CRITICAL ITEMS LIST (CIL)

No. 10-05-04-03R/02

SYSTEM:	Space Shuttle RSRM 10	CRITICALITY CATEGORY:	1
SUBSYSTEM:	Assembly Hardware/Interface 10-05	PART NAME:	Forward-to-Aft Exit Cone Joint, Sealing Compound (1)
ASSEMBLY:	Fwd-to-Aft Exit Cone Interface 10-05-04		
FMEA ITEM NO.:	10-05-04-03R Rev M	PART NO.:	(See Section 6.0)
CIL REV NO.:	M (DCN-533)	PHASE(S):	Boost (BT)
DATE:	10 Apr 2002	QUANTITY:	(See Section 6.0)
SUPERSEDES PAGE:	359-1ff.	EFFECTIVITY:	(See Table 101-6)
DATED:	31 Jul 2000	HAZARD REF.:	BN-02
CIL ANALYST:	R. E. L. Hamilton		
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 Thermal failure

3.0 FAILURE EFFECTS: Burn-through of the primary and secondary O-rings. Burn-through of metal housing and loss of Aft Exit Cone resulting in thrust imbalance between SRBs causing loss of RSRM, SRB, crew, and vehicle

4.0 FAILURE CAUSES (FC):

FC NO.	DESCRIPTION	FAILURE CAUSE KEY
1.1	Failure of sealant (bond line, void, tears, cracks)	
1.1.1	Sealing compound surfaces not properly prepared or adequately cleaned	A
1.1.2	Primer and sealing compound not properly mixed, applied, or cured	B
1.1.3	Contamination	C
1.1.4	Process environments detrimental to bond strength	D
1.1.5	Nonconforming material properties	E

5.0 REDUNDANCY SCREENS:

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

6.0 ITEM DESCRIPTION:

1. Sealing compound provides thermal protection between the two nozzle assembly items at their phenolic surface interface. A gap is provided between the two phenolic surfaces for the following reasons:

   a. To allow thermal expansion of nozzle assembly parts during motor burn
   b. To allow positive and full surface mate-up while providing for surface contour tolerances

2. Sealing compound is pressure back filled into the gap between the two nozzle assembly items after the two items are bolted together and the leak test was successfully performed. The assembled joint is per engineering drawings (Figures 1 and 2).

TABLE 1. MATERIALS

Drawing No.	Name	Material	Specification	Quantity
1U77647	Aft Booster Build-up--KSC			1/motor
1U77640	Segment, Rocket Motor, Aft			1/motor
1U79157	Exit Cone Assembly-Nozzle, Aft			1/motor
	Primer (Adhesive-Sealant Silicone RTV)	A One-Part Dilute Solution of Reactive Solvent	STW4-3875	A/R
	Sealing Compound (Sealant, Silicone, RTV)	A Two-Part, Room-Temperature Vulcanizing Silicon Rubber	STW5-2813	A/R

6.1 CHARACTERISTICS:

1. The unit is bolted together with silicone rubber material pressure back filled into the gap between the two nozzle assembly items. Sealing compound is back filled into the gap deeper than the maximum expected char line.

2. Sealing compound provides an ablative high-temperature flexible thermal barrier for nozzle phenolic layers that face together at the joint. The function of sealant is to protect joint metal components from heat affect and the O-rings from erosion.

