FLIGHT READINESS STATEMENT
STS-95/ET-98
EXTERNAL TANK PROJECT
PRE-FLIGHT REVIEW

EXTERNAL TANK ET-98/STS-95, AS IDENTIFIED IN THE EXTERNAL TANK PROJECT PRE-FLIGHT REVIEW DATED SEPTEMBER 17, 1998, IS CONSIDERED READY TO SUPPORT FLIGHT UPON ACCEPTABLE DISPOSITION OF OPEN/PLANNED WORK AND/OR OPEN ACTIONS.

for E. C. SMITH/EB01

J. W. KILPATRICK/EL01

J. L. LUSK/EE31

B. E. GOLDBERG/ED01

A. F. WHITAKER/EH01

H. V. McCONNAUGHEY/EP01

A. O. HARRIS/CR01

for M. D. SMILES/CR70

P. V. COUNTS/SA31, CHAIRMAN

STICK TO BASIS OF CERTS
TEST SIMILITUDE ANALYSIS ETC
(5) - GET FROM BEN

① PRODUCE MINUTES WITH ACTIONS AND CHART REVISIONS

② DRY RUN WITH DON / TOMMY (F.M. PROOF AND CRUD "CARD" POTENTIAL CONFUSION)

September 17, 1998

Space Shuttle External Tank

STS-95 ET-98 Pre-Flight Review

ACTION: ET PROJECT RESOLVE CONTROL WT LEVEL II VIOLATION SUSPENSE 10/10/98

A) ADD/EXPAND WTS CHART TO DESCRIBE WHERE WEIGHT CONTINGENCY IS FOCUSED ET10 ADD "1ST FLIGHT CHANGES"

B) ADD ET11 BASIS IS SIMILITUDE
ET 14/21 ADD PROOF TEST REQT (F.M. 71.0)
ET 18/19 REFLECT REDESIGN WAS TO REDUCE SCRAP TO TO CRACKS DURING FORMING
ET 23 CLARIFY 2219 FRAMES
ET 27 CLARIFY F.S. ON CLASS II

C) ACTION BEN G. VERIFY/ASSURE FAULT TREE TEAM IS WORKING PROCESS CHANGE FOR "THIRD GUN SPRAY" AND ADD TO CHART 35 STATEMENT THAT ALL PROPERTIES WERE MET

ET 48 ADD WAS / NOW ON WELD ANALYSIS ALSO CONSIDER COMBINING PROCESS CHANGE(S) IN WANDA'S PRESENTATION TO AVOID CONFUSION

ET 50 ADD BASIS FOR CERTIFICATION (SIMILITUDE) PROVING TEST

ET 55 ENVIRONMENTAL REQ CAUSED CLOSURE OF RESIN FITTING
PVC NOTE: MUST COMPLETE FRD TEST

ET 59 EXPLAIN WHY NOT SAFETY OF FLIGHT

ET 63 ADD RATIONALE AND BASIS OF CERTIFICATION & STRIPPING AND REPLACING LOCAL (BAD) AREAS OF FOAM AND ADD CHART(S) TO DESCRIBE PDL REPAIRS AND LOCATION ON RIBS

ACTION UPDATE B X 252 CHARTS TO BE IDENTICAL TO CHANGES IDENTIFIED AT MINI DUR DRY RUN

ET98pfr.4250.ls.9/98

Agenda

• ***Overview***	***Jim Feeley***
• ***Prior Mission Performance Summary***	
• ***Current Mission/External Tank Highlights***	
• ET-98 Mass Properties Status	Mike Simpson
• Changes	
• Senior Management Review NCDs: None	
• Special Topics	
• SRM&QA Assessment	Terry McKeough
• KSC Processing	Wes Lattin
• Verification/Certification	Jim Feeley
• Mission Unique Assessment	
• Readiness Statement	
• Appendices	
• A: Minor Changes	
• B: SRM&QA Assessment	
• C: KSC Processing	
• D: Previously reviewed material	

Overview

- Review covers changes, differences and "out of family" non-conformances not previously flown and/or reviewed

- This review for STS-95/ET-98 includes:
  - Prior mission performance summary
  - Items specific to mission STS-95
  - Details of previously presented items are included in the Appendix

- **<u>FRR Series</u>**

- ET/SRB Mate Review	8/17/98
- Pre-flight Review	9/17/98
- Space Shuttle Vehicle FRR	10/15/98
- Mission Management Team (L-1 Day)	10/28/98

Prior Mission Performance Summary

STS-91/ET-96, 6/2/98

System	Performance
OMRSD/LCC	No Violations
Instrumentation	Nominal

Prior Mission Performance Summary

STS-91/ET-96, 6/2/98

System	Performance
MPS	• Nominal
ET Hazardous Gas	• Nominal
TPS	• Discussed as Special Topic
ET disposal	• Nominal
Orbiter tile damage	• Lower surface, above average - Diameter > 1" = 45 - Total = 145
Post flight photo review	• Images from hand held 35mm were dark • Umbilical well cameras show - Sanded area on LO2 ogive in good condition - Divots under forward bipod - Divots on -Y thrust panel • +Y thrust panel in shadow

Mission/External Tank Highlights

STS-95/ET-98, 10/29/98

Mission	**STS-95**
• Launch	10/29/98
- Window	1400-1630 EST
- Pad	B
- Orbiter	Discovery (OV-103)
- Orbital inclination	28.5° - Insertion at 310 NM
- ET photo coverage	• Crew photos from cockpit window • Umbilical well cameras • SRB forward skirt camera
• Primary payload	SpaceHAB-SM
• Landing	11/7/98
- Time	1204 EST
- Location	KSC

External Tank	**ET-98**
• DD250 acceptance	6/4/98
• Shipped to launch site	6/12/98

ET98pfr.4250.ls.9/98

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ET-98 Mass Properties Status

Issue:

- ET-98 Weight Status (predicted vs. actual)

Background:

- The specification weight for ET-98 is 57,911 lbs
- The nominal control weight for SLWT is 58,005±511 lbs
- ET-98 was weighed 6/23/98
  - Predicted weight 57,814 lbs
  - Scale weight* 58,549 lbs **Tension weighing system*
  - Delta +735 lbs
- ET-98 scale weight exceeded maximum control weight requirement by 33 lbs
- Scale weight was reported and used by Level II in Mission Planning
- No corrective action is planned to reduce ET-98 weight
- Revisions to weight prediction methodology in work to account for delta between predicted and scale weight

ET98pfr.4250.ls.9/98

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Changes List

Description	Presenter
Configuration	
• **Propellant Tank Reallocations (J31195/J31195A)**	**Wanda Sigur**
• **LH2 Aft Dome Redesign (B01982AJ)**	
• **LH2 Tank Longeron/ Frame 1973.5 Interface (B01982AA)**	
• **Welded Frame Material Substitution (B02022)**	
• **1871 Frame Outer Chord Extrusion (J31158)**	
• **Implementation of Dual Cover Pass (J31188)**	
• **Revised LH2 Tank Foam Thickness (J31178)**	
• LO2 Feedline Fairing Fastener Location (B01775G)	Appendix A
• RSS Deletion - Fastener Installations (B02010)	Appendix A
Process	
• Barrel Panel Etch Sequence (J31192)	Peter Hinkeldey
• Revised Penetrant Inspection (B02033)	
• Revision of Tank Weld Process from VPPA (J31155/J31155A/J31155B)	
Requirement	
• LH2 Pre-press Cycle Count (LCC 00832)	Brian Piekarski
• LH2 Overfill Sensor Limits (RCN KS13507)	

NO FRR

Propellant Tank Reallocations

J31195/J31195A

Change:

- Reallocated ET-98 LO2 Tank to ET-97
- Reallocated ET-99 LH2 Tank to ET-98

Background/ Reason:

- ET-98 LO2 tank passed proof test before ET-97 LO2 tank
- ET-99 LH2 tank passed proof test before ET-98 LH2 tank
- Management decision to reallocate tanks
  - Standard Procedure 49:12

Basis for Certification:

- Design requirements identical
- All parts are either identical or incorporate minor changes that have no effect on form, fit or function
  - No COQ or HCS impacts
- Successful proof test and post-proof inspection

LH2 Aft Dome Redesign

Yes FRR
Yes MRTE

B01982AJ

Change:

- Resized portions of the gore and cap and reverted to Al 2219 cap material

Background/ Reason:

- Preclude contour deviations due to LH2 tank aft dome/cap weld shrinkage
  - Al 2195 aft cap gave only a marginal weight advantage over the Al 2219 version
  - Reverting to Al 2219 aft cap improved producibility

LH2 Aft Dome Redesign

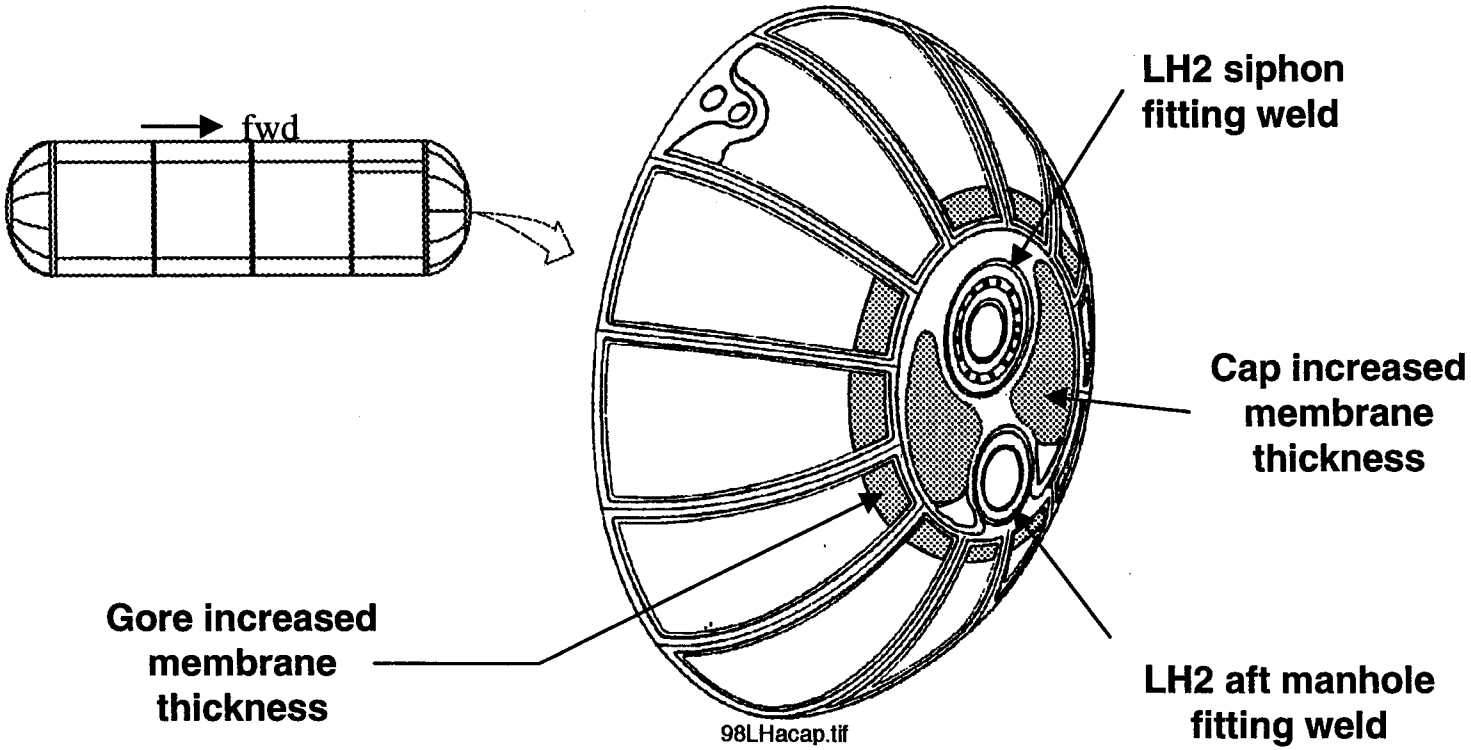
B01982AJ

Description:

- Increased LH2 aft cap membrane thickness
- Fabricated LH2 aft cap from Al 2219
- Increased membrane thickness in 11 of 12 aft dome gores in the areas adjacent to the LH2 tank aft dome/cap weld
  - Gore with penetrations unchanged
- Reduced weld land thickness on dome cap penetration fittings
  - Cap same as LWT configuration

LH2 Aft Dome Redesign

B01982AJ



LH2 Aft Dome Redesign

B01982AJ

Basis for Certification:

- Successful proof test
  - Proof Test Demonstrated Limit Load

    Cap: 1.43

    Gores: 1.35

F.M. PROOF > 1.0

- Analysis
  - Stress, FS (failure mode: ultimate tension)

Element	*Required*	*Was*	*Now*
Cap	1.25	1.63	2.0
Gores	1.28	1.41	1.81

LH2 Tank Longeron/Frame 1973.5 Interface

B01982AA

Change:

- Revised longeron lugs, back-up fittings, and attach bolts for frame 1973.5 to longeron connection

Background/ Reason:

- Enhancement of margins for internal loads at frame 1973.5 to longeron interface led to increase of attachment bolt sizes, back-up fittings, and lug thickness
- Forming cracks occurred on the longeron in 1973.5 interface region during the straightening of the forging

