

SRB CRITICAL ITEMS LIST

SUBSYSTEM: STRUCTURES AND MISCELLANEOUS ITEMS

ITEM NAME: Thermal Protection System - Aft Skirt Kick Ring

PART NO.: 10115-0001 (LH),
10116-0001 (RH)

FM CODE: A02

ITEM CODE: 60-03-08

REVISION: Basic

CRITICALITY CATEGORY: 1

REACTION TIME: Seconds

NO. REQUIRED: 1

DATE: March 1, 2001

CRITICAL PHASES: Boost

SUPERCEDES: March 31, 1999

FMEA PAGE NO.: E-37

ANALYST: R. Raley/S. Parvathaneni

SHEET 1 OF 8

APPROVED: S. Parvathaneni

CN 042

CN 042

CN 042

CN 042

FAILURE MODE AND CAUSES: Loss of Kick Ring thermal protection caused by:

- Degraded thermal or physical properties due to improper constituents, layup and cure, delamination or natural environments. (Degraded Properties)
- Inadequate TPS thickness. (Inadequate Thickness)
- Fastener system failure. (Fastener System Failure)

FAILURE EFFECT SUMMARY: Loss of mission, vehicle and crew due to loss of flight control and/or recontact of SRB with ET/Orbiter.

RATIONALE FOR RETENTION:

A. DESIGN

- The Kick Ring is insulated with molded glass phenolic segments (0.25 inch thick) that are mechanically attached to stand-offs on the Kick Ring. Fasteners on the Forward side are oversealed with RTV-133 sealant. Cork insulated panels are used between the Kick Ring and systems tunnel. Sealing to prevent hot gas flow is accomplished with RTV rubber seals, K5NA/RT 455 (ALT.) and RTV-133.
- Thermal protection requirements are presented in SE-019-068-2H, (SRB Thermal Design Data Book). Thermal insulation requirements were established by test and analysis.
- Material properties were determined by development testing at the MSFC Modified Hot Gas Facility and Aerotherm Arc Jet Facility. The range of thermal environments, acoustic and vibration, stress and pressure loads were obtained from applicable documentation and encompassed the maximum

CN 042

and minimum values. Design properties derived from these tests are reported in SE-019-068-2H. Verification testing was performed per "SRB/TPS Verification Test Plan," NASA Letters EP44 (79-54), EP44 (79-79), EP44 (79-120) and EE11 (S-80-34) using analytically determined TPS material thicknesses, maximum heat loads and rates for the applicable regions, and representative model configurations. Subsequent changes in TPS materials, thickness, configuration, etc. were verified on an individual basis using current environments and loads. (e.g. Addition of BTA as alternate material to K5NA/RT 455 (ALT.) was authorized by approval of ECP-2850F.)

Subsequent changes in SRB environments were reviewed to verify that original verification parameters were not exceeded.

CN 042

- O Certification was performed per document SE-019-149-2H, (SRB/TPS Certification Plan.) Subsequent changes in TPS materials and/or thickness or configuration will be certified based on verification test results. Changes to certification requirements (environments and/or loads) are reviewed to verify that existing requirements are not exceeded.
- O The following Certificates of Qualification (COQs) are applicable to the TPS materials required:

Glass Phenolic

- Laminate - USA SRBE COQ A-TPS-8116
- Silicon Seal - USA SRBE COQ A-TPS-8114
- Cork/EC-2216 B/A
- Clear Amber Adhesive - USA SRBE COQ A-TPS-8109
- K5NA - USA SRBE COQ A-TPS-8108
- BTA - USA SRBE COQ A-TPS-8120
- Deft - USA SRBE COQ A-TPS-8125
- RTV-133 - USA SRBE COQ A-TPS-8102
- Zinc Primers - USA SRBE COQ A-TPS-8129
- RT 455 - USA SRBE COQ A-TPS-8130

CN 042

- O Analysis indicates that with a design factor of safety of 1.4, a margin of safety of + 0.22 exists on the Fastener system with the maximum ascent loads.
- O The Aft Skirt Kick Ring glass phenolic components requirements are specified on USA SRBE drawings 10752-0009 thru -0013, -0018, -0069, and -0072 thru -0075 (Ring Segment Assemblies, Ring Splice Covers, etc.). The cork insulated panel requirements are specified on 10751-0040 and 10751-0041 (Insulated Closure Panel). Installation and closeout of the Kick Ring thermal protection components are specified on USA SRBE drawings 10115-0003, 10116-0003 (Kick Ring Insulation Installation). 10115-0008, 10116-0008 (TPS Closeout Installation) and 10111-0036 (Insulation Closeout, Aft Booster Assembly). Other documents controlling Aft Skirt Kick Ring insulation requirements include:

O Glass Phenolic Laminate:

10SPC-0007 Specification for Insulation, Laminate, Glass Phenolic

O Cork/EC-2216 B/A Clear Amber Adhesive:

10753-0009 Cork Insulation
 10753-0007 Adhesive Cork Bonding
 10PRC-0018 Insulation Application, Cork

O BTA:

10753-0032 BTA Insulation Formulation
 10PRC-0546 BTA Procedure for Troweled Application

O K5NA/RT 455 (ALT.) :

MSFC-SPEC-1918 Ablative Compound, Thermal
 MSFC-SPEC-1919 Ablative Compound, Thermal, Application and Cure of

■
 CN 042

O RTV-133:

10753-0014 Adhesive, RTV
 10PRC-0025 Procedure for RTV-133, Application

O Substrate Protective Finish:

10A00527 Sealing of Fasteners Subject to Seawater Exposure on the SRB, excluding the SRM.
 10PRC-0442 Protective Finish for Aluminum and Steel Alloys

O Remove all TPS after every flight

B. TESTING

Testing of the glass phenolic material by the vendor is accomplished in accordance with 10SPC-0007.

Testing to verify the acceptability of the insulation application is accomplished in accordance with the following:

- O Materials vendor tests/certifies the proper composition/formulation of basic glass phenolic materials, seals, etc. (Degraded Properties)
- O Vendor of Kick Ring phenolic parts performs tests in accordance with 10SPC-0007 to verify acceptable volatiles content, resin content and resin flow of the uncured material. Each roll of material requires testing. Vendor prepares and tests flat laminate test panels in accordance with 10SPC-0007 to verify acceptable interlaminar shear strength of the cured material. The number of tests required depends on the number of rolls in each lot. (Degraded Properties/Debonding)

- O Cork application is verified per 10REQ-0021, para. 4.1.4.
 - o Cork/adhesive bonding verification is accomplished by fabricating one cork panel for each day of cork application operations. The panel is processed into four flatwise tensile specimens and one test panel for topcoat analysis. (Degraded Properties/Debonding)
- O K5NA/RT 455 (ALT.) acceptability is verified per OMRSD File V, Vol. I, requirement no. B09GEN.010, 10REQ-0021 para. 4.1.3 and MSFC-SPEC-1918/MSFC-SPEC-1919.
 - o To verify acceptability of K5NA/RT 455 (ALT.) constituents, formulation, mixing, application and cure for each lot of K5NA/RT 455 (ALT.) submitted for acceptance, vendor performs tests such as tensile, hardness, specific gravity and thermogravimetric analysis (TGA). (Degraded Properties) CN 042
 - o To verify acceptability of K5NA/RT 455 (ALT.) constituents, formulation, mixing application and cure for production hardware, three tensile specimens are prepared and tested from at least one batch mixed, for each day of K5NA/RT 455 (ALT.) processing. Hardness is verified for each batch and on the hardware. (Degraded Properties). CN 042
- O BTA acceptability is verified per 10REQ-0021, para. 4.1.2
 - o To verify acceptability of BTA constituents, formulation, mixing, application and cure, three tensile specimens and two density coupons are prepared and tested from at least one batch mixed, for each day of BTA processing. Hardness is measured on the density coupons and on the flight hardware. (Degraded Properties) CN 042
- O Glass phenolic component thickness is determined by the number of plies and the required thickness is verified by inspection. (Inadequate Thickness)
- O Cork thickness is verified by part number and inspection. (Inadequate Thickness)
- O Vendor certifies fastener material and strength. (Fastener System Failure)

C. INSPECTION

Inspections to verify the acceptability of glass phenolic components at the vendors facility are accomplished in accordance with 10SPC-0007 and USA SRBE SIP 1268. (Degraded Properties)

- O USA SRBE QAR verifies glass phenolic component material certification in accordance with SIP 1268. (Degraded Properties)
- O USA SRBE QAR verifies that all steps on vendor manufacturing paper are accepted by vendor QA and completed for each shipment in accordance with SIP 1268 and verifies test data. (Degraded Properties)
- O BTA acceptability is verified per 10REQ-0021, para. 4.1.2., including the following:
 - o Preparation of surfaces to be insulated: verify that the surface is abraded, clean and dry before insulation application is made. (Debonding)
 - o Formulation of each mix of BTA insulation: verify formulation and mixing of basic ingredients. (Degraded Properties)

