FLIGHT READINESS STATEMENT
STS-94/ET-86 AND STS-85/ET-87
EXTERNAL TANK PROJECT
PRE-FLIGHT REVIEW

EXTERNAL TANKS ET-86/STS-94 AND ET-87/STS-85, AS IDENTIFIED IN THE EXTERNAL TANK PROJECT PRE-FLIGHT REVIEW DATED JUNE 11, 1997, ARE CONSIDERED READY TO SUPPORT FLIGHT UPON ACCEPTABLE DISPOSITION OF OPEN/PLANNED WORK AND/OR OPEN ACTIONS.

E. C. SMITH/EB01

M. A. PESSIN/EE31

for A. F. WHITAKER/EH01

For A. O. HARRIS/CR01

for G. R. WALLACE/EL01

W. R. HUMPHRIES/ED01

S. P. SAUCIER/EP01

M. D. SMILES/CR70

P. V. COUNTS/SA31, CHAIRMAN

June 11, 1997

Space Shuttle
External Tank

STS-94/ET-86 and STS-85/ET-87 Pre-Flight Review

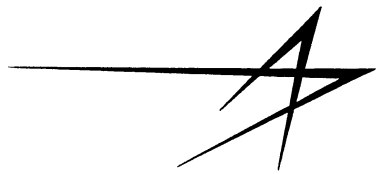
Frank McDaniel
at
MSFC
20 copies

LOCKHEED MARTIN

Manned Space Systems

ET86/87PFR.4250.dd.6/97

Agenda



• ***Overview***	***Jim Feeley***
• ***Prior Mission Performance Summary***	
• ***Current Mission/External Tank Highlights***	
• Changes	
• Senior Management Review NCDs: None	
• SRM&QA Assessment	Terry McKeough
• KSC Processing	Brian Knipfing
• Verification/Certification	Jim Feeley
• Mission Unique Assessment	
• Readiness Statement	
• Appendices	
- A: Minor Changes	
- B: SRM&QA Assessment	
- C: KSC Processing	
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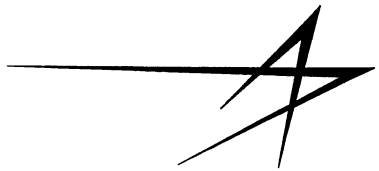
Overview



- Review covers changes/differences/non-conformances not previously flown and/or reviewed

- This review for STS-94/ET-86 and STS-85/ET-87 includes:
  - Prior mission performance summary
  - Items specific to mission STS-94 and STS-85
  - Details of previously presented items are included in the Appendix

• **FRR Series**	**ET-86**	**ET-87**
- Mission Specific Reviews		
• ET/SRB Mate	5/7/97	6/18/97 (S)
• Pre-flight review	6/11/97	6/11/97
• Space Shuttle Vehicle FRR	6/19/97 (S)	7/24/97 (S)
• Mission Management Team (L-2 Day)	6/29/97 (S)	8/5/97 (S)

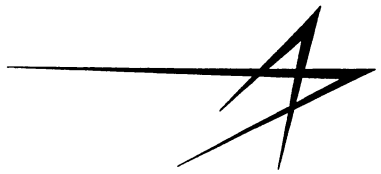
Prior Mission Performance Summary

System	Performance	
	STS-83/ET-84, 4/4/97	***STS-84/ET85, 5/15/97***
OMRSD	No violations	No violations
LCC	Nominal	Nominal
Instrumentation	Nominal	Nominal
MPS	Nominal	Nominal
ET Hazardous Gas	Nominal	Nominal
TPS	Nominal	Nominal
ET disposal	Nominal	Nominal
Orbiter tile damage	Lower surface, below average • Total = 38 • >1" = 7	Lower surface, below average • Total = 67 • >1" = 10
Post flight photo review	No issues	No issues

Mission/External Tank Highlights

Mission	STS-94	STS-85
• **Launch**	7/1/97	8/7/97
- Window	1437 - 1707 EDT	1039 - 1235 EDT
- Pad	A	A
- Orbiter	Columbia (OV-102)	Discovery (OV-103)
- Orbital inclination	28.45° - Insertion at 160 NM	57.0° - Insertion at 160 NM
- ET photo coverage	• Umbilical well cameras • Crew photos from cockpit window	• Crew photos from cockpit window
• **Primary payload**	Reflight of Microgravity Science Laboratory-1	CRISTA-SPAS-2
• **Landing**	7/17/97	8/18/97
- Time	0723 EDT	0727 EDT
- Location	KSC	KSC
External Tank	**ET-86**	**ET-87**
• DD250 acceptance	10/8/96	12/4/96
• Shipped to launch site	1/9/97	3/28/97

Agenda



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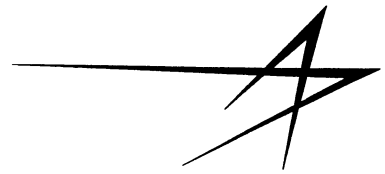
Changes - List