ET98pfr.4250.ls.9/98

LH2 Tank Longeron/Frame 1973.5 Interface

B01982AA

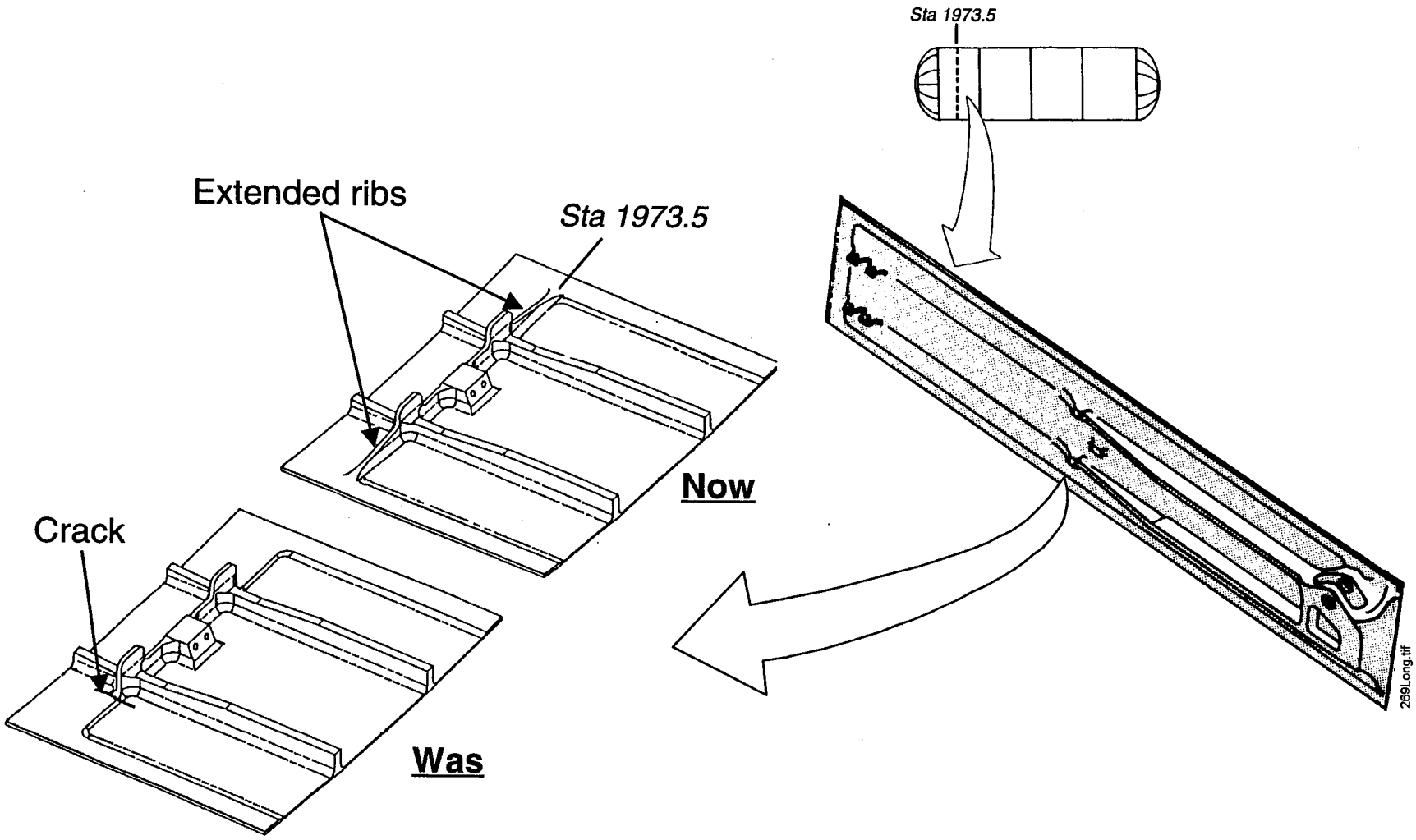
Description:

- Added short ribs on longeron at sta 1973.5
- Increased attachment bolt size and revised interface hardware at this location
- Replaced aft back-up stiffener with machined fitting
- Added forward machined back-up fitting

- Related minor changes in appendix
  - H35809 -366, -513, -519, -656

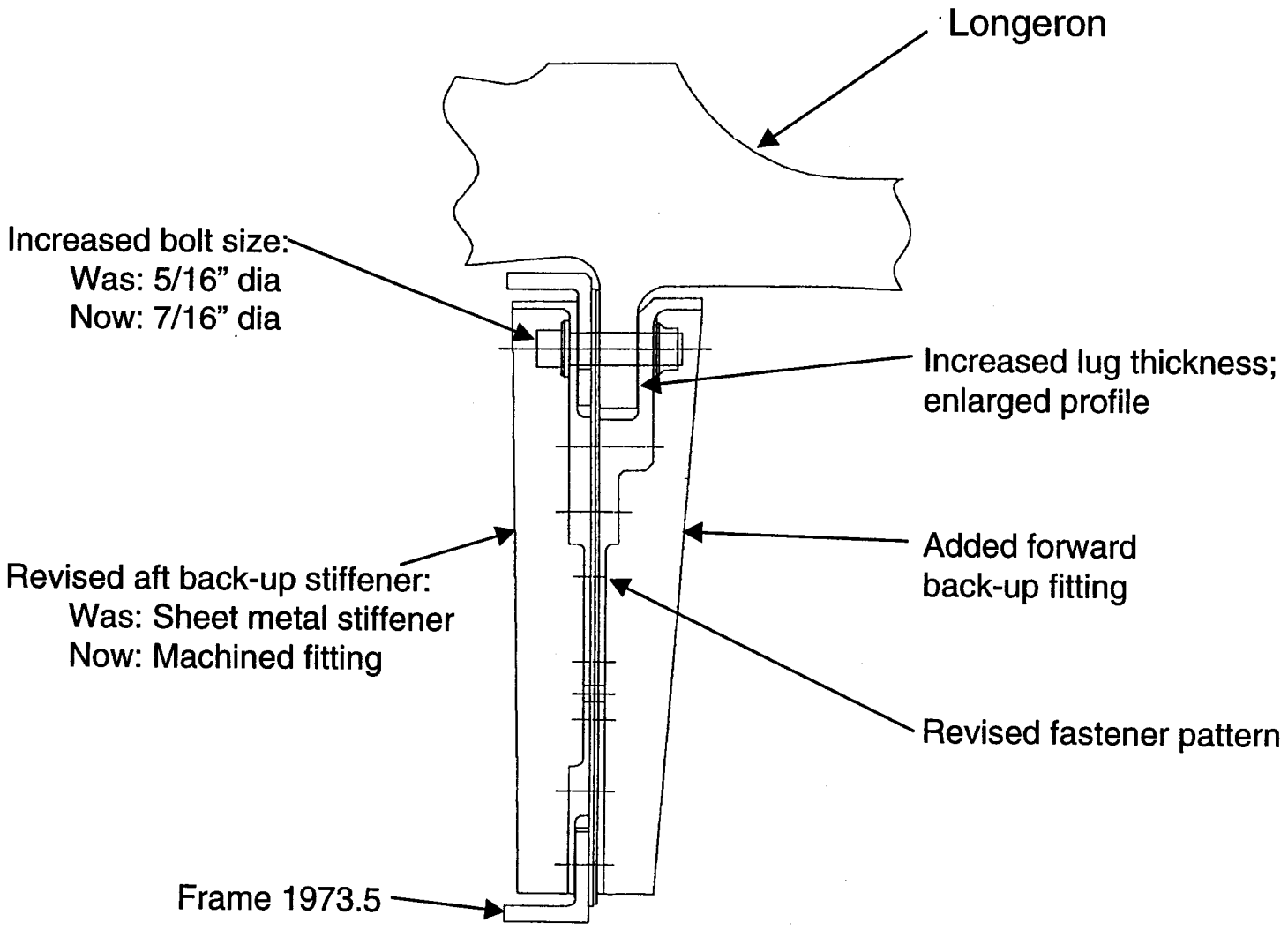
LH2 Tank Longeron/Frame 1973.5 Interface

B01982AA



LH2 Tank Longeron/Frame 1973.5 Interface

B01982AA



LH2 Tank Longeron/Frame 1973.5 Interface

B01982AA

Basis for Certification:

- Proof test demonstrated FS=1.08
- Stress Analysis

Element	Failure Mode	Factor of Safety		
		Required	Was	Now
Lug	Ultimate Shear/Bearing	1.27	1.27	1.37
Bolt	Ultimate Shear	1.27	1.27	1.38
Frame Chord	Ultimate Tension	1.40	1.65	1.65
Frame Web	Ultimate Stability	1.27	1.32	1.32

- Similarity

Welded Frame Material Substitution

B02022

Change:

- Substituted Al 2219 for Al 2195 for welded frame extrusions

Background/ Reason:

- Weld intersection cracks caused severe schedule/ cost impacts because the repairs were numerous and required multiple tank proof tests
  - Replacing 2195 outer chords with 2219 mitigates intersection cracking
- Independent NASA Review Team recommended use of Al 2219 extrusions

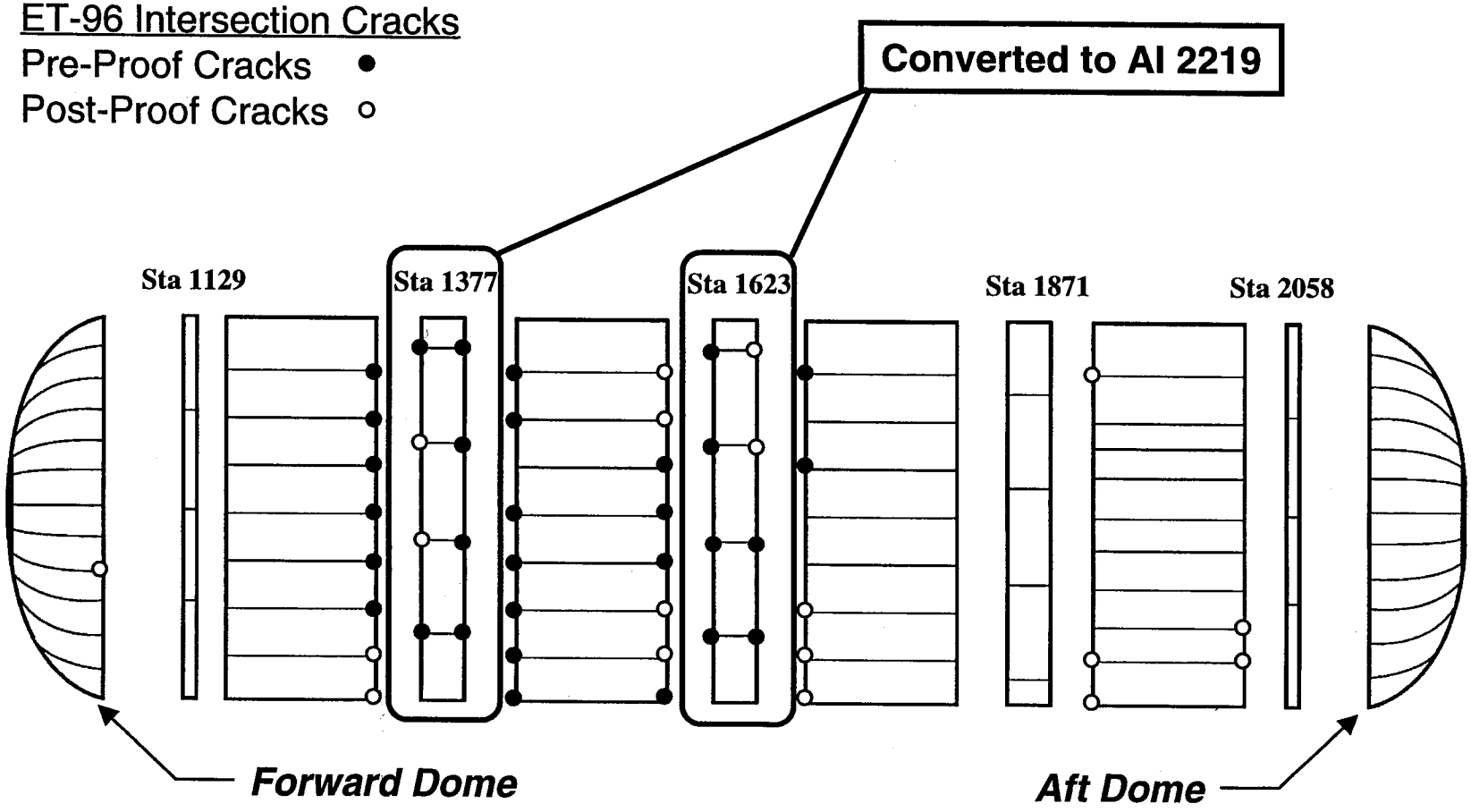
Description:

- Replaced Al 2195 extrusions with Al 2219 extrusions for Frames 1377 and 1624

Welded Frame Material Substitution

B02022

ET-96 Intersection Cracks
Pre-Proof Cracks ●
Post-Proof Cracks ○



ET98pfr.4250.ls.9/98

Welded Frame Material Substitution

B02022

Basis for Certification:

- Successful proof test and post-proof inspection
  - Demonstrated FS = 1.12
- Stress Analysis:
  - FS (failure mode: inner chord ultimate tension)

Element	*Required*	*Was*	*Now*
Frame 1377	1.25	1.28	1.25
Frame 1624	1.25	1.53	1.25

1871 Frame Outer Chord Extrusion

J31158

Change:

- Used Class II extrusions (Al 2219) for outer frame chords

Background/ Reason:

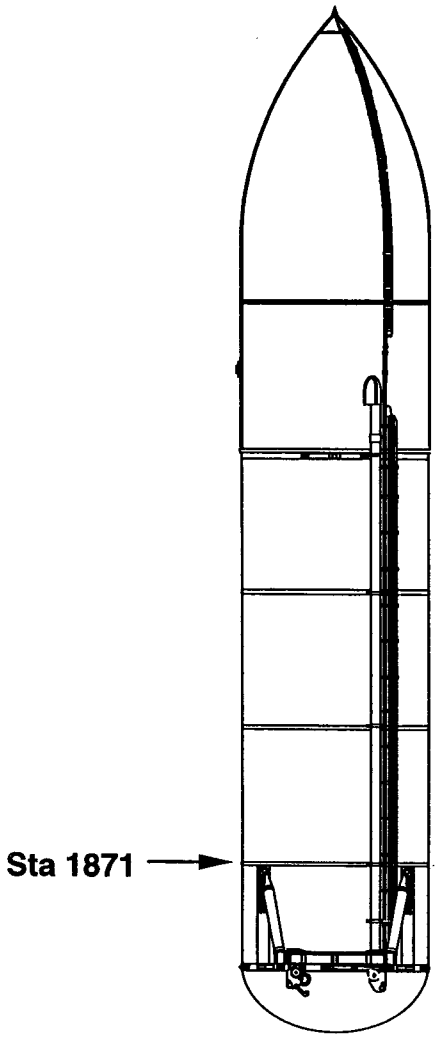
- Class II chords implemented to avoid reduced allowables associated with Class I chords
  - Allowables were acceptable

