

SRB CRITICAL ITEMS LIST

SUBSYSTEM: STRUCTURES AND MISCELLANEOUS ITEMS

ITEM NAME: Thermal Protection System - Nose Cap

PART NO.: 10750-0022

FM CODE: A01

ITEM CODE: 60-03-01

REVISION: Basic

CRITICALITY CATEGORY: 1

REACTION TIME: Seconds

NO. REQUIRED: 1

DATE: March 1, 2001

CRITICAL PHASES: Boost, Separation

SUPERCEDES: March 31, 2000

FMEA PAGE NO.: E-28

ANALYST: S. Parvathaneni

SHEET 1 OF 7

APPROVED: S. Parvathaneni

DCN 042

DCN 042

FAILURE MODE AND CAUSES: Loss of Nose Cap thermal protection 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 or improper application of insulation and insulation topcoat. (Debonding)

FAILURE EFFECT SUMMARY: Loss of mission, vehicle and crew caused by SRB breakup and/or generated debris contacting the ET or Orbiter.

RATIONALE FOR RETENTION:

A. DESIGN

- O The Nose Cap is insulated with 0.150-0.300 inch thick MCC-1 (Marshall Convergent Coating). Closeout and repair are accomplished with K5NA/RT 455 (ALT.) or BTA.
- 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 environment, acoustic and vibration, and stress loads were

DCN 042

obtained from applicable documentation and encompassed 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), EP44 (79-120), EE11 (S-80-34) and 10PLN-0061 using analytically determined TPS material thicknesses, maximum heat loads and rates for the applicable regions, and representative model configurations. Thermal analysis, as reported in MSFC Memo EP44 (79-49) and USA SRBE memo RGE-006-88E, indicates that 0.125 inch thick cork can be used on the Nose Cone. 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. The KSC Production Spray Facility was also certified by test; results are reported in MSFC memorandums EP44 (79-103), EP44 (81-91) and 10ENR-0006. Subsequent changes in TPS materials and/or thicknesses were certified based on verification test results. Changes to certification requirements (environments and/or loads) are reviewed to verify that existing requirements are not exceeded.

The following Certificates of Qualification (COQs) are applicable to the TPS materials required:

- MCC-1 - USA SRBE COQ A-TPS-8127
- Zinc Primers - USA SRBE COQ A-TPS-8129
- K5NA - USA SRBE COQ A-TPS-8108
- BTA - USA SRBE COQ A-TPS-8120
- Hypalon - USA SRBE COQ A-TPS-8106
- Deft - USA SRBE COQ A-TPS-8125
- RT 455 - USA SRBE COQ A-TPS-8130
- Hentzen - USA SRBE COQ A-TPS-8131

DCN 042

DCN 042

Nose Cap insulation requirements (materials, thickness, etc.) are specified on USA SRBE drawing 10750-0022 (Nose Cap, Insulated). Other documents controlling Nose Cap insulation requirements include:

- O MCC-1:
 - o 10753-0064 Marshall Convergent Coating, Sprayable
 - o 10PRC-0637 Procedure for Insulation Application

O Insulation Topcoat:

- o 10PRC-0013 Paint, Chlorosulfonated Polyethylene 09463
- o 10PRC-0028 TPS Topcoat, Application of

O K5NA/RT 455 (ALT.):

DCN 042

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

O BTA:

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

O Substrate Protective Finish

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

B. TESTING

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

- O MCC-1 acceptability is verified per 10REQ-0021, para., 4.1.1.2
 - o Acceptability of MCC-1 constituents, formulation, mixing, cure and proper adherence to substrate is verified by density testing and flatwise tensile tests. (Degraded Properties, Debonding)
 - o Thickness measurements (Eddy Current) are taken on flight hardware at 9 to 12 inch intervals over the area of application. (inadequate Thickness)

- 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 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)
DCN 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).
DCN 042
- O Topcoat application integrity is verified per 10REQ-0021, para. 4.1.5 by performing a dry tape test per test panel. (Debonding)

C. INSPECTION

- O MCC-1 acceptability is verified per 10REQ-0021, para., 4.1.1.2, including the following:
 - o Verify surfaces to be insulated are clean and dry before insulation application. (Debonding)
 - o Verify flow rate parameters are within acceptable range for resin, catalyst, glass eccosphere and K54 concentration. (Degraded Properties, Debonding)
 - o Verify process parameters are within acceptable range for air pressure, temperature, stand-off distance and humidity. (Degraded Properties, Debonding)
 - o Verify proper cure temperature and time cycle is followed. (Degraded Properties)
 - o Verify finish, thickness, and absence of voids. (Debonding, Inadequate Thickness)

- 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)
 - o Verification of the formulation of each lot of K5NA/RT 455 (ALT.) insulation received. (Degraded Properties)

DCN 042

DCN 042

- o Application of K5NA/RT 455 (ALT.): verify that K5NA/RT 455 (ALT.) is applied within the application life. (Degraded Properties) DCN 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) DCN 042
- O Topcoat (Chlorosulfonated Polyethylene Paint) application acceptability is verified per 10REQ-0021, para. 4.1.5.
 - o Preparation of insulated surfaces to be topcoated: 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 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 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.), MCC-1, SLA-220, Glass Phenolic Laminate, etc.) to identify possible degradation or damage. (Degraded Properties) DCN 042
- 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.), MCC-1, etc.) to identify possible damage or degradation prior to delivery to SPC. (Degraded Properties) DCN 042
- O USA SRBE PQAR verifies that substrate protective finish meets drawing and specification requirements in accordance with SIP 1500. (Debonding)
- O Visual inspections verify the integrity of TPS and/or topcoat on the Nose Cap prior to rollout per OMRSD File V, Vol. 1, requirement number B09TP0.010. (Degraded Properties/Debonding)

Critical Processes/Inspections:

- O MCC-1 application per 10PRC-0637
- O K5NA/RT 455 (ALT.) application per MSFC-SPEC-1919
- O Insulation topcoat application per 10PRC-0028
- O Substrate protective finish application per 10PRC-0442
- O BTA application per 10PRC-0546

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.