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

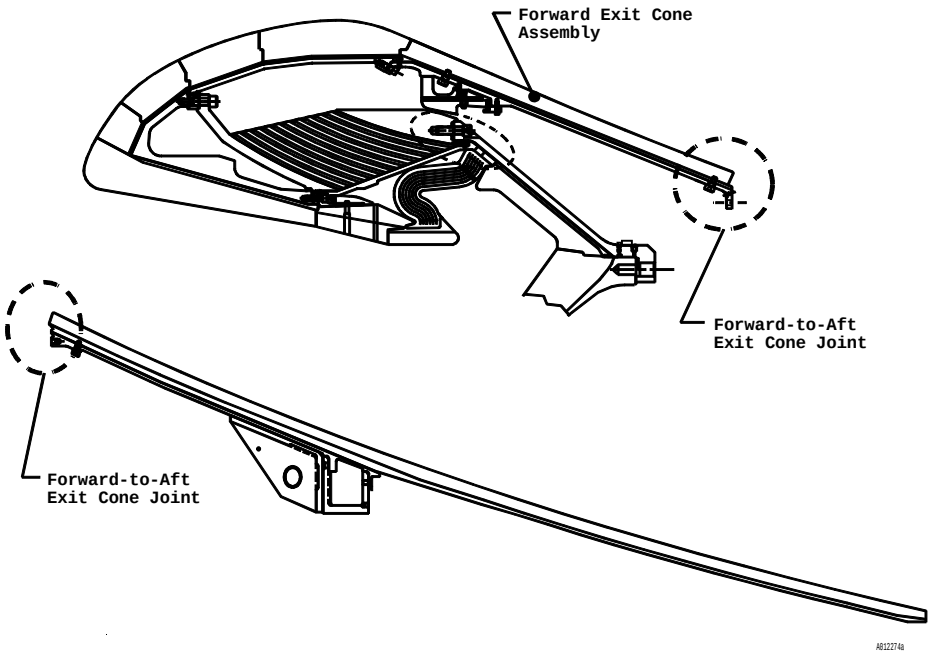

Figure 1. Forward-to-Aft Exit Cone Joint Location

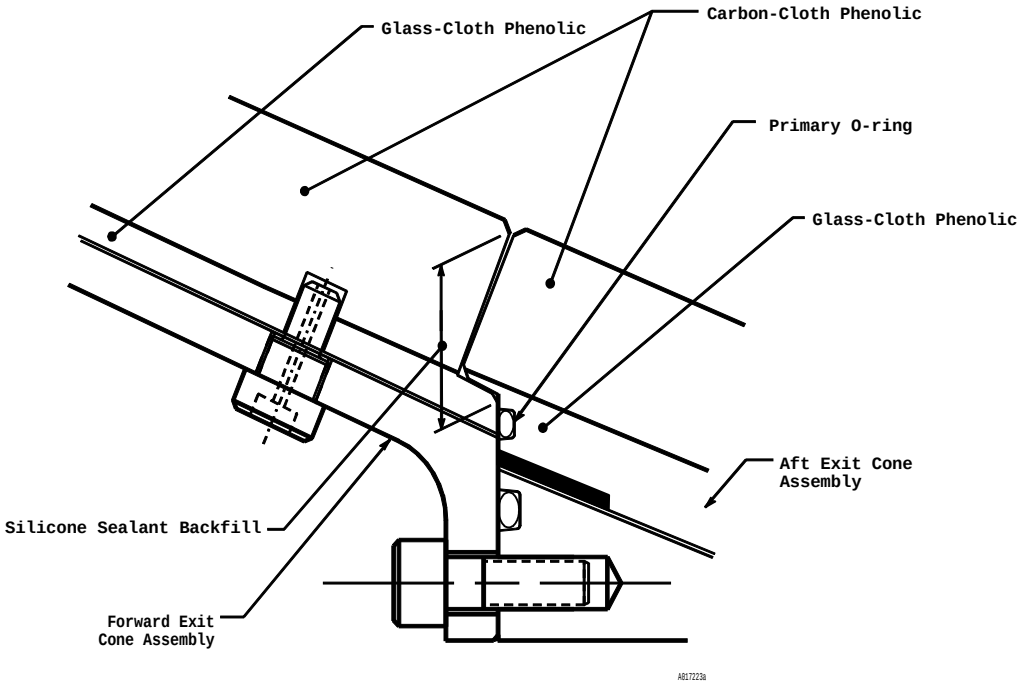

Figure 2. Forward-to-Aft Exit Cone Joint, Sealing Compound

9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN	FAILURE CAUSES	
	A	1. Interface surfaces are cleaned and inspected prior to application of primer and sealing compound per engineering drawings.
	A,B,C,D,E	2. Sealing compound and method of application were qualified through testing. Results of these tests are documented in TWR-18764-11.
	A,B,C,D,E	3. Exit cone RTV primer and silicone sealing compound are verified for life requirements, formulation, mixing, surface preparation, application, cure and physical properties.
	B	4. Two-part sealing compound mix ratio is controlled per engineering and mixing instructions per shop planning.
	B	5. Primer is prepared by the supplier per engineering.
	B	6. Primer and sealing compound application and cure are controlled per engineering drawings and shop planning.
	C,D	7. Primer is a one-component, Room-Temperature Vulcanizing (RTV) silicone.
	C,D	8. Sealant, Silicone, RTV is a two-part, RTV silicone elastomer, supplied in separate sealed containers.
	C,D	9. Overall contamination requirements and process environmental control of shuttle processing facilities are established per JSC Specification SN-C-0005. Detailed requirements are in OMRSD File V, Volume I.
	E	10. Material properties for primer and sealing compound are controlled per engineering.
	E	11. Sealing compound consists of a silicone rubber base and a catalyst. The supplier supplies the correct amount of each component material to achieve the proper mix ratio per engineering.
	D	12. 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 performance of the RSRM nozzle were identified due to PE.
533	D	13. 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 forward exit cone assembly and the aft exit cone 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 Adhesive-Sealant Silicone RTV verify:	
C		a.	Contains no foreign matter	AIY002
C		b.	Material is homogeneous	AIY004
E		c.	Primer color	AIY001
E	(T)	d.	Specific gravity	AIY007
E	(T)	e.	Total solids content	AIY015
		2.	For New Sealant, Silicone, RTV verify:	
C		a.	Shipping and handling damage	ADQ223
C		b.	Workmanship is uniform in appearance, quality and color	ANF045
E	(T)	c.	Elongation	ANF000,ANF002,ANF004
E	(T)	d.	Flow	ANF011,ANF013
E	(T)	e.	Shore A hardness	ANF021,ANF023,SAA042
E	(T)	f.	Specific gravity	ANF029,ANF031,SAA043
E	(T)	g.	Tensile strength	ANF037,ANF039,ANF040
		3.	KSC verifies:	
A,B,C,D,E	(T)	a.	Life requirements, formulation, mixing, surface preparation, application, cure and physical properties for materials applied at KSC per OMRSD File V, Vol I, B09GEN.010	OMD023
A		b.	Forward exit cone mating surfaces prior to assembly to ensure absence of damage or contamination per OMRSD File V, Vol I, B47SG0.072	OMD080
A		c.	Aft exit cone mating surfaces for damage or contamination prior to application of primer and again just prior to assembly (including blacklight inspection for contamination) per OMRSD File V, Vol I, B47NZ0.032	OMD048
B,D		d.	Silicone sealing compound and exit cone mating surface temperatures are within specified limits prior to application per OMRSD File V, Vol I, B47NZ0.140	OMD059