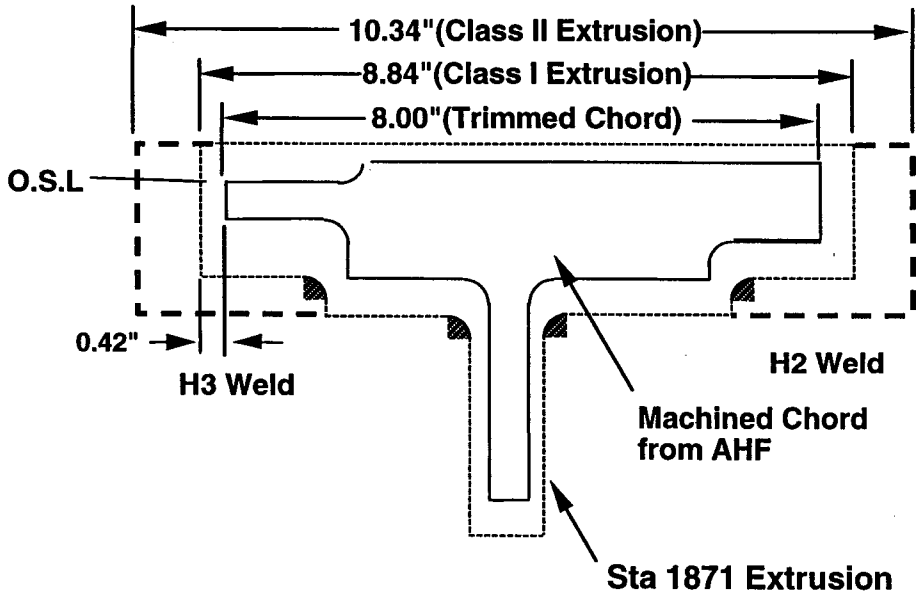
Description:

- Replaced Al 2219 Class I extrusions with Al 2219 Class II extrusions on 1871 +Z Frame Chords
  - Class II extrusions have better controlled grain structure and improved as-welded allowables

1871 Frame Outer Chord Extrusion

J31158





- "As-extruded" grain structure at weld location affects weld strength
  - As-welded properties increase with additional trimming
- Class II extrusions are redesigned to provide increased trim material

1871 Frame Outer Chord Extrusion

J31158

Basis for Certification:

- Successful proof test and post-proof inspection
  - Demonstrated FS = 1.64
- Improved Al 2219 Class II extrusion allowables derived by test

	Allowables (ksi)	
	Class I	*Class II*
Parent	58.0	58.0
As welded*		
• room temp.	34.1 min 36.6 avg	36.0 min 39.0 avg
• -423°F	41.2	46.8

* *0.5" weld thickness referenced. Similar improvements for other thicknesses.*

- Stress Analysis:
  - FS = 1.76, unchanged
  - Required FS = 1.26
  - Failure mode: outer chord stem ultimate bearing

Clarify

ET98pfr.4250.ls.9/98

Implementation of Dual Cover Pass

YES FRR
YES MATE

J31188

Change:

- Implemented dual cover pass weld process with Variable Polarity Plasma Arc (VPPA)

Background/ Reason:

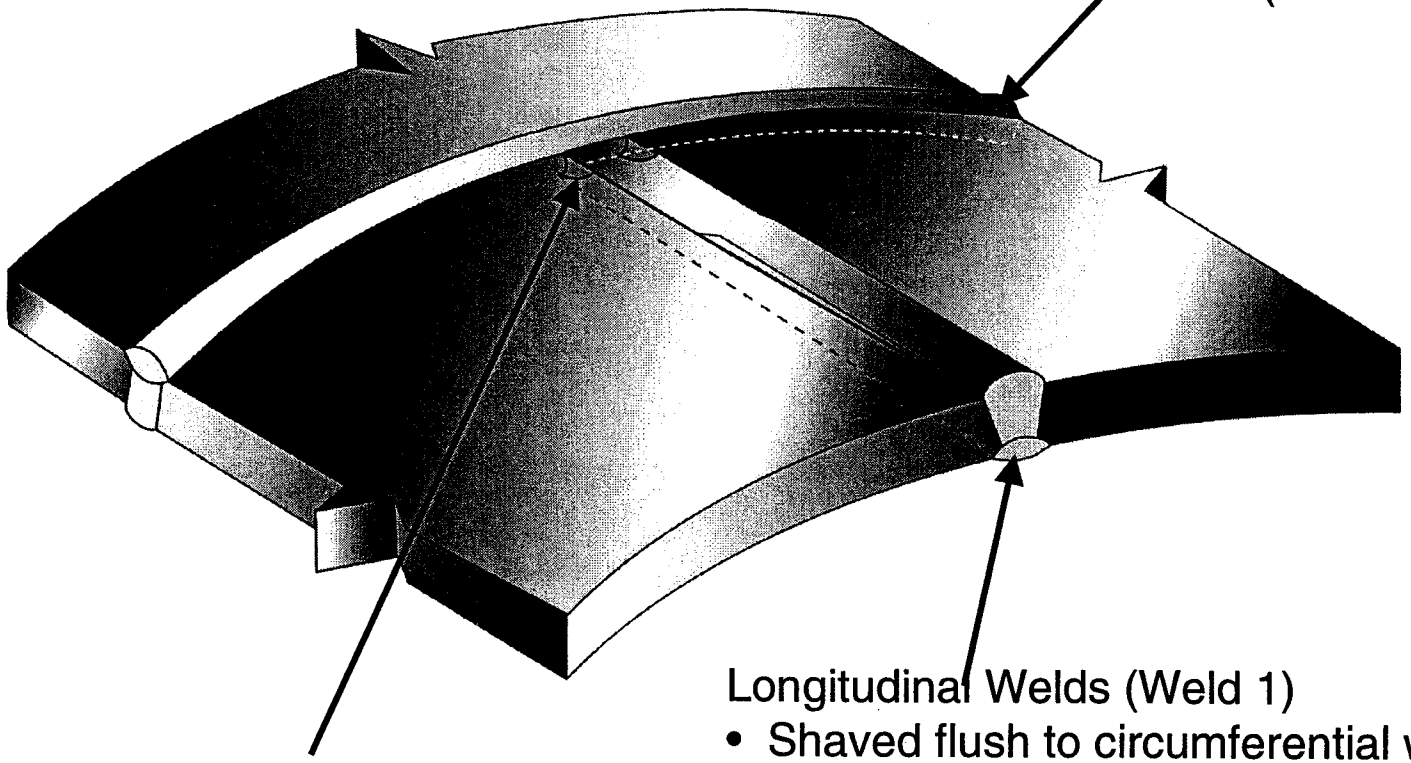
- High incidence of pre- and post-proof cracks on circumferential welds at longitudinal weld intersections
- Dual cover pass reduces sensitivity to intersection cracking and subsequent repairs
  - Eliminates the residual stress element associated with cross-over (weld 2) cover passes
- VPPA process reduced weld defect repair issues due to "cleaning action" of plasma process

Implementation of Dual Cover Pass

J31188

Intersection Cracks

Prior to Implementation of Dual Cover Pass

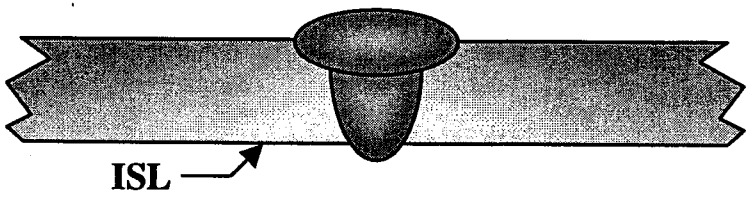


ET98pfr.4250.ls.9/98

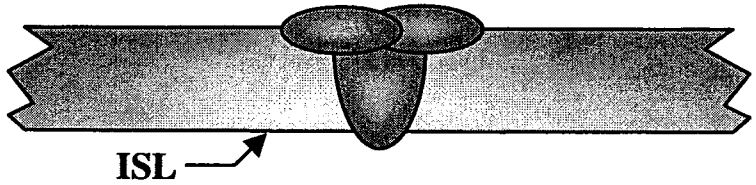
Implementation of Dual Cover Pass

J31188

Single Cover Pass



Dual Cover Pass



Was

- SPAW Weld Process (Vertical)
- Single Cover Pass

Now

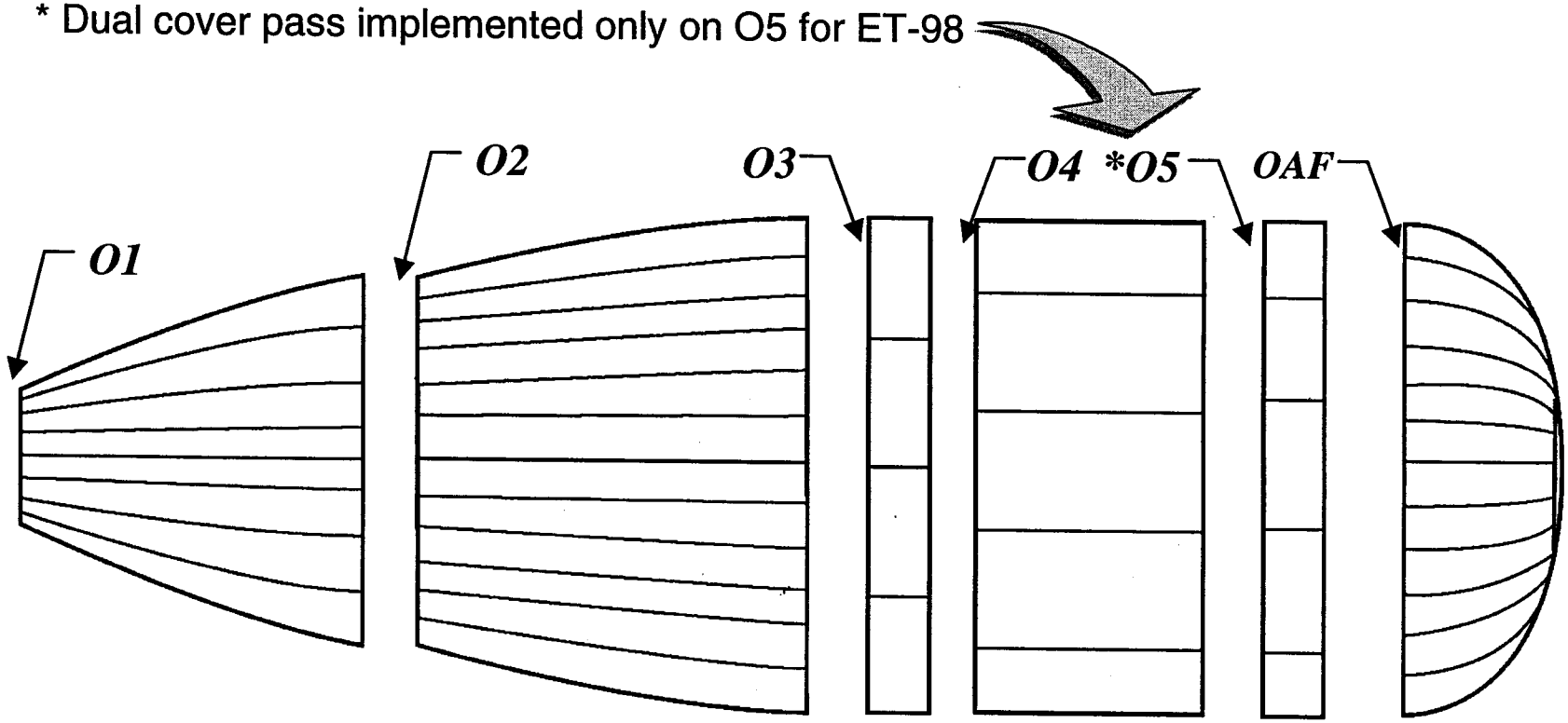
- VPPA (Vertical)
- Dual Cover Pass

Implementation of Dual Cover Pass

J31188

LO2 Tank Weld Locations

* Dual cover pass implemented only on O5 for ET-98

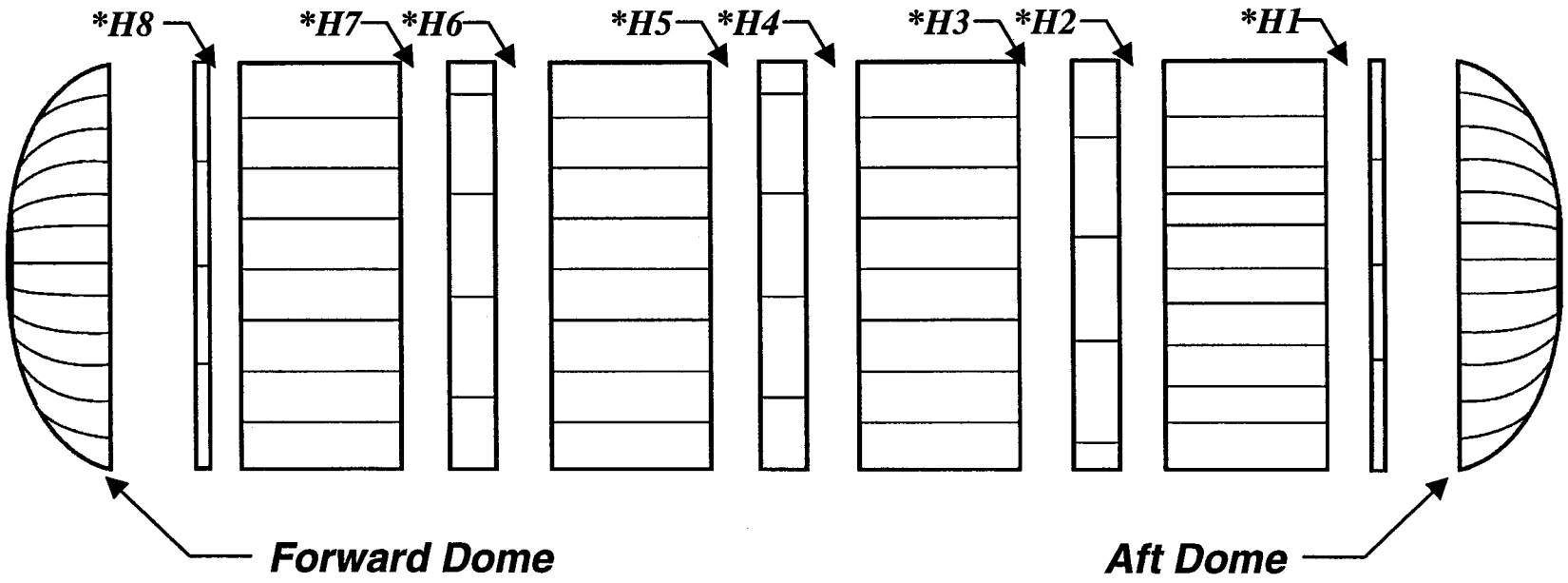


Implementation of Dual Cover Pass

J31188

LH2 Tank Weld Locations

* Dual cover pass implemented on H1 through H8 for ET-98



Implementation of Dual Cover Pass

J31188

Basis for Certification:

- Successful proof test and post-proof inspection
- Qualification and certification for the dual cover pass weld was done using a similar approach as the original SLWT weld allowables
- Design and as-built margins were analyzed using the dual cover pass allowables
- Margins meet or exceed safety factor requirements

