SRB CRITICAL ITEMS LIST

SUBSYSTEM: STRUCTURES AND MISCELLANEOUS ITEMS

ITEM NAME: Thermal Protection System - Forward Skirt Thrust Post

PART NO.: 10121-0040 (LH), 10122-0032 (RH)

FM CODE: A02

ITEM CODE: 60-03-03

REVISION: Basic

CRITICALITY CATEGORY: 1

REACTION TIME: Seconds

NO. REQUIRED: 1

DATE: March 1, 2002

CRITICAL PHASES: Boost, Separation

SUPERCEDES: March 1, 2001

FMEA PAGE NO.: E-31

ANALYST: S. Parvathaneni

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SHEET 1 OF 5

APPROVED: S. Parvathaneni

FAILURE MODE AND CAUSES: Loss of Forward Skirt Thrust Post 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, adhesive failure or improper application of insulation topcoat. (Debonding)

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

RATIONALE FOR RETENTION:

A. DESIGN

O The Forward Skirt thrust post is insulated with 0.125 and 0.250 inch thick cork bonded with EC-2216 B/A Clear Amber adhesive/MCC-1 (alternate). Closeout and repair are accomplished with K5NA/RT 455 (ALT.) or BTA. CN 044

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 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) 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, etc. were verified on an individual basis using current environments and loads. (Addition of BTA as an alternate TPS material was authorized by approval of ECP-2850) Subsequent changes in SRB environments were reviewed to verify that original verification parameters were not exceeded.

O Certification was performed per document SE-019-149-2H, SRB/TPS Certification Plan. Subsequent changes in TPS materials and/or thickness 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:

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
Hypalon - USA SRBE COQ A-TPS-8106
Deft - USA SRBE COQ A-TPS-8125
Zinc Primers - USA SRBE COQ A-TPS-8129
RT 455 - USA SRBE COQ A-TPS-8130
MCC-1 - USA SRBE COQ A-TPS-8127

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O Forward Skirt Thrust Post insulation requirements (materials, thickness, etc.) are specified on USA SRBE drawings 10121-0031, 10122-0024, 10122-0024, 10122-0034 (Forward Skirt Insulation Installation) and 10121-0007, 10122-0007 (Insulation Closeout Installation).

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Other documents controlling Forward Skirt thrust post insulation requirements include:

O Insulation Topcoat:

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

O MCC-1:

- o 10753-0064 Marshall Convergent Coating, Sprayable
- o 10PRC-0637 Procedure for Insulation Application CN 044

O K5NA/RT 455 (ALT.):

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

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

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

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

O Remove all TPS after every flight

B. TESTING

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

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 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. (Debonding)

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 Curent) are taken on flight hardware at 9 to 12 inch intervals over the area of application. (Inadequate Thickness)

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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)

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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. (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)
- 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)

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 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) CN 044

O Topcoat (chlorosulfonated polyethylene paint) application acceptability is verifed 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 On repainted structures, USA SRBE Quality performs surface inspections prior to application of conversion coating primer and topcoat; performs topcoat inspection and verifies adhesion tests. (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, MCC-1, K5NA/RT 455 (ALT.), SLA-220, Glass Phenolic Laminate, etc.) to identify possible degradation or damage. (Degraded Properties) CN 044

O Visual inspection verifies the integrity of TPS and/or TPS topcoat on the forward skirt thrust post prior to rollout 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, MCC-1, K5NA/RT 455 (ALT.), etc.) to identify possible damage or degradation prior to delivery to SPC. (Degraded Properties)

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Critical Processes/Inspections:

- O Cork application per 10PRC-0018
- O K5NA/RT 455 (ALT.) application per MSFC-SPEC-1919
- O BTA application per 10PRC-0546
- O Insulation topcoat application per 10PRC-0028
- O Substrate protective finish per 10PRC-0442
- O MCC-1 aspplication per 10PRC-0637 CN 044

D. FAILURE HISTORY

O Criticality Category 1:

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

E. OPERATIONAL USE

O Not applicable to this failure mode.