CRITICAL ITEMS LIST (CIL)

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

SYSTEM:	Space Shuttle RSRM 10	CRITICALITY CATEGORY:	1
SUBSYSTEM:	Nozzle Subsystem 10-02	PART NAME:	Nozzle Final Assembly (1)
ASSEMBLY:	Nozzle and Aft Exit Cone 10-02-01	PART NO.:	(See Section 6.0)
FMEA ITEM NO.:	10-02-01-01R 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:	305-1ff.	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: 1.0 Performance mismatch between SRMs

3.0 FAILURE EFFECTS: No effect on RSRM. Thrust imbalance between SRBs causing loss of SRB, crew, and vehicle

4.0 FAILURE CAUSES (FC):

FC NO.	DESCRIPTION	FAILURE CAUSE KEY
1.1	Mismatched erosion between SRMs	A
1.2	Geometric differences between nozzles	B

5.0 REDUNDANCY SCREENS:

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

6.0 ITEM DESCRIPTION:

1. Nozzle Assembly, Final consists of structural steel and aluminum members protected against erosive, thermal, and pressure environments by carbon, silica, and glass phenolic liners (Figure 1). Materials are listed in Table 1.

TABLE 1. MATERIALS

Drawing No.	Name	Material	Specification	Quantity
	Carbon-Cloth Phenolic, Pre-impregnated	Carbon Cloth Reinforcement with Phenolic Resin	STW5-3279	A/R

6.1 CHARACTERISTICS:

1. The RSRM nozzle assembly is a partially submerged, convergent-divergent movable design containing an aft pivot point flexible bearing as the vector mechanism. The assembly has an omni-directional Thrust Vector Control (TVC) deflection capability of 8 degree in a free state, but is constrained by two actuators to approximately 6.5 degrees. Dual-action, hydraulic-powered actuators are attached to the aft skirt below the kick ring and to the RSRM actuator attach brackets located next to the exit cone compliance ring to provide nozzle deflection.

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

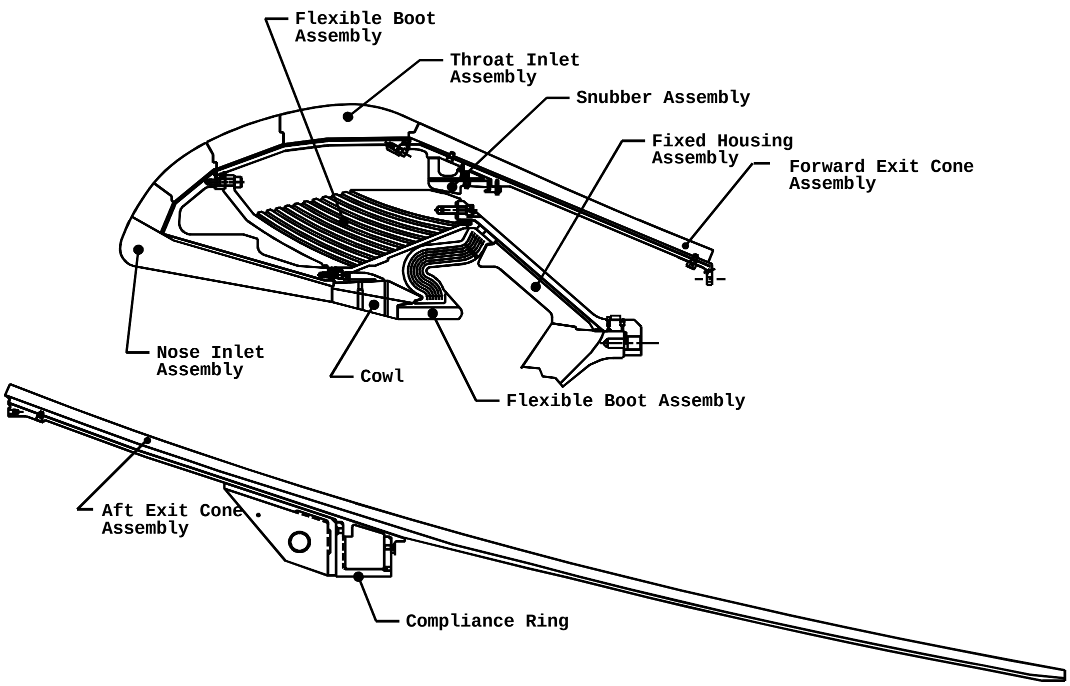

Figure 1. Nozzle Final Assembly

9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN FAILURE CAUSES:

DCN	Failure Cause	No.	Rationale
	A	1.	Ablative material is limited to Carbon-Cloth Phenolic with low sodium and ash content to minimize erosion per engineering.
	A	2.	Carbon-cloth phenolic ply angles of the nozzle reduce fiber tensile strain and eliminate pocketing erosion. A series of sub-scale static tests for evaluating ply angle design were performed. The results showed smooth, uniform erosion distributed over the entire nose, inlet, and throat regions per TWR-14746.
	A	3.	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.
	A,B	4.	Machining and tooling provide the proper nozzle contour per TWR-10341.
	A,B	5.	Nozzle contour design is qualified per TWR-18764-09 and 11.
	A,B	6.	Ballistic history demonstrates that differences between matched pair motors were within the required limitations per TWR-14415.
	B	7.	Engineering drawings control the nozzle configuration.
	A,B	8.	Nozzle ablative surfaces are protected from environmental contamination and damage during storage and shipping by a foam nozzle plug, storage containers, and specially designed railcars per TWR-16563 and TWR-13880.
	A,B	9.	The record review department has the functional assignment of a record review buy-off (for a complete nozzle build buy-off).
533	A	10.	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 nozzle phenolics 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 CODES
		1.	For New Nozzle Assembly, Final verify:	
	A,B	a.	By review of accept tags that end items are acceptable	ADR071