	Proof Demonstrated FS
LH2 H1-H8	1.01 - 1.57
LO2 O5	1.01 - 2.57

Revised LH2 Tank Foam Thickness

J31178

Change:

- Revised LH2 tank barrel TPS nominal thickness dimensions and tolerances
- Implemented a "switch-to-third-gun" spray process

Background/ Reason:

- As a candidate for weight savings, a thick/thin foam configuration targeting the minimum thickness was implemented for ET-88 and up
- LH2 Tank Barrel minimum foam thickness was violated on ET-89 within the center ("C") band
  - Higher foam thickness target was applied to subsequent tanks to prevent minimum thickness violations
- Under-thickness resulted from spray gun "lacquering"
  - Built up foam material at the gun tip affected the fan pattern and reduced the anticipated foam thickness

Revised LH2 Tank Foam Thickness

J31178

Description:

- Modified spray process to allow switching to a third gun during the LH2 tank barrel TPS application
  - Third gun in the spray cell reduces the effect of "lacquering"
- Reverted to original TPS thicknesses and tolerances scoped for the SLWT
  - Requirements were changed for ETs 91, 96 & 97 until the third gun could be incorporated in the spray cell
  - Change affects Bands "A", "B", and "C" on the LH2 Tank Barrel

Basis for Certification:

- Producibility enhancement to assure that thickness requirements are met
  - Not a configuration change
- Stress Analysis:
  - FS = 1.13, unchanged
    - Failure mode: bond line delamination
- Acceptance tests unchanged

Changes List

Description	Presenter
Configuration	
• Propellant Tank Reallocations (J31195/J31195A)	Wanda Sigur
• LH2 Aft Dome Redesign (B01982AJ)	
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• Revised LH2 Tank Foam Thickness (J31178)	
• LO2 Feedline Fairing Fastener Location (B01775G)	Appendix A
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Process	
• **Barrel Panel Etch Sequence (J31192)**	**Peter Hinkeldey**
• **Revised Penetrant Inspection (B02033)**	
• **Revision of Tank Weld Process from VPPA (J31155/J31155A/J31155B)**	
Requirement	
• LH2 Pre-press Cycle Count (LCC 00832)	Brian Piekarski
• LH2 Overfill Sensor Limits (RCN KS13507)	

Barrel Panel Etch Sequence

J31192

Basis for Certification:

- Full etch and penetrant inspection still performed on all panels with "dual eyes" requirement
  - Deletion of redundant in-process inspection does not affect product quality
- Change approved by MSFC Fracture Control Board

Revised Penetrant Inspection Acceptance

B02033

Change:

- Revise penetrant inspection criteria to clarify weld acceptance and to limit the use of 10x magnification with white light.

Background/ Reason:

- NASA Quality Team at the SLWT Design Certification Review stated that the use of 10x magnification and white light for determining the relevance of a penetrant indication violates STP2501 and STP 2507
- RID Q-007 was issued
  - Practice allows acceptance of linear indications which violates specified acceptance criteria and allows rejectable penetrant indications to be accepted on the basis of visual white light evaluation alone

Revised Penetrant Inspection Acceptance

B02033

Description:

- 10x magnification with white light may be used only as a secondary evaluation to determine whether a linear indication is within the criteria for a scratch, gouge or tool mark
- Definitions for cracks, linear indications, scratches, gouges, tool marks, and linear porosity/inclusions were revised
- Linear indications up to 0.040 inch are acceptable
- Linear porosity without other linear indications and all other non-linear indications are acceptable
- Transverse linear penetrant indications on Al-Li plasma root beads are no longer acceptable
- For scratch, gouge or tool mark identification, bottom of indication must be visible

Revised Penetrant Inspection Acceptance

B02033

Basis for Certification:

- Acceptance process enhanced
- Approval from MAF & MSFC Fracture Control Boards
  - Closure of RID and signed MOU

Revision of Tank Weld Process from VPPA

NO

J31155/J31155A/J31155B

Change:

- Changed weld process from VPPA to alternate methods already in use

Background/ Reason:

- To reduce the number and severity of weld defects

Revision of Tank Weld Process from VPPA

J31155/J31155A/J31155B

Basis for Certification:

- Successful proof test and post-proof inspection
- Qualification and certification of GTAW and SPAW weld process using a similar approach as used in baseline SLWT weld allowables test program
- Design and as-built margins are acceptable

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Requirement	
• **LH2 Pre-press Cycle Count (LCC 00832)**	**Brian Piekarski**
• **LH2 Overfill Sensor Limits (RCN KS13507)**	

Level II
No PRR

LH2 Pre-press Cycle Count

LCN 00832 (LCC ET-04)

Change:

- Increased the maximum number of LH2 tank pre-pressurization command cycles from 10 to 13 for 0.5 second helium bursts

Background/ Reason:

- To obtain increased engine start pressures for Block II SSMEs, helium pre-press burst durations were decreased from 1 second to 0.5 second
  - More bursts are required to maintain pressure, so the upper limit of 5 pressure cycles during pre-press was increased to 10
  - Based on SLWT tanking test data, the maximum number should be higher than 10
- Shorter helium pre-press bursts will be used with the lower pre-press pressures to obtain experience prior to the implementation of Block II SSMEs

Rationale for Change:

- Analysis includes previously unavailable LH2 pressurization system performance
  - Obtained during the STS-91 SLWT Tanking Test

LH2 Overfill Sensor Limits

RCN KS13507

Change:

- Increased the maximum limit on the LH2 tank overfill sensor from 1% to 20% during replenish

Background/ Reason:

- Minor overfill sensor activity was seen on STS-84 and subsequent flights
  - Sensor indicated <0.2% wet, 3 or less occurrences
  - Concurrent with LH2 tank TPS changes
- Sensor activity increased substantially for SLWT
  - Tanking test: <2.1% wet, 24 occurrences
  - STS-91 tanking: <1.2% wet, 26 occurrences
- ET Design changes in the TPS and the SLWT metal are the most likely causes for the increases in overfill sensor activity.
- Overfill sensor violation would cause stop flow
  - If late in the countdown, launch would be scrubbed due to time required for recovery to LH2 replenish

LH2 Overfill Sensor Limits

RCN KS13507

Rationale for Change:

- Previous limit for the overfill sensor was < 20 % wet
  - No sensor activity had been experienced, so the limit was reduced to < 1% wet for STS-26R and subsequent loadings (RCN MS7762).
- Analysis:
  - Maximum limit of 20% provides 8 minutes margin for execution of a stop flow
  - Execution time of a stop flow is a maximum of 10 seconds
- Change does not affect safety of personnel or hardware
  - Replenish valve is automatically closed if the overfill sensor indicates wet for 1 second.

Agenda

• Overview	Jim Feeley
• Prior Mission Performance Summary	
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• ET-98 Mass Properties Status	Mike Simpson
• Changes	
• Senior Management Review NCDs: None	
• ***Special Topics***	
• SRM&QA Assessment	Terry McKeough
• KSC Processing	
• Verification/Certification	Jim Feeley
• Mission Unique Assessment	
• Readiness Statement	
• Appendices	
• A: Minor Changes	
• B: SRM&QA Assessment	
• C: KSC Processing	
• D: Previously reviewed material	

Special Topics

Description	Presenter
• **Composite Nose Cone Resin Requalification**	**Robert Biggs**
• Intertank Thrust Panel Foam Loss (IFA STS-87-T-01)	Steven Copsey
- Circumferential Rib Closeout Foam	Louis Palermo
- Installation of Intertank Thrust Panel Instrumentation (FEC KET-0040)	
- Hi-Q Flight Trajectory	
- Grid on Intertank Thrust Panel (FEC KET-0041)	

Composite Nose Cone Resin Requalification

Change:

- Requalified composite nose cone resin

Background/ Reason:

- Baseline resin fabricated at Oxychem (Tonawanda, NY facility)
  - Flown on STS-86/ET-88 and STS-91/ET-96
- Environmental issues resulted in product termination at N.Y. facility
- Attempts to qualify "generic" phenolic resin fabricated by Georgia Pacific unsuccessful
- Solution was to obtain original resin formulation fabricated at a different Oxychem facility (Niagara Falls)

Description:

- Incorporates resin of the same chemistry and production process, but fabricated at different facility

Composite Nose Cone Resin Requalification

Basis for Certification:

- Material development program using first 3 lots of material
  - Mechanical properties from room temperature to 1000°F
  - Thermal properties
    - Conductivity/specific heat/thermal expansion
  - Maximum temperature performance tests
  - 5"x10" subcomponent heated compression tests
  - All tests show the Tonawanda resin and the Niagara resin are equivalent
  - Critical mechanical properties slightly improved

Composite Nose Cone Resin Requalification

Basis for Certification (continued):

- Stress Analysis: Meets required FS (1.40)
  - Was: Composite Cone Lot 40822 (Tonawanda resin)
    - FS=1.68 (outer ply crippling)
  - Now: Composite Cone Lot 50530 (Niagara resin)
    - FS=1.72 (outer ply crippling)
    - ET-88 critical properties envelope requalification properties
- Thermal Analysis: Temperatures within mechanical property and maximum temperature test data base
- Chemical analysis (fingerprinting) on all lots
- Inspection: Controlled by STM and STP
  - Material RAP test
  - Tag end coupon material mechanical properties, permeability, and HGF ablation performance
  - 100% Non-Destructive Evaluation (thermography)

Special Topics

Description	Presenter
• Composite Nose Cone Resin Requalification	Robert Biggs
• **Intertank Thrust Panel Foam Loss (IFA STS-87-T-01)**	**Steven Copsey**
- **Circumferential Rib Closeout Foam**	
- Installation of Intertank Thrust Panel Instrumentation (FEC KET-0040)	Louis Palermo
- Hi-Q Flight Trajectory	
- Grid on Intertank Thrust Panel (FEC KET-0041)	

Intertank Thrust Panel Foam Loss

IFA STS-87-T-01

Background:

- Out-of-family tile damage on STS-87/ET-89 led to establishment of an independent ET Investigation Team to determine cause of the ET Intertank thrust panel foam loss
- All instances of foam loss have been turn around maintenance issue
  - Not safety of flight

Status:

- Intertank TPS Debris Tiger Team established
- Weekly status to management
- Investigation priority is to determine cause of Intertank TPS foam loss and closure of STS-87 IFA
- All investigation findings continue to support that TPS loss is maintenance issue, not safety of flight for accepted hardware
- Corrective actions have shown improved performance
  - Sanded/machined foam

Intertank Thrust Panel Foam Loss

IFA STS-87-T-01

Investigations/ Actions Status:

- Fault Tree Assessment to identify root cause
  - Reviewing all vendor/MAF/KSC processing
    - No observations of note
    - Assessing nominal processing variations (GVTA destructive testing)
  - Assessing ET design and mission environments
- Preliminary DOE (Design of Experiment) assessment ~~perform~~ed and subdivided into three groupings that can be combined and tested
  - Group A: vacuum, substrate temperature, substrate bending, heating rate, humidity precondition
  - Group B: vacuum, heating rate, oscillating shock, substrate bending, axial loads, aero shear
  - Group C: vibration, acoustics, substrate bending, foam surface temperature

DEFINED

Intertank Thrust Panel Foam Loss

IFA STS-87-T-01

Investigations/ Actions Status (continued):

- F-15 flight test bed
- Basic material evaluation:
  - Fracture testing
  - Thermal mechanical testing
  - Microstructure analysis
  - Element level composition and capability testing
- Obtain additional flight data:
  - Camera added to SRB Forward Skirt to view -Y thrust panel on STS-95/ET-98
  - Plans for camera on two additional flights
  - Instrumentation added on ET Intertank with cable and data recording to SRB EDAS
    - Six accelerometers added for STS-95/ET-98 to obtain ascent flight data
    - Additional instrumentation on successive flights

Intertank Thrust Panel Foam Loss

IFA STS-87-T-01

ET-98 Configuration:

- SLWT incorporated a fully auto-machined Intertank with addition of seven circumferential ribs
- ET-98 utilizes a BX-250 foam instead of SS-1171 closeout on the seven circumferential ribs
  - No dimensional configuration change from ET-96

Rationale for Acceptance:

- No constraint to flight
  - Loss of thrust panel foam at demonstrated levels is not a safety of flight concern
  - Turnaround maintenance issue only
- ET-98 foam is "in-family" with previously flown foam configurations
  - properties
  - machined configuration
- Previously demonstrated foam loss levels were low risk to orbiter and ET
- In-family performance expected from ET-98

Circumferential Rib Closeout Foam

Change:

- Revised circumferential rib closeout foam

Background/ Reason:

- SLWT Intertank thrust panel configuration has seven circumferential ribs
- SS-1171 foam used on ET-96 and ET-97
  - Hand spray of SS-1171 extremely sensitive
  - ET-96 and ET-97 each had approximately 280 PDL repairs
  - Resolution of post-separation photos not sufficient to evaluate SS-1171 performance
- ET-98 MRB disposition: use BX-250 for closeout
  - Operators developed/demonstrated spray technique on GVTA
  - ET-98 required only 30 repairs

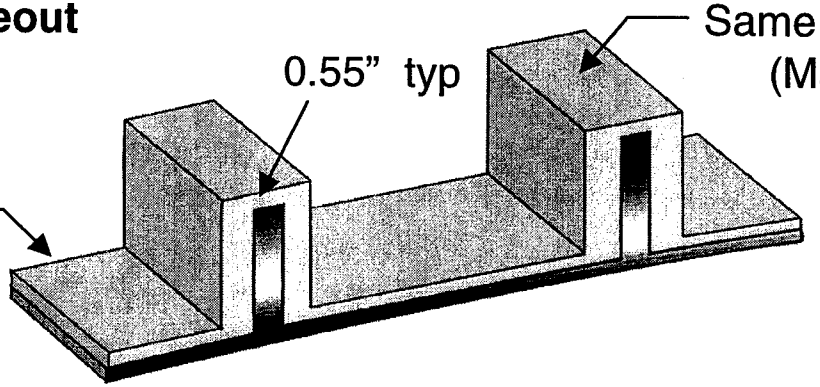
Description:

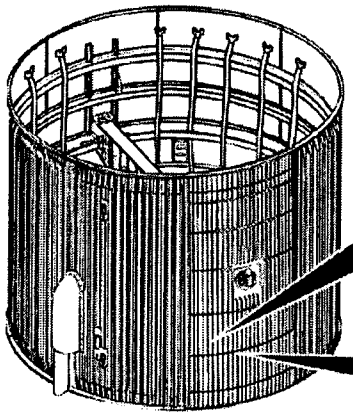
- Replaced SS-1171 foam with BX-250 foam
  - No dimensional change from STS-91/ET-96