Description (Change No.)	Effectivity	Presenter
• GFP LO2/LH2 umbilical disconnect part number change (B01985D)	ET-86 and subs	Not presented - Included in Appendix A
• Increase LO2 aft dome foam coverage (B01993)	ET-86 and subs	Jim Feeley
• Alternate blowing agent foam usage		Steve Copsey
- NCFI 24-124 on LO2 tank sidewall (B01987F)	ET-86 and subs	
- SS-1171 on LO2 aft dome (B01987B)	ET-87 and subs	
• Delete LO2 tank slosh baffle section at Station 780 (B02004)	ET-87 and subs	Brian Piekarski

Increase LO2 Tank Aft Dome Foam Coverage

Change:

- Increase foam coverage on LO2 aft dome in area around manhole cover and feedline fitting

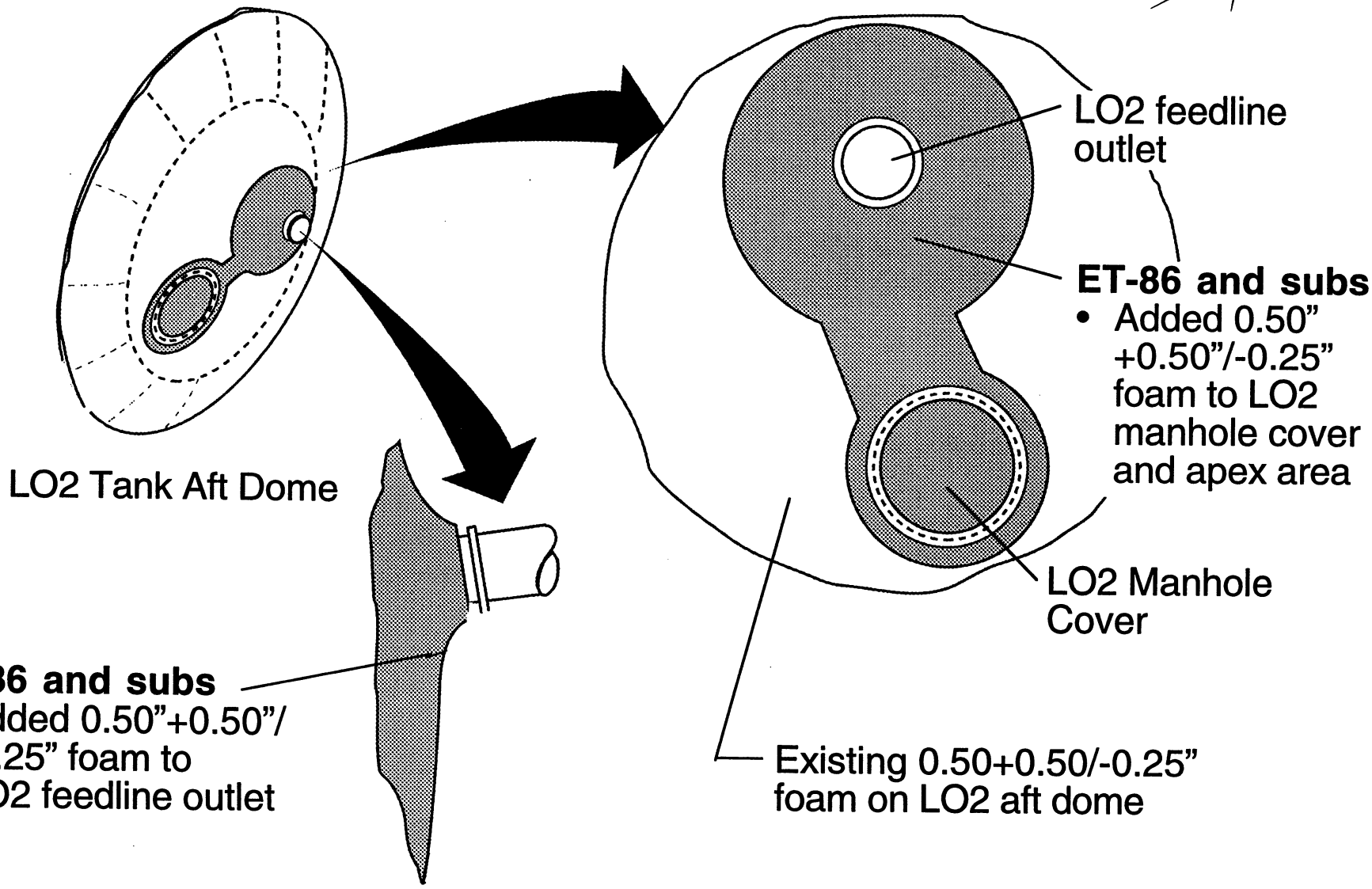
Background/ Reason:

- Study initiated to evaluate candidates to increase Shuttle lift performance
  - Heat leak of uninsulated area previously accounted for in prelaunch and launch propellant predictions
  - Application of foam to bare areas reduces heat leak resulting in potential for payload increase
- Foam previously not applied on the LO2 aft dome manhole cover and LO2 feedline areas (approximately 38 ft^2) to accomodate production process
  - Improvements to production process now permits additional foam application
  - Heated Intertank purge was sized to account for bare areas

Description:

- Apