SUBSYSTEM STRUCTURES AND MISCELLANEOUS ITEMS

ITEM NAME: Thermal Protection System - Aft Strut Covers

PART NO.: 10754-0001 thru 10754-0010 FM CODE: A01

ITEM CODE: 60-03-07 REVISION: Basic

CRITICALITY CATEGORY: 1 REACTION TIME: Seconds

NO. REQUIRED: 1 Set Per Strut DATE: March 1, 2001 CN 042

CRITICAL PHASES: Boost SUPERCEDES: March 31, 1997 CN 042

FMEA PAGE NO.: E-35 ANALYST: W. Keller/S. Parvathaneni

SHEET 1 OF 7 APPROVED: S. Parvathaneni CN 042

FAILURE MODE AND CAUSES: Loss of Aft Strut Covers 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 loss of flight control or loss of separation capability.

RATIONALE FOR RETENTION:

A. DESIGN

O The Aft Strut Covers are insulated with 0.375 inch thick cork bonded with EC-2216 B/A Clear Amber adhesive. Closeout and repair are accomplished with K5NA/RT 455 (ALT.) or BTA. The covers are closed out with K5NA/RT 455 (ALT.), RTV-133 sealant and PR-855 foam at final assembly. CN 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 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(79-79), 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, configu- ration, etc. were verified on an individual basis using current environments and loads. (Addition of BTA as an alternate TPS closeout 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 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.

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

Cork/EC-2216 B/A Clear Amber		
Adhesive	-	USA SRBE QOQ A-TPS-8109
K5NA	-	USA SRBE COQ A-TPS-8108
BTA	-	USA SRBE COQ A-TPS-8120
PR-855	-	USA SRBE COQ A-TPS-8114
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
Hentzen	-	USA SRBE COQ A-TPS-8131

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Aft Strut Cover insulation requirements (materials, thickness, etc.) are specified on USA SRBE drawings 10754-0001 thru 10754-0006 (strut covers insulated). Closeout of the insulated covers is defined on drawings 10130-0003, 10130-0004 (Diagonal Strut Assemblies) and 10100-0059 (SRB TPS Closeout Installation).

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 Application for Aluminum and Steel Alloys

O K5NA/RT 455 (ALT.):

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

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 PR-855

10753-0011	Sealant, Foam
10PRC-0026	Procedure for PR-855 Application

O BTA:

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

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 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 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.

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- 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)

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- 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).

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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 cord: 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:

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- 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)

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- o Application of K5NA/RT 455 (ALT.): verify that K5NA/RT 455 (ALT.) is applied within the application life. (Degraded Properties)

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- 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)

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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 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 USA SRBE Quality verifies that substrate protective finish meets drawing and 10PRC-0442 requirements. (Debonding)

O USA SRBE Quality performs pre-topcoat insulation inspections and topcoat application inspections. (Debonding)

O Shelf life, formulation, mixing, surface preparation, application, cure, and physical properties of K5NA/RT 455 (ALT.), PR-855 and RTV-133 are verified per OMRSD File V, Vol. 1, requirement number B09GEN.010. (Degraded Properties)

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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)

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O Visual inspection verifies the integrity of TPS and/or TPS topcoat on the Aft Strut Covers per OMRSD File V, Vol. 1, requirement number B09TP0.010. (Degraded Properties/Debonding)

O Visual inspection of the TPS closeout application verifies that there is no cracking, evidence of contamination, fungus or debonding of the Aft Strut Covers per OMRSD File V, Vol. 1, requirement number B09TP0.020. (Degraded Properties/Debonding)

Critical Process/Inspections:

O Cork application per 10PRC-0018
O K5NA/RT 455 (ALT.) application per MSFC-SPEC-1919
O BTA application per 10PRC-0546 CN 042
O Insulation topcoat application per 10PRC-0028
O Substrate protective finish per 10PRC-0442
O PR-855 Silicone foam installation per 10PRC-0026
O RTV-133 adhesive 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.