ET98pfr.4250.ls.9/98

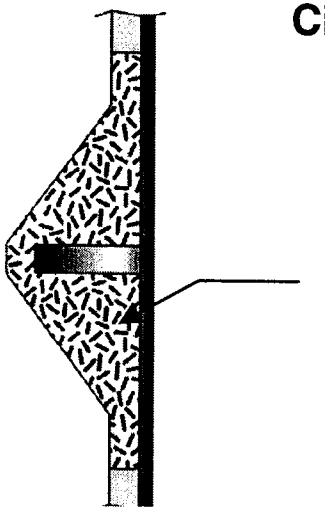
Circumferential Rib Closeout Foam

Longitudinal Rib Closeout





GS 266 19D FRR ET 98
266_foam.eps



Circumferential Rib Closeout
(7 locations each side)

- **STS-91/ET-96**
  - Machined SS-1171
- **STS-95/ET-98**
  - Machined BX-250

ET98pfr.4250.ls.9/98

Circumferential Rib Closeout Foam

Basis for Certification:

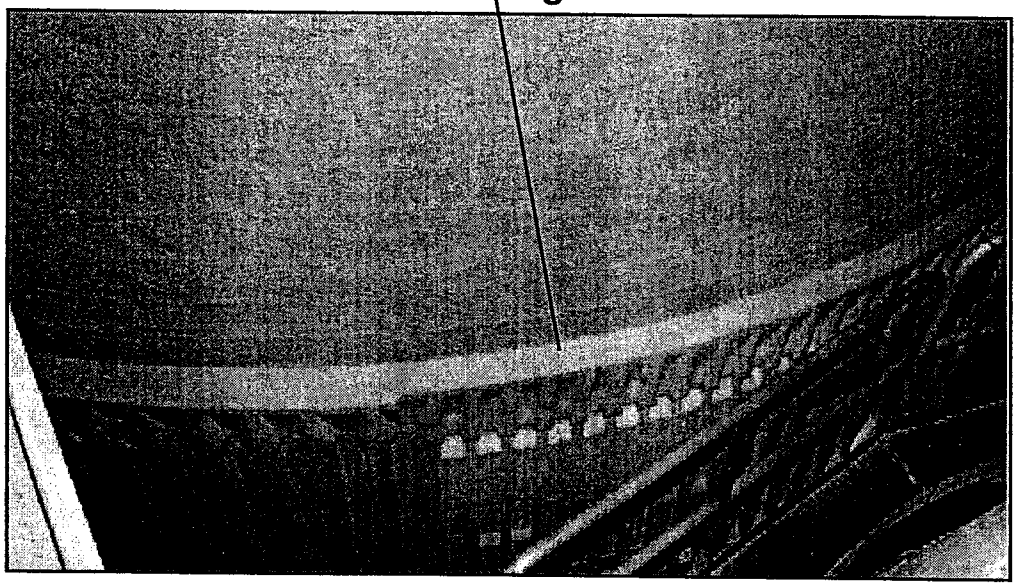
- BX-250 used in many areas on ET since ET-1
  - Similar areas
    - LO2/Intertank flange closeout
    - +Z, -Z aero vents
    - RSS Antenna
    - Thrust strut longeron closeout
    - Bipod ramps/PAL ramps
    - Wedges on LWT configuration circumferential ribs at forward end of thrust panels (covered with CPR)
      - ET-51 through ET-87
  - Post-separation photographs show excellent performance

Circumferential Rib Closeout Foam

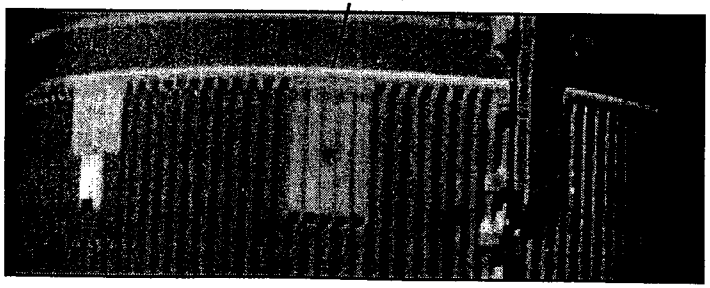
Similar BX-250 Closeouts

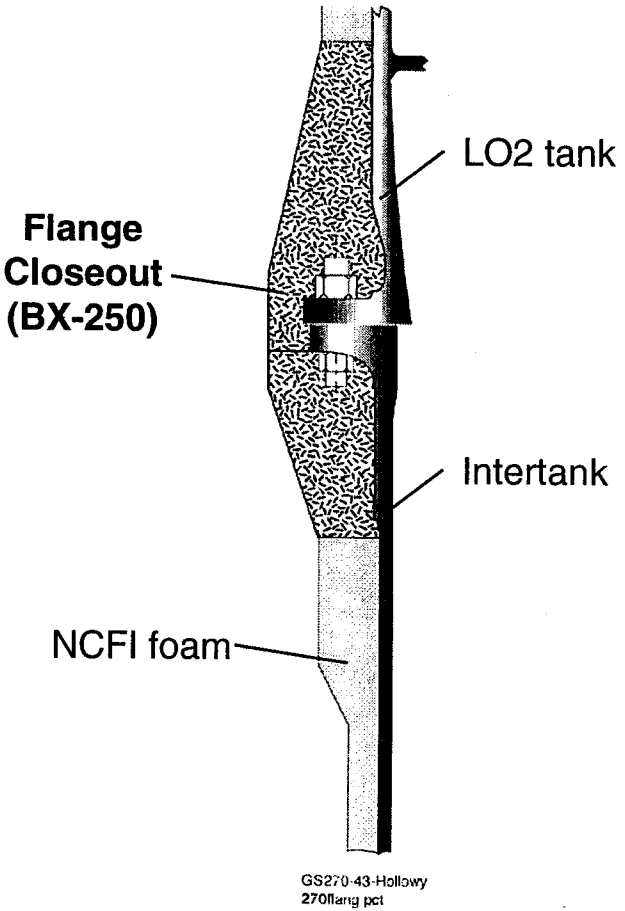
- LO2 Tank/Intertank Flange Closeout

Pre-Flight



Post-Separation

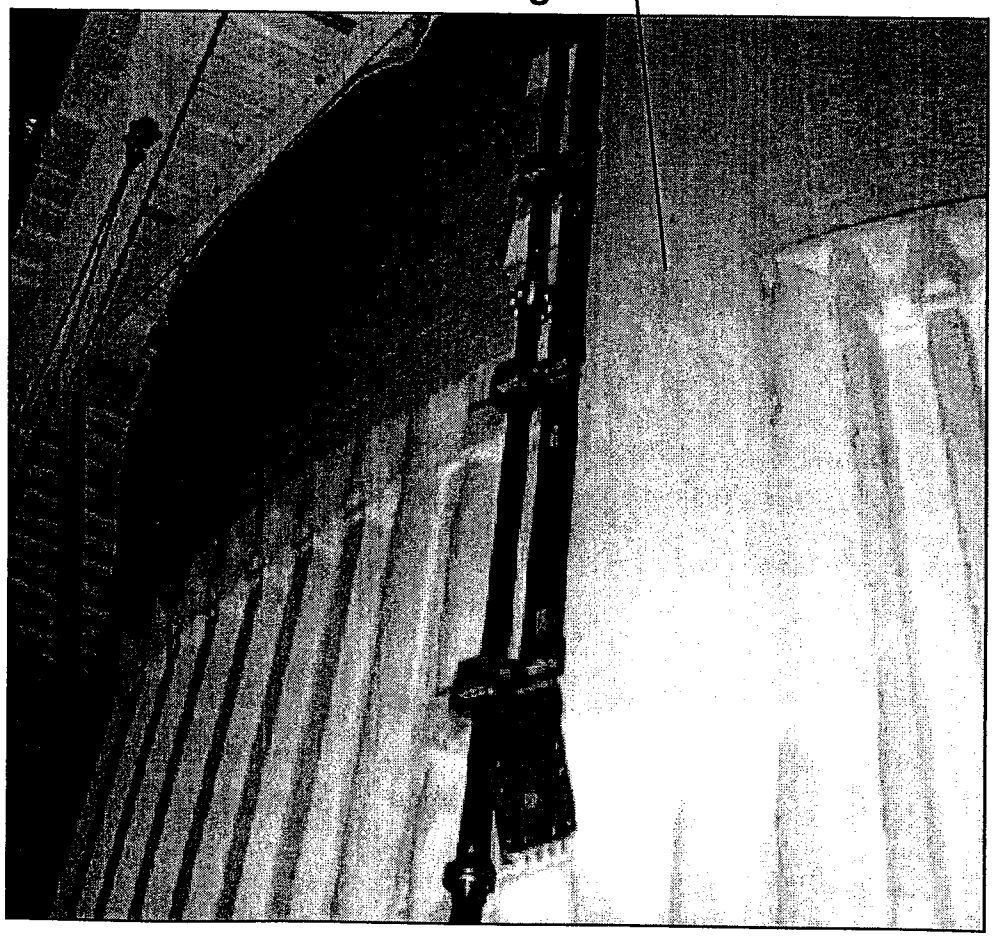


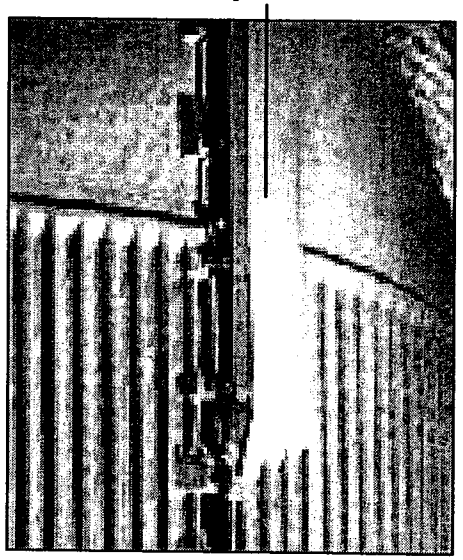


Circumferential Rib Closeout Foam

Similar BX-250 Closeouts

- PAL Ramps



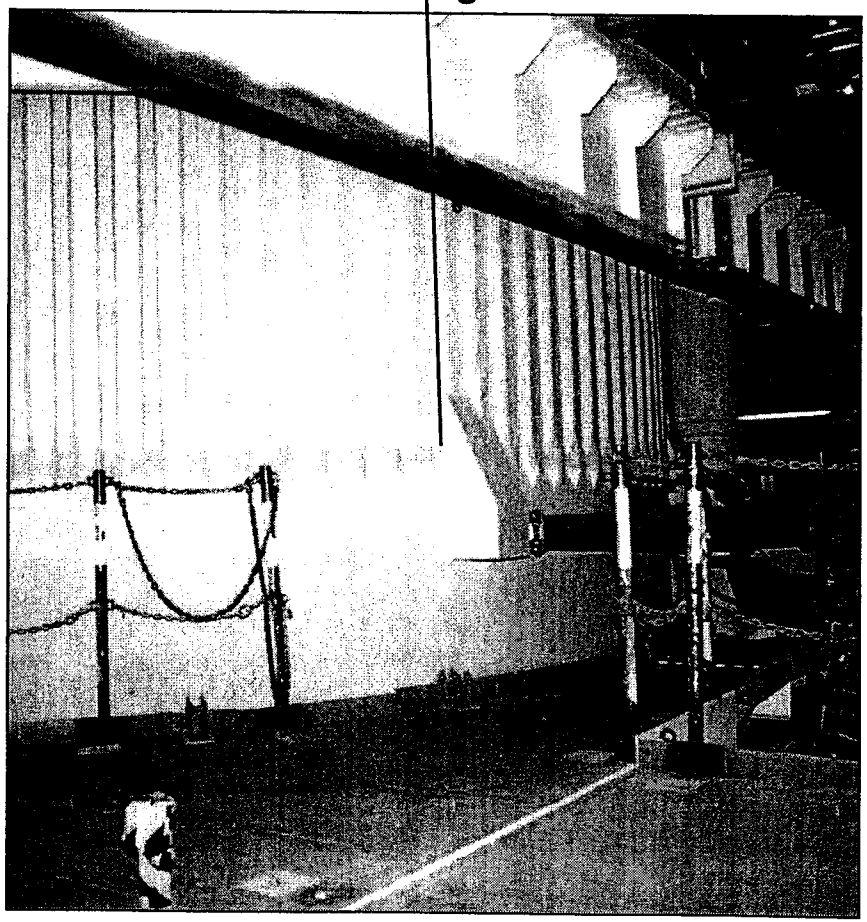


Circumferential Rib Closeout Foam

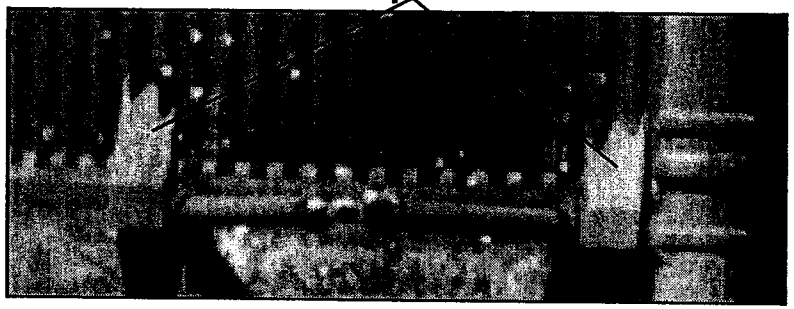
Similar BX-250 Closeouts

- Bipod Ramps

Pre-Flight



Post-Separation



Circumferential Rib Closeout Foam

Basis for Certification (continued):

- Extensive certification/qualification database developed

Test Description	Approximate Number of Tests
Physical properties - Density, thermal strain, flammability, corrosion, oxygen index, thermal conductivity	500
Mechanical properties - Compressive/tensile strength, cryoflex, shear	1000
Liquid properties (chemical and instrumental fingerprinting)	170
Lot to lot variation	7 lots
Storage life	6 yr.
Performance	
Wind tunnel and Hot gas - Aero/thermal ascent	20
Plasma arc - Aero/thermal re-entry	20
Combined environments - Acoustic, flight loads, and cryo substrate temperature - Intertank	1
PAL ramp - cryogenic strain (Flexure)	3

