

SRB CRITICAL ITEMS LIST

SUBSYSTEM: STRUCTURES AND MISCELLANEOUS ITEMS

ITEM NAME: Thermal Protection System - Range Safety Crossover Components

PART NO.: 10756-0001 through FM CODE: A01  
10756-0005, 10756-0013  
through 10756-0015 and  
10100-0061

ITEM CODE: 60-03-13 REVISION: Basic

CRITICALITY CATEGORY: 1 REACTION TIME: Seconds

NO. REQUIRED: 1 Set DATE: March 1, 2001

CRITICAL PHASES: Boost, Separation SUPERCEDES: March 31, 1998

FMEA PAGE NO.: E-47 ANALYST: W. Keller/S. Parvathaneni

SHEET 1 OF 7 APPROVED: S. Parvathaneni

DCN 042

DCN 042

DCN 042

FAILURE MODE AND CAUSES: Loss of Range Safety crossover components thermal protection system caused by:

- O Degraded thermal or physical properties due to improper constituents formulation, mixing, application cure or natural environments. (Degraded Properties)
- O Inadequate TPS thickness. (Inadequate thickness)
- O Debonding due to improper application of substrate paint system, improper substrate preparation, adhesive failure or improper application of insulation topcoat. (Debonding)

FAILURE EFFECT SUMMARY: Loss of mission, vehicle and crew due to generated debris contacting the ET or orbiter.

RATIONALE FOR RETENTION:

A. DESIGN

- O The Range Safety crossover components are insulated with 0.25 inch thick cork bonded with EC-2216 B/A Clear Amber adhesive. Repair and closeout are accomplished with K5NA/RT 455 (ALT.) or BTA. After SRB/ET mate, the installed components are closed out with K5NA/RT 455 (ALT.) and RTV-133.

DCN 042

- O Thermal protection requirements are presented in SE-019-068-2H (SRB thermal design data book). Thermal insulation requirements were established by test and analysis.

- O Material properties were determined by development testing at the MSFC modified hot gas facility, AEDC and AMES wind tunnels. The range of thermal environments, acoustic and vibration, stress and pressure loads were obtained from applicable documentation and encompasses the maximum and minimum values. Design properties derived from these tests are reported in SE-019-068-2H.
- O Verification testing was performed per "SRB/TPS verification test plan." NASA letters EP44(79-54), 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, subsequent changes in SRB environments were reviewed to verify that original verification parameters were not exceeded. (Addition of BTA as an alternate TPS closeout material was authorized by approval of ECP 2850.)
- 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 are applicable to the TPS materials required:
  - o Cork/EC - 2216 B/A Clear Amber adhesive - USA SRBE COQ A-TPS-8109
  - o K5NA - USA SRBE COQ A-TPS-8108
  - o BTA - USA SRBE COQ A-TPS-8120
  - o Hypalon - USA SRBE COQ A-TPS-8106
  - o Deft - USA SRBE COQ A-TPS-8125
  - o RTV-133 - USA SRBE COQ A-TPS-8102
  - o Zinc Primers - USA SRBE COQ A-TPS-8129
  - o RT 455 - USA SRBE COQ A-TPS-8130
  - o Hentzen - USA SRBE COQ A-TPS-8131

DCN 042

- O Range safety crossover components insulation requirements (materials, thickness, etc.) are specified on USA SRBE drawings 10756-0001 through 10756-0005, 10756-0013 through 10756-0015 (Insulated Transition, Disconnect, Cover and Support Assemblies). Closeout of the insulated components is defined on drawings 10121-0007, 10122-0007 (Insulation Closeout Installation, Fwd Skirt, LH and RH) and 10100-0059 (SRB TPS Closeout Installation).
- O Other documents controlling strut cover insulation requirements include:
  - o Cork/EC-2216 B/A clear amber adhesive:
    - 10753-0009 Cork, Insulation
    - 10753-0007 Adhesive Cork Bonding
    - 10PRC-0018 Insulation Application, Cork

- o Substrate protective finish:
  - 10A00527 Sealing of Fasteners subject to seawater exposure on the SRB
  - 10PRC-0442 Protective finish for aluminum and steel alloys
  
- o K5NA/RT 455 (ALT.):
  - MSFC-SPEC-1918 Ablative Compound, Thermal
  - MSFC-SPEC-1919 Ablative Compound, Thermal, Application and Cure of
  
- o BTA:
  - 10753-0032 BTA Insulation Formulation
  - 10PRC-0546 BTA Procedure for Troweled Application
  
- o Insulation Topcoat:
  - 10PRC-0013 Paint, Chlorosulfonated Polyethylene 09463
  - 10PRC-0028 TPS Topcoat, Application of
  
- o RTV-133:
  - 10753-0014 Adhesive, RTV
  - 10PRC-0025 Procedure for RTV-133, Application
  
- O Remove all TPS after every flight
  
- B. TESTING
  
- O Testing to verify the acceptability of the insulation application is accomplished in accordance with the following:

DCN 042

- 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)
  - 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).
- 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)
- O Vendor part number and inspection verifies cork thickness. MTA-2, K5NA/RT 455 (ALT.) and RTV-133 thickness is verified by inspection. (Inadequate thickness)

DCN 042

DCN 042

DCN 042

DCN 042

C. INSPECTION

- 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 K5NA/RT 455 (ALT.) acceptability is verified per 10REQ-0021, para. 4.1.3, including the following:

DCN 042

- o Preparation of surfaces to be insulated: verify that the surface is abraded, clean and dry before insulation application is made. (Debonding)
- o Verification of the formulation of each lot of K5NA/RT 455 (ALT.) insulation received. (Degraded Properties)
- o Application of K5NA/RT 455 (ALT.): verify that K5NA/RT 455 (ALT.) is applied within the application life. (Degraded Properties)
- 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)

DCN 042

DCN 042

DCN 042

- 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 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 quality verifies that substrate protective finish meets drawing and 10PRC-0442 requirements. (Debonding)
- 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)
- DCN 042
- O Shelf life, formulation, mixing, surface preparation, application, cure and physical properties of K5NA/RT 455 (ALT.) and RTV-133 are verified per OMRSD File V, Vol. 1, requirement number B09GEN.010. (Degraded Properties/Debonding)
- DCN 042
- O Visual inspection verifies the integrity of TPS and/or TPS topcoat on the Range Safety crossover components per OMRSD File V, Vol. 1, requirement number B09TP0.010. (Degraded Properties/Debonding)
- 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)

DCN 042

- O TPS closeout application inspection is performed after completion of K5NA/RT 455 (ALT.) cure per OMRSD File V, Vol. 1, requirement number B09TP0.020. (Inadequate Thickness/Debonding)

DCN 042

CRITICAL PROCESSES/INSPECTION:

- O Cork application per 10PRC-0018
- O BTA application per 10PRC-0546
- O K5NA/RT 455 (ALT.) application per MSFC-SPEC-1919
- O Insulation topcoat application per 10PRC-0028
- O Substrate protective finish per 10PRC-0442
- O RTV-133 application per 10PRC-0025

DCN 042

D. FAILURE HISTORY

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

E. OPERATIONAL USE

- o Not applicable to this failure mode.