G 16. Support equipment used to test, handle, transport, and assemble or disassemble the RSRM is certified and verified per TWR-15723.

G 17. 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.

G 18. 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,F,G 19. Analysis of carbon-cloth phenolic ply angle changes for the nozzle was performed. Results show that redesigned nozzle phenolic components have a reduced in-plane fiber strain and wedge-out potential per TWR-16975. New loads that were driven by the Performance Enhancement (PE) Program were addressed in TWR-73984. No significant effects on the performance of the RSRM nozzle were identified due to PE.

533 E,F,G 20. Thermal analysis per TWR-17219 shows the nozzle phenolic meets the new performance factor equation based on the remaining virgin material after boost phase is complete. This performance factor will be equal to or greater than a safety factor of 1.4 for the nose inlet assembly per TWR-74238 and TWR-75135. (Carbon phenolic-to-glass interface, bondline temperature and metal housing temperatures were all taken into consideration). The new performance factor will insure that the CEI requirements will be met which requires that the bond between carbon and glass will not exceed 600 degree F, bondline of glass-to-metal remains at ambient temperature during boost phase, and the metal will not be heat affected at splashdown.

9.2 TEST AND INSPECTION:

DCN	FAILURE CAUSES and TESTS (T)			CIL CODE
		1.	For New Housing Assembly-Nose/Inlet, Nozzle verify:	
A,B		a.	Diameter	AFE026,AFE022,AFE017
A,B		b.	Profile	AFE126
A,B		c.	Run out	AFE135,AFE136
A,B		d.	Flatness	AFE009,AFE013
A,B		e.	Height	AFE050
A,B		f.	True position	AFE161,AFE161A
A,B		g.	Alodine coating applied to designated surfaces	AFE001
A,B		h.	Thickness of primer	AFE122
A,B		i.	Thickness of top coat	AFE098
C,D,E,F	(T)	j.	Material composition	AFE080
C,D,E,F	(T)	k.	Elongation	AFE083B
C,D,E,F	(T)	l.	Ultimate strength	AFE083
C,D,E,F	(T)	m.	Yield strength	AFE083A
C,D,E,F	(T)	n.	Ultrasonic	AFE166
C,D,E,F		o.	Dye penetrant	AFE051
C,D,E,F	(T)	p.	Proof test	AFE069
		2.	For Refurbished Housing Assembly-Nose/Inlet Nozzle verify:	
A,B		a.	Roundness	AFE132,AFE130
A,B		b.	Diameter	AFE015
A,B		c.	Straightness	AFE101,AFE103,AFE105,AFE107,AFE152
A,B,C,D,E,F		d.	Flatness	AFE154,AFE156
A,B		e.	Height	AFE048
A,B		f.	Wall thickness	AFE168
A,B		g.	Corrosion pitting	AFE004
A,B		h.	Tapped holes	AFE157
A,B		i.	Thickness of primer	HHH050
A,B		j.	Thickness of top coat	AFE098A
C,D,E,F		k.	Dye penetrant	AFE033
C,D,E,F		l.	Painted surfaces for indications of heat degradation	AFE097
C,D,E,F	(T)	m.	Proof test	AFE077
		3.	For New Bearing Assembly, Nozzle Flexible verify:	
C,D,E,F	(T)	a.	Tensile leak test	ADJ064
		4.	For Refurbished Bearing Assembly, Nozzle Flexible:	
C,D,E,F	(T)	a.	Verify tensile leak test	ADJ064A
		5.	For New Segment Assembly, Rocket Motor:	
G		a.	Verify nozzle assembly for handling damage and protective cover is cleaned and in place	AGJ167