Special Topics

Description	Presenter
• Composite Nose Cone Resin Requalification	Robert Biggs
• Intertank Thrust Panel Foam Loss (IFA STS-87-T-01)	Steven Copsey
- Circumferential Rib Closeout Foam	
- **Installation of Intertank Thrust Panel Instrumentation (FEC KET-0040)**	**Louis Palermo**
- **Hi-Q Flight Trajectory**	
- **Grid on Intertank Thrust Panel (FEC KET-0041)**	

Installation of Thrust Panel Instrumentation

FEC-KET-0040

Change:

- FEC-KET-0040: Installation of Flight Instrumentation on the ET Intertank -Y Thrust Panel

Background/ Reason:

- Post flight inspection of STS-87 revealed out-of-family damage to Orbiter tiles possibly caused by foam loss from the ET Intertank Thrust Panel
- Foam loss is still occurring despite efforts to reduce the amount of loss
- Induced environment data is needed to support the closure of the ET Intertank Thrust Panel Foam Loss fault tree
  - Data will be used to validate design values

Installation of Thrust Panel Instrumentation

FEC-KET-0040

Description:

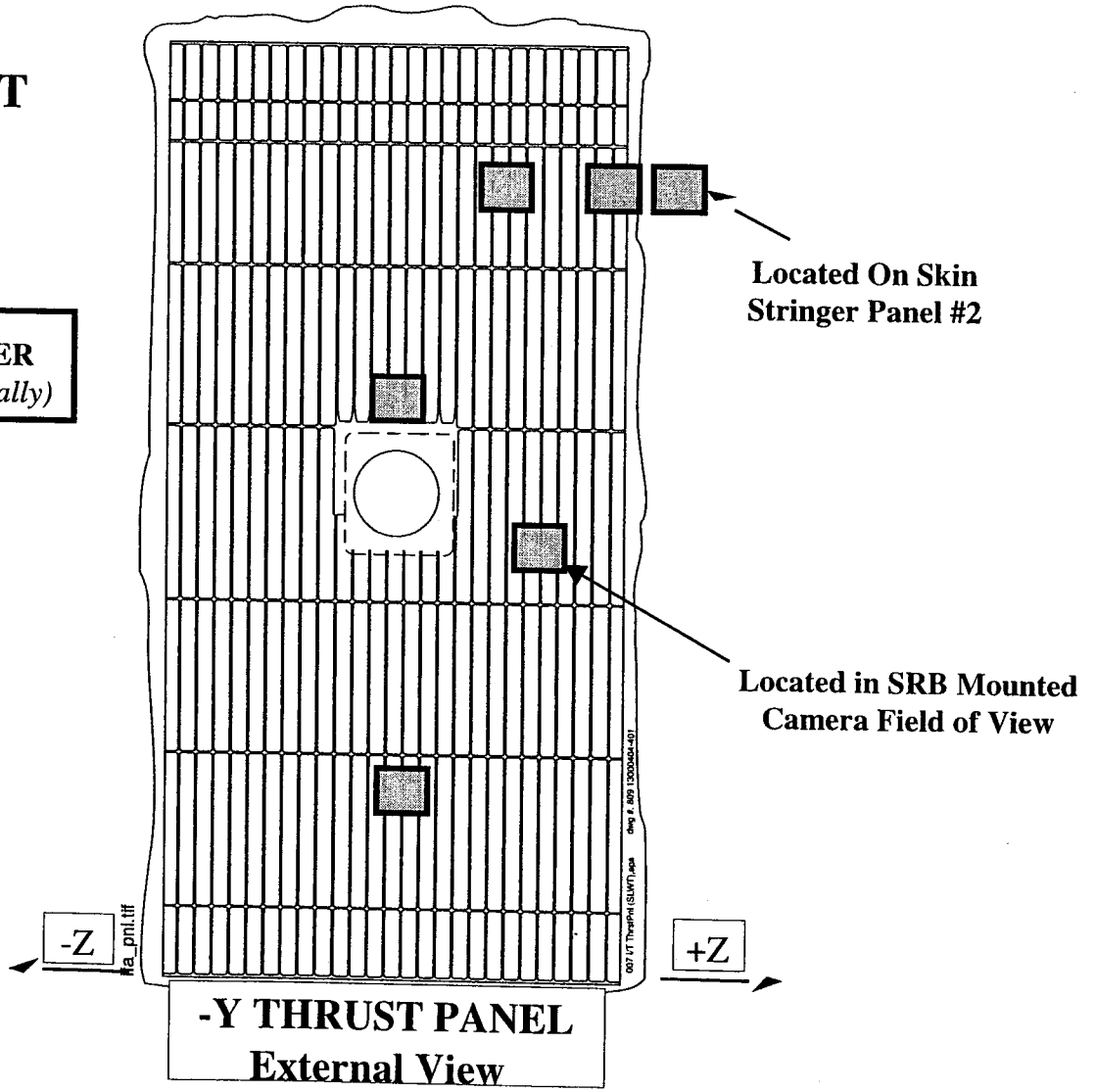
- Six GFP accelerometers and filters were installed on the -Y Intertank Thrust Panel at locations to measure ascent vibration environment
  - Measurement range: ±300 g
  - Frequency range: 0 to 250 Hz
    - Limited by data acquisition system
  - Data will be recorded using the Enhanced Data Acquisition System (EDAS) located in the L/H SRB Forward Skirt
- Connection to EDAS is through the L/H ET/SRB RSS cross-strap connector
  - Utilizes 30 available pins on the -Y cross-strap connector
    - Maintains 2 pin signal barrier between RSS and DFI functions
  - Cabling designed and manufactured at MAF
- Weight impact ≈ +10 lbs

Installation of Thrust Panel Instrumentation

FEC-KET-0040

MEASUREMENT LOCATIONS

ACCELEROMETER
(to be mounted internally)



Installation of Thrust Panel Instrumentation

FEC-KET-0040

Installation:

- Cabling installed by USA prior to ET/SRB mate
- Filters and accelerometers were installed by MAF team
  - Filters and accelerometers were adhesively bonded to surface with supplemental scrim cloth/adhesive reinforced straps
  - Wires were adhesively bonded at end of runs and at bends with aluminum tape used between adhesive bonds
    - Similar to Development Flight Instrumentation installation

Installation of Thrust Panel Instrumentation

FEC-KET-0040

Basis for Certification:

- Criticality 3 - No flight function
- Change request approved at PRCB on 7/30/98
  - Instrumentation package mini-DCR to be held 9/24/98
- Filters and accelerometers calibrated by vendor
  - Similar components successfully flown on SRB (STS-91)
- Performed functional "end to end" test after installation
- Performed adhesive bond test to ensure that bonded accelerometers will withstand flight environments
- Analysis shows no impact to structural factors of safety
- Electromagnetic interference test will be performed with RSS powered up during S0008 following Orbiter mate

Hi-Q Flight Trajectory

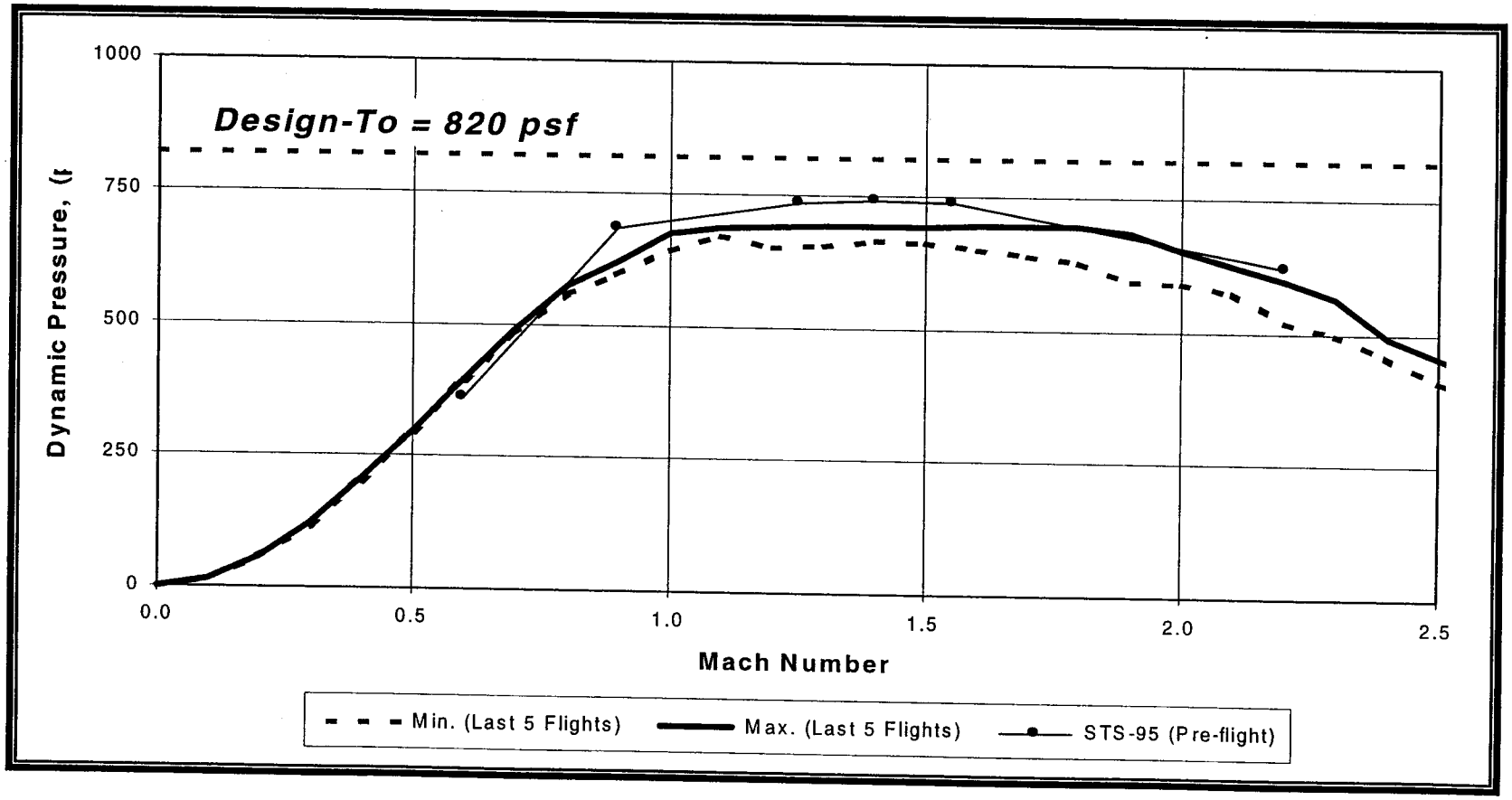
Issue:

- STS-95 predicted dynamic pressure is higher than those recently flown with NCFI 24-124 Intertank foam

Background:

- Concern that the increase in Q would aggravate occurrence of foam loss
  - Predicted maximum dynamic pressure is 740 psf
  - Maximum flown to date with NCFI 24-124 foam on Intertank is 700 psf

Hi-Q Flight Trajectory



Hi-Q Flight Trajectory

Rationale for Acceptance:

- STS-95 predicted dynamic pressure is well within design requirements
- Analysis and tests show high (>2.0) factors of safety for known dynamic pressure sensitive failure modes
  - Crush test indicated no appreciable loss of foam strength at Q=3600 psf
  - Shear test on machined foam indicated capability to sustain Q=7500 psf
- Dynamic pressure has not been identified as a probable root cause of foam loss in fault tree
  - The amount of impact damage has varied while peak pressure remained nearly constant
- Foam loss is calculated to occur between Mach 2.5 and Mach 4.0
  - Q at these Mach numbers well below peak values and not significantly greater than recent flights
- No challenges to flight safety rationale identified
  - Foam loss is a maintenance concern - Not a safety of flight concern

Grid on Intertank SRB Camera Field of View

FEC-KET-0041

Change:

- Apply grid on Intertank thrust panel for area that will be in the SRB camera field of view

Background/ Reason:

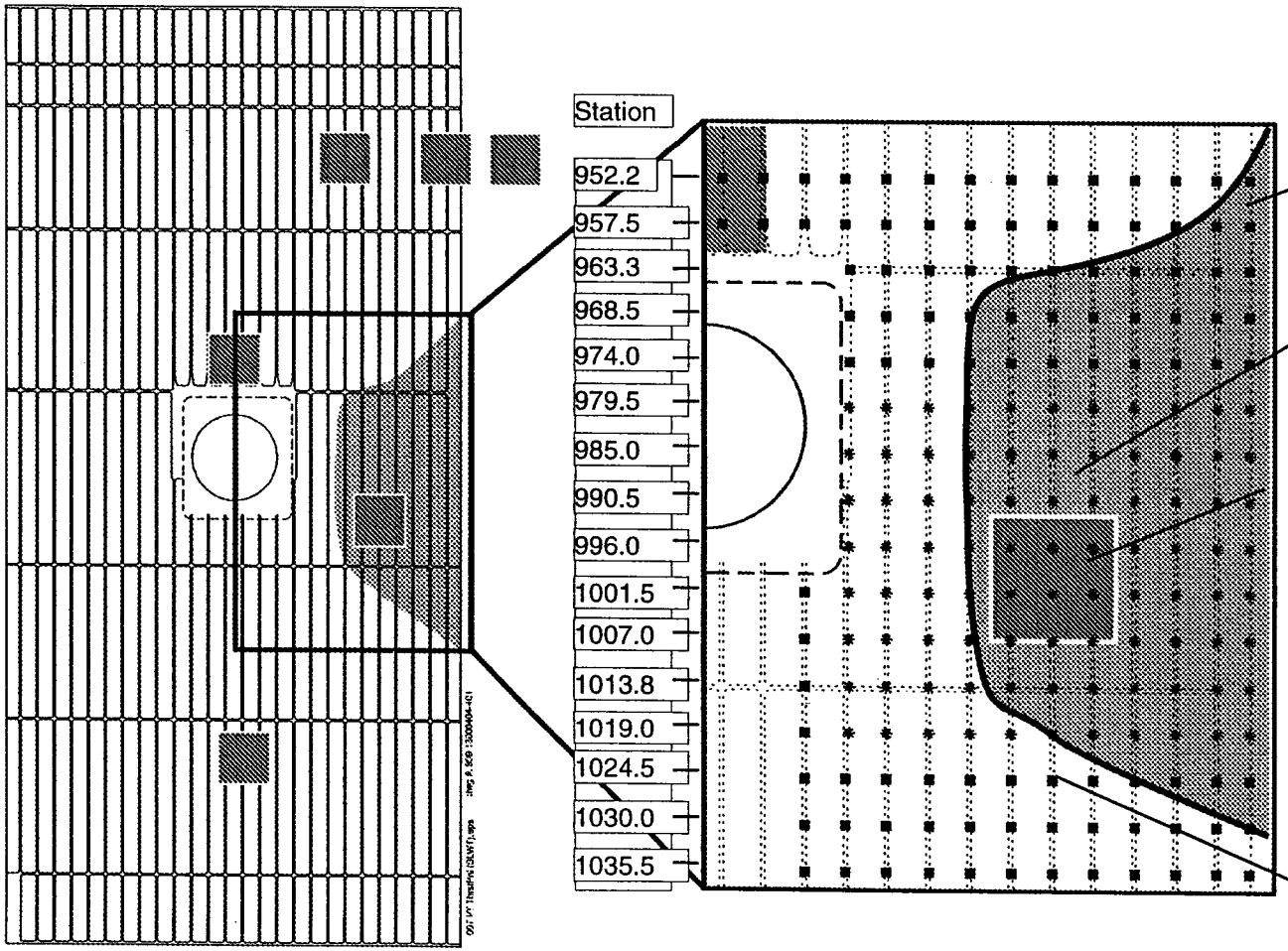
- Application of a grid will enhance photographic analysis of potential foam loss on the STS-95/ET-98 thrust panel