- o Completion of cure: verify BTA material is cured and ready for subsequent operations based on three hardness tests. (Degraded Properties)
- o Finishing and Inspection: Verify that the BTA after cure is free of defects such as unacceptable sags, voids, cracks and holes. (Degraded Properties)
- o Thickness and integrity of application: Verify BTA applications for compliance with drawing requirements or that the BTA thickness is equal to adjacent insulation thickness and has a smooth surface finish. (Inadequate Thickness)
- O To ensure that RTV insulations meet requirements, the acceptability of mixing, surface preparation, application and cure are verified per OMRSD File V, Vol. 1, Requirement number B09GEN.010. (Degraded Properties/Debonding)
- O K5NA/RT 455 (ALT.) acceptability is verified per 10REQ-0021, para. 4.1.3, including the following:
 - o Preparation of surfaces to be insulated: verify that the surface is abraded, clean and dry before insulation application is made. (Debonding) CN 042
 - o Verification of the formulation of each lot of K5NA/RT 455 (ALT.) insulation received. (Degraded Properties) CN 042
 - o Completion of cure: verify hardness meets Durometer type D 15 minimum. (Degraded Properties)
 - o Thickness and integrity of application: verify K5NA/RT 455 (ALT.) applications for compliance with drawing requirements or that the K5NA/RT 455 (ALT.) thickness is equal to adjacent insulation thickness and has a smooth surface finish. (Inadequate Thickness) CN 042
- O Cork insulation acceptability is verified per 10REQ-0021, para. 4.1.4 including the following:
 - o Preparation of surfaces to be insulated: verify that the surface is abraded, clean and dry before insulation application is made. (Debonding)
 - o Proper formulation and mixing of adhesive (EC-2216 B/A): verify formulation and mixing of amber adhesive accelerator (Part A) to adhesive base (Part B). (Degraded Properties)
 - o Cork thickness: verify cork thickness is in compliance with drawing requirements. (Inadequate Thickness)
 - o Integrity of bonded cork: inspect bonded cork for integrity of cured bond lines, and absence of wrinkles, cracks and blisters. (Debonding)
 - o Verify process control acceptance of cork bonding by flatwise tensile strength tests. (Debonding)
- O Topcoat (chlorosulfonated polyethylene paint) application acceptability is verified per 10REQ-0021, para. 4.1.5.
 - o Preparation of surfaces to be insulated: verify that the surface is abraded, clean and dry before insulation application is made. (Debonding)
 - o Formulation of each mix of topcoat material: verify chlorosulfonated polyethylene paint/activator mix ratio by weight. (Degraded Properties)
 - o Topcoat application integrity and thickness: verify dry tape test adhesion and topcoat thickness on test panel. Inspect completed topcoat application after final coat is complete for absence of overspray, blisters, sags, runs, cracking, peeling and discoloration. (Degraded Properties/Debonding)

- O USA SRBE QAR verifies that glass phenolic components are per drawing requirements in accordance with SIP 1268. (Inadequate Thickness)
- O Perform TPS assessment walkdown inspection prior to rollout per OMRSD File V, Vol. 1, requirement number B09TP0.010.
 - o Visually assess the TPS (Cork, K5NA/RT 455 (ALT.) , SLA-220, Glass Phenolic Laminate, etc.) to identify possible degradation or damage. (Degraded Properties) CN 042
- O Visual inspection verifies the integrity of TPS and/or TPS topcoat on the aft skirt kick ring per OMRSD File V, Vol. 1, requirement number B09TP0.010. (Degraded Properties)
- O Perform a visual assessment of the Integrity of TPS and/or TPS topcoat on all applicable flight structures per 10REQ-0021, para., 4.1.7.1 prior to transfer to SPC.
 - o Visually assess the TPS (Cork, K5NA/RT 455 (ALT.) , etc.) to identify possible damage or degradation prior to delivery to SPC. (Degraded Properties) CN 042
- O Shelf life, formulation, mixing, surface preparation, application, cure and physical properties of K5NA/RT 455 (ALT.) are verified per OMRSD File V, Vol. 1, requirement number B09GEN.010. Visual inspection of the TPS closeout application verifies that there is no cracking, evidence of contamination, fungus, or debonding on the Aft Skirt Kick Ring per OMRSD File V, Vol. 1, requirement number B09TP0.020. (Degraded Properties/Debonding) CN 042
- O To verify acceptability of fastener system, installation of fasteners is witnessed and verified by USA SRBE or SPC Quality, (Fastener System Failure) in accordance with drawings 10111-0032, 10115-0003 and 10116-0002. (Degraded Properties)

Critical Processes/Inspections:

- O Glass phenolic laminate processing per 10SPC-0007
- O Cork application per 10PRC-0018
- O K5NA/RT 455 (ALT.) application per MSFC-SPEC-1919
- O Insulation topcoat application per 10PRC-0028 CN 042
- O Substrate protective finish per 10PRC-0442
- O BTA application per 10PRC-0546
- O RTV-133 application per 10PRC-0025

D. FAILURE HISTORY

- O Failure Histories may be obtained from the PRACA database.

E. OPERATIONAL USE

- O Not applicable to this failure mode.

THIS PAGE INTENTIONALLY LEFT BLANK