Description:

- Applied grid using Staedtler Lumocolor marker from the Intertank -Y ET/SRB fitting to the rib/stringer panel splice (Station 952 to Station 1035.5)
  - Grid extends beyond the camera field of view to an area that is typically seen on separation photos
  - Grid was applied to 13 rib tops and to the first stringer of the +Z side
    - 1.0" square blocks are equally spaced on 5.5" centers
    - Camera field of view is marked with 1.0" symbol (*)
- Performed detailed photographic mapping of SRB camera field of view using a 35mm camera to document pre-flight configuration

Grid on Intertank SRB Camera Field of View

FEC-KET-0041



GS 270-43B - Holloway 98Thrln.eps

Accelerometer Locations (mounted internally)

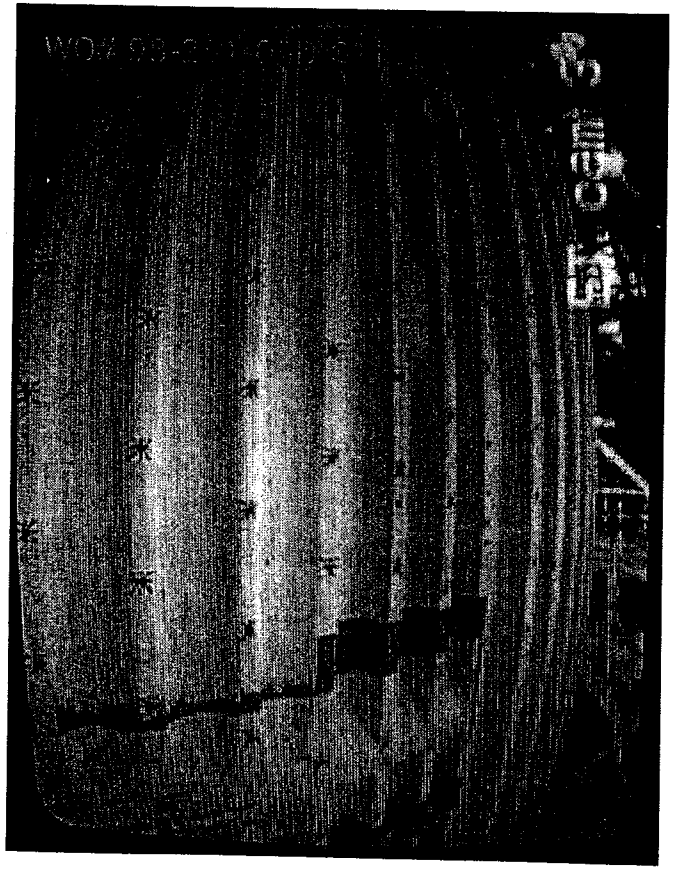
SRB Mounted Camera Field of View

ET98pfr.4250.ls.9/98

Grid on Intertank SRB Camera Field of View

FEC-KET-0041

- View of ET from SRB camera



Grid on Intertank SRB Camera Field of View

FEC-KET-0041

Basis for Certification:

- Staedtler Lumocolor pen has been approved marking tool for foam applications throughout life of External Tank Program
- Similar to previously flown applications
  - Used to mark grid in thrust panel foam reduction effort on STS-89/ET-90 and STS-90/ET-91 at KSC
  - Used on earlier LWT vehicles to identify vent hole location on two-tone foam applications on thrust panels
  - Used to apply GO2 vent hood alignment grid and ET/SRB mating targets
  - Used to identify any non-conformance and repairs locations

Agenda

• Overview	Jim Feeley
• Prior Mission Performance Summary	
• Current Mission/External Tank Highlights	
• ET-98 Mass Properties Status	Mike Simpson
• Changes	
• Senior Management Review NCDs: None	
• Special Topics	
• ***SRM&QA Assessment***	***Terry McKeough***
• KSC Processing	Wes Lattin
• Verification/Certification	Jim Feeley
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SRM&QA Assessment

as of 9/11/98

Item	Status
• Alerts	None Open
• MRB Assessment	Complete - No issues/no impact to hazard controls
• Hazard Assessment	Complete - All hazard reports were re-assessed and hazard controls verified
• Corrective Action Problem Summaries (CAPS) - T-067PF, Loss of Intertank SOFI during Ascent of STS-87/ET-89	Open clearance all ETs • Previously discussed as Special Topic

Agenda

• Overview	Jim Feeley
• Prior Mission Performance Summary	
• Current Mission/External Tank Highlights	
• ET-98 Mass Properties Status	Mike Simpson
• Changes	
• Senior Management Review NCDs: None	
• Special Topics	
• SRM&QA Assessment	Terry McKeough
• ***KSC Processing***	***Wes Lattin***
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KSC Processing - Status

as of 9/11/98

- Discrepancy Reports (DRs)/Problem Reports (PRs) Review
  - All PR/MRB discrepancies/dispositions similar to previously flown vehicles
  - All MRBs have been reviewed by MAF Reliability for potential SMR
- Limited Life Component/ET Status
  - All within required life through scheduled launch date plus 90 days
- OMRSD Exceptions/Waivers: None

KSC Processing - Status

as of 9/11/98

- Changes
  - ET modifications

• Mod Kits	0	
• DC&R	0	
• Bldg 45	2	- Temp/Pressure Gauges - Orbiter Scales
• FEC	3	- LO2 Ogive TPS Trim* - Thrust Panel Instrumentation - Grid on Intertank
- OMRSD/LCC	2	- LH2 Pre-press Cycle Count - LH2 Overfill Sensor Limit
- Software	3	- Incorporated OMRS/LCC changes - LH2 tank initial pre-pressurization

- SIM Load (S0044) 9/14/98
- SIM Launch (S0056) 10/06/98

** Previously flown on STS-91/ET-96*

Agenda

• Overview	Jim Feeley
• Prior Mission Performance Summary	
• Current Mission/External Tank Highlights	
• ET-98 Mass Properties Status	Mike Simpson
• Changes	
• Senior Management Review NCDs: None	
• Special Topics	
• SRM&QA Assessment	Terry McKeough
• KSC Processing	
• ***Verification/Certification***	***Jim Feeley***
• ***Mission Unique Assessment***	
• Readiness Statement	
• Appendices	
• A: Minor Changes	
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• C: KSC Processing	
• D: Previously reviewed material	

Verification/Certification

as of 9/11/98

Item	Status
• NSTS 07700, Volume X Baseline - Revision L, Change 246	No Issues
• Certification documentation - Hardware Certification Sheets (HCS) - Certificates of Qualification (COQ)	Complete - No Issues
• Waivers/Deviations	Complete - No Issues

Mission Unique Assessment

as of 9/11/98

Category/Item	STS-95
• Review of MRB actions using updated loads	ECD 10/15/98
• MPS Preflight Prediction Package	ECD 10/19/98

Readiness Statement

The External Tank, ET-98, is hereby certified and ready for STS-95 flight pending completion/closure of open and planned work

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Terry L. Hibbard

Vice President, External Tank Project
Lockheed Martin Michoud Space Systems

Appendices

- A: Minor Changes
- B: SRM&QA Assessment
  - NCD Assessment Criteria
- C: KSC Processing
  - Limited Life Components
  - Modification Summaries/Status
  - Alternate Blowing Agent Usage at KSC
  - Software Changes
  - OMRSD Exceptions/Waivers: None
  - OMRSD Changes (RCNs): None
- D: Previously presented items
  - Level II Waivers

Minor Changes

Description	Reason	Basis for Certification
Implement redesigned and improved metal LO2 feedline fairing (B01775G/K)	Dimension and tolerance issues on former design required MRB NCDs	Similarity to former metal fairing
Deletion of ET Range Safety Systems (B02010)	- Fastener grip length revised on panel/buttstrap and fastener installations to accommodate radius block deletion at panel assembly	Was: FS > 2.0 Now: FS > 2.0 (FS improves due to elimination of eccentricity)
	- Install fasteners on panels 2 and 7 using autoriveter; not incorporated on ET-96 due to RSS support structure interference with tool	FS unchanged since structural configuration is the same

Class II or JS/DCN Changes

- All Class I/II JS/DCN changes have been reviewed by MSFC Resident Office
- All Class II STP/STM/Standards changes have been reviewed by MSFC M&P Lab
- These changes are acceptable for flight and summarized in this appendix (presentation not required)
  - Presentation criteria - Selection for presentation based on changes affecting:
    - Processes
    - Configuration
    - Material
    - Alternate Hardware
  - Presentation rejection criteria - All changes that do not affect configuration, material or processes
    - Revise Point of Incorporation
    - Drawing Clarification
    - Non-Flight Hardware Installation/Removal
    - Datum Changes
    - Update Usage/List of Materials (L/M)
    - Drawing Incorporation Errors
    - Manufacturing Aid
    - Drawing Errors
    - Fastener Type/Grip
    - Tolerance Change
    - Productivity
    - Minor changes taken care of by initial release of Class I Change
      (Same categories as above)

Minor Class II Changes – Electrical

Change No.	Description
H35809-927	Update ET OI electrical schematic to deletion of of spare wire

Minor Class II Changes – Propulsion/Mechanical

Change No.	Description
H35809-415 -416 -417 -418 -419 -420 -422	Revise stainless steel tubing proof pressure test value to a standard 5600/6000 psig for all 1/4 inch and 3/8 inch OD flared tubes
H35809-760	Revise GO2 vent valve mounting hardware due to variation of in-tolerance thickness of valve casting
H35809-903	Added sealant (krytox) at interface between GO2 vent duct fittings and LO2 tank ogive at Sta 371 for corrosion resistance and electrical bonding
H35809-908	Clarify installation of support for GH2 pressure line on forward LH2 tank dome
H35809-955	Delete Teflon tubing requirements for small diameter wire harnesses on LO2 tank cable tray final assembly drawing
H35809-959	Clarify drawing by separating tube and tube assembly bend data table into detail and assembly information
H50001-792	Revise pressure transducer tubing installation from the sub-assembly level to final assembly installation

Minor Class II Changes – Propulsion/Mechanical

Change No.	Description
J31196-006 -008 -009	Create DCN allowing manufacturing to rework installation of helium inject flex hose and tube assembly

Minor Class II Changes – Structural

Change No.	Description
H35809-263	Revise "not to exceed" weight on LH2 barrel 1 panel machining drawing
H35809-319	Added sealing surface acceptance criteria flag note to LH2 siphon fitting closure drawing
H35809-356 -359 -360 -361 -386 -387	Create new LH2 tank barrel 1 formed, machined and trimmed panel drawing with revised rib thickness
H35809-366	Revised Frame 1973 fitting installation drawing to require 1.50" of material instead of 1.75"
H35809-426	Revised LH2 barrel 4 machined drawing to revise number of places for views Z and V
H35809-509	Revised LH2 tank barrel 1 mechanical assembly drawing to add washers and update bolt grip lengths
H35809-513	Revised longeron machining drawing to add tooling points, allow test coupon saw violations, add regions of allowable forging washout, add area for vendor identification, and remove explicit handling hole locations
H35809-514	Revised Frame 1973 segment assembly drawing to locate shorter doubler to avoid doubler interference with longeron

Minor Class II Changes – Structural

Change No.	Description
H35809-531	Correct Sta 941 frame segment assembly drawing to show shim installation in correct view (drawing previously called out 2 views)
H35809-553	Correct the penetrant inspection class and type called out for LH2 tank machined panel
H35809-555	Revise LH2 dome cap siphon plate welded assembly drawing to add vibro marking to represent the "0" degree location on the HAM weld same as HSP weld
H35809-559	Revised barrel 1 welded assembly to replace tooling holes alignment tolerance with rib alignment tolerance
H35809-560	Relax tolerance on tooling hole location on the LH2 tank barrel 3 and 4 trim drawing
H35809-564	Correct -Z Intertank half section fastener installation drawing to callout rivet in hole reserved for electrical cable suppport
H35809-570 -639	Added tooling holes to LH2 barrel panel trimmed for barrel clocking
H35809-591	Revise fastener callouts on Intertank buttstrap installation drawing to avoid component damage due to manual installation of fasteners
H35809-593	Revise LH2 barrel panel machined drawing “not to exceed” weight from 499 lbs to 501 lbs

Minor Class II Changes – Structural

Change No.	Description
H35809-608	Revise LH2 tank barrel 1 mechanical assembly to add spotfaces to prevent fasteners from riding radii
H35809-656	Use 26L14-6 fasteners instead of 26L14-5-10 fasteners on Intertank longeron tie installation
H35809-676	Add weld planishing requirement notes on LH2 aft dome and cap assembly; planishing not required for ET-99 & up
H35809-680	Replaced SLWT fitting with LWT fitting to preclude interference with HFDC weld
H35809-690	Added STP 2024 (screw threads insert installation) to sheet 1 of outer chord drawing - Inadvertantly omitted
H35809-691	Revised weld start and stop locations on LH2 aft dome to barrel weld assembly and mechanical installations
H35809-814	Audit finding - Clarify/enhance use of scribed arrows on LO2 tank weld assembly drawing
H35809-825	Revise epoxy primer application on LO2 aft dome to mask an area of 3.0 inches in diameter around the electrical feed through connector
H35809-915	Specified fastener head orientation on cable tray and fairing installation drawing - Ensures that cables inside fairing cannot be damaged by fastener threads

Minor Class II Changes – Structural

Change No.	Description
H35809-923	Revised SLWT weld acceptance manual x-ray requirements due to roll ring interference on the H8/HB4 intersection welds
H35809-952	Revise drawings to call out STP 2003 Class 1 (countersunk and flushness requirements) for faying surfaces
H36809-029	Allow light lubrication of nose cone fastener threads to reduce torque at installation
J31156-001 -002 -013	Revise LH2 tank formed and machined panel dimension from datum A to longitudinal edge and update not to exceed weight
J31159-001 -002 -003 -004	Revise LH2 barrel 1 trimmed panel to remove 0.030" mid point rise
J31160-001 -002 -004 -005	Revise Frame 1973 to barrel 1 attach fittings tapped hole size and machined fitting end pad from 0.25" min. to 0.30" min.
J31163A-003	Revise LO2 barrel welded assembly to add taper trim to a mid point rise 0.030" +/-0.015" to longitudinal edges of all panels prior to welding
J31176-004 -006 -007	Correct erroneous ICD callout on ET/SRB fitting installation and carrier O-ring drawing

Minor Class II Changes – Structural

Change No.	Description
J31182-001	Revise frame 1973 mechanical assembly to apply load at 8 weld lands for improving barrel contour
J31192-001 -002	Revise LH2 barrel panel maching drawings to delete STP 2507 and increase edge flatness tolerance within 1 foot of corners to +/=0.060"
J31193-004	Replace fasteners on Intertank stringer end caps with improved fasteners to reduce the possibility of stringer cracking

Minor Class II Changes – TPS

Change No.	Description
H35809-743	Provide foam thickness requirements for six areas on intertank thrust panels that were inadvertently omitted at initial drawing release
H35809-763	Eliminate manual foam trims aft of GH2 umbilical which are accomplished during automated foam machining and provide foam thickness requirements within the ice/frost zones of intertank stringer and thrust panels
H35809-784 -846	Revise requirements for plug pull and density testing on forward ogive cover TPS; revise drawing to eliminate random plug pull tensile test and show approximate location
H35809-867	Clarify view for LO2 tank cryoflex panel foam close-out to show how intertank/LO2 tank flange close-out trim interfaces with cryoflex close-out
H35809-925	Revise LH2 aft dome siphon membrane SLA panels to alleviate panel cracking during installation
H35809-986	Revise aero venting machined foam thickness dimension from .70 +/- .05 to .70 +/- .06; add note to specify a circumference dimension of 58.12 +/- .32 inch

Minor Class II Changes – Systems

Change No.	Description
H35809-951	Replace ET pressure monitoring system with dessicant filter assembly

Class Changes - STPs/STMs/STDs/AVL

Change No.	Document	Description
H35809-948	EQTP1003 Fingerprint Testing	Revise SS-1171 constituent fingerprint ranges based on expanded database
H35809-884	E768 Copper Wire	Replace cancelled Mil Spec with alternate Mil Spec
H35809-885	J562 Polyester Tape	Replace obsolete vendor tape designation with current designation
H35809-916	K924 Sodium Chromate	Remove procurement specification revision letter from code sheet
H36809-032	STP1006 Fab & Test Al 2195 Chords	Specify that only one test specimen is required in the longitudinal direction for extrusions too small to obtain specimens in the transverse direction
H35809-988	STP1011 Forming Al 2195 Barrel Panels	Delete requirement for testing after forming operations because testing performed at Mill is sufficient
H35809-852	STP1510/1522 Hand Compacted Ablator	Specify to add heptane directly to catalyst to minimize catalyst loss during mixing
J31193-003	STP2002 Blind Rivet Installation	Add requirements for new M24243 rivets for stinger end caps

Class Changes - STPs/STMs/STDs/AVL

Change No.	Document	Description
H35809-809	STP2010 Retention of Bearings	Specify proof load requirements for Type II staked bearings in STP and delete requirement for drawing to specify proof load requirement
H36809-017	STP2012 Tube Fabrication and Installation	Clarify that surface finish requirement for tubing flares in STP applies to central 80% of flare to agree with PPD
J31174-001/ H35809-798	STP2012/ Code 4250 Tube Fabrication and Installation	Require Ultrasonic and Eddy Current inspection of tubing material and require leak check after proof and specify that drawing will define minimum clearance for clamping when required
H35809-900	STP2014 Installation of Bolts	Add allowance for gauging through holes instead of bolt thread protrusion past nut after installation to assure proper bolt length selection
H35809-870	STP2501 Penetrant Inspection	Allow etch per STP5006 Method II or IV for weld beads and machined parts, specify penetrant solvent remover and reduce drying temp. from 180 to 160F max
H35809-938	STP2503 Radiographic Inspection	Clarify identification/labeling requirements and add 80900000069 reference

Class Changes - STPs/STMs/STDs/AVL

Change No.	Document	Description
H35809-871	STP2507 Al 2195 Penetrant Inspection	Allow etch per STP5006 Method II or IV for weld beads and machined parts, specify penetrant solvent remover and reduce drying temp. from 180 to 160° F max
H35809-879	STP4502 Preservation and Packing Details	Add STP5005 as applicable reference document and allow abrasive cleaning for work in progress
H35809-880	STP5005/K1A8 Abrasive Cleaning	Add material and requirements for powered abrasive aluminum cleaning
J31190-001	STP5008 Cleaning Oxygen & Pneumatic Systems STP5009 Cleaning of LOX & LH2 Tanks	Specify allowable particle size distributions below 100 microns to eliminate potential pressure difference exceedance across system screens
H35809-869/ H35809-912	STP5501 Al 2219 Fusion Welding	• Revise pre-weld gap requirements to allow .060 on linear joints • Add allowance for adjustments in weld schedule for differences between test fixture and flight tooling • Specify that re-qualification tests require one panel welded at nominal set point • New acceptance criteria for porosity and inclusions • Make criteria for grades 2 & 3 same as 2195 specifications

Class Changes - STPs/STMs/STDs/AVL

Change No.	Document	Description
H35809-875/ H35809-913	STP5506 Al 2219 VPPA Welding	• Revise pre-weld gap requirements to allow .060 on linear joints • Make criteria for grades 2 & 3 same as 2195 specifications
H35809-817	STP5507 Al 2195 Fusion Welding	• Make bead height requirement consistent with other 2195 specifications, • Add allowance for adjustments in weld schedule for differences between test fixture and flight tooling
J31188-004,-010, & -018/ H35809-930	STP5508 Al 2195 VPPA Welding	• Revise pre-weld gap requirements to allow .060 on linear joints • Make qualification strength requirements compatible with 809-3510 requirements • Add dual cover pass requirements (Different J31188 PDP No's for different weld implementations)
H35809-816	STP5509 Soft Plasma Arc Welding	Make bead height requirement consistent with other 2195 specifications
H35809-932	STP5509 Soft Plasma Arc Welding	• Revise pre-weld gap requirements to allow .060 on linear joints • Make qualification strength requirements compatible with 809-3510 requirements

Class Changes - STPs/STMs/STDs/AVL

Change No.	Document	Description
J31180-001	STP6009/J536 Thermal Isolator Installation with double sided tape	Implement 18 month shelf life on J536C and unlimited shelf life for J536B tapes and require tape application just prior to assembly
H35809-910	STP6510 Moisture Proofing of Connectors STP6513 Bonding Wires to ET Surfaces STP6514 Bonding Wires to LH2 Tank Interior	Add Lord 4973 as alternate adhesive to Crest 391 and shorten maximum pot Life from 3 Hr. to 2 Hr.
H35809-920	STP7523 Graphite Polyimide	Add allowance for abrading wrinkles when specified on the Engineering Drawing

NCD Assessment Criteria

- Assessment of all MRB Items
  - Adequacy of technical dispositions
  - Completeness of required repair/retest
  - First time occurrences/SMR
  - Verification of margin of safety assessment/documented
  - Review of impact to hazards
  - Engineering review for impact to loads
  - Engineering review for reduced extrusion to plate weld allowables

ET-98 DR/PR/OMRSD Waiver/Exceptions

as of 9/16/98

System	Discrepancy	Problem	MRB Items	Exceptions/ Waivers
• Electrical	0	1	0	0
• Propulsion/ Pneumatics	0	1	0	0
• Range Safety	0	0	0	0
• Structures	0	0	0	0
• Thermal (TPS)	0	4	3	0
Total	**0**	**6**	**3**	**0**

ET98pfrc.4250.ls.9/98

ET-98 PR/MRBs

PR No./Status	Title/Description	Disposition
Thermal		
PET-98-TS-0001	Three underfills and three voids in aft hardpoint checkout spray.	• Use-As-Repaired • Closeout performance is not negatively affected • Areas Returned to Drawing thickness requirements
PET-98-TS-0003	Underfill at –Z corner of the –Y fairing aft periphery closeout.	• Use-As-Repaired • Closeout performance is not negatively affected • Areas Returned to Drawing thickness requirements

ET-98 PR/MRBs

PR No./Status	Title/Description	Disposition
Thermal		
PET-98-TS-0004	During removal of GSE near the bipod struts, NAS 627-6 bolt fell and hit the ET box beam.	Repair with SLA type 1 • Repair meets 80900000010 repair criteria • Repair is within database • No evidence of substrate damage

ET-98 Limited Life Components

Cycle Sensitive

Description	Part No.	Serial No.	Limit	Required	Remaining
LH2 Manhole Cover Assy -Fwd	80914081488 -509	00599200	8	1	8
LO2 Tank Mechanical Assy	80912002000 -500	00566100	8	1	8
LH2 Tank Mechanical Assy	80914002000 -500	00636200	8	1	8
LO2 Manhole Cover Assy	80911001205 -509	00645160	8	1	8

ET-98 Limited Life Components

Cycle Sensitive

Description	Part No.	Serial No.	Limit	Required	Remaining
LO2 Fwd Ogive Cover Plate	80911001207 -509	00642050	8	1	8
LH2 Manhole Cover Assy -Aft	80911001444 -509	00632050	8	1	8
LH2 Tank Syphon Closure	80911001445 -502	00652460	8	1	8

ET-98 Limited Life Components

Age Sensitive

Description	Part No.	Serial No.	Limit	Initiation	Expiration
External Tank	80901000000 -500	00000091	6 Yrs	6/98	6/2004

ET-98 Limited Life Components

Age Sensitive Pyrotechnics -

10 Years Life/Requires Lot Verification Tests After 4 and 7 Years

Description	Part No.	Lot No.	Serial No.	Latest Retest	Expiration
Separator Assy GUCP	PD500020-059	AAH	0001141	01/1998	01/2002
Cartridge Assy	PD500020-030	AAH	0001283	01/1998	01/2002
Cartridge Assy	PD500020-030	AAH	0001372	01/1998	01/2002

ET-98 Software Changes

Description	Reason	Status
1) Incorporate one second delay between initial LH2 press and start of prepress pulses for STS-95/ET-98.	The RCN SS13373M required the delay for STS-91/ET-96. It was discovered during the tanking test that the delay was not incorporated into the software. Due to time constraints the requirement was waived for STS-91/ET-96	Incorporated
2) Increase LH2 Overfill sensor reactive control limit from 1% to 20%	Prevent reactive stop flow during replenish due to increased boil-off rate for SLWT. RCN KS13507	Incorporated
3) Increase the number of allowable LH2 prepress pulses from 10 to 13.	Based on ET-96 Tanking Test data analysis, the prepress pulse count limit was increased. This change takes into account the missing 1 sec. Software delay and the response time of the prepress valve. LCN 00832	In-Work Approved by PRCB

ET-98 Alternate Blowing Agent Usage at KSC

Foam	Document	Description	Location	Size
SS-1171	T5141	Aft Hardpoint Closeout	xt 1973-2076, 180 degrees	4410 sq. ins.
PDL-1034	PR-TS-0001	Aft Hardpoint	xt 1973-2076, 180 degrees	10 sq. ins.
PDL-1034	T5249	ET/SRB Aft Fairing Closeout	xt 2058, 70/290 degrees	240 sq. ins.
PDL-1034	T5244	ET/0RB Jack Pad Closeout	xt 1129, 15/345 degrees	9 sq. ins.

Level II Waivers - Baseline

Document / Requirement	Authority	Paragraph	Waiver No.	Effectivity
NSTS 07700 Vol V – Information Management Requirements				
Generic part name, type, common designation, and part manufacturer H4 code are not required for EEE parts status print out	S00127B 6/28/88	Table C.5 Item 2SR-10	6	ETs 49 & up
Data required in limited life status report is supplied in acceptance data package	S00127B 6/28/88	Table C.6 Item 2SR-7	8	ETs 49 & up
Requirement to deliver element pressure vessel historical data to EPO will remain at contractor facility	S00127B 6/28/88	Table C.6 Item 2SR-7	10	ETs 49 & up

Level II Waivers - Baseline

Document / Requirement	Authority	Paragraph	Waiver No.	Effectivity
NSTS 07700 Vol X – Space Shuttle Flight and Ground System Specification, Book 1 Requirements				
Electrical wiring of redundant systems NSTS 08080-1, 20A/4B	S040732G 6/18/88	Table 2.0	362	ETs 23, 27-29, 31 & up
Electrical bonding per MIL-B-5087B (2)	S040732M 9/9/88	3.6.14	378	ETs 23, 27-29, 31 & up
Soldering, circuit boards, and connectors	S040732M 9/9/88	3.6.15.1.1	379	ETs 23, 27-29, 31 & up
PD7400106 circuit boards	S040732M 9/9/88	3.6.15.2.1	382	ETs 23, 27-29, 31 & up
PCM MUX and pressure transducer circuit boards	S040732M 9/9/88	3.6.15.2.1	383	ETs 23, 27-29, 31 & up
Soldering of electrical connectors	S094779C 2/21/91	3.6.15.1.1	573	ETs 37, 41 & up

Level II Waivers - Baseline

Document / Requirement	Authority	Paragraph	Waiver No.	Effectivity
NSTS 07700-10-MVP-01– Shuttle Master Verification Plan				
Environmental acceptance of ET components	S002130H 3/7/89	3.7.1	13	ETs 23, 27-29, 31 & up
NSTS 07700-10-MVP-01– Shuttle Master Verification Plan				
LH2 feedline bellows	S005203G-R1 8/2/91	3.6.15.1.1	573	ETs 37, 41 & up

Level II Waivers - Baseline

Document / Requirement	Authority	Paragraph	Waiver No.	Effectivity
SL-E-0001 – Specification Electromagnetic Compatibility Requirement				
Wire marking is not applicable to the ET	S40732K 9/27/89	3.2.5	3	ETs 23, 27-29, 31 & up
SW-E-0002 – Ground Support Equipment General Design Requirements				
Factor of safety applied to yield for GUCP leg	S87020L 8/17/88	3.6.15.1.1	573	ETs 37, 41 & up

New 38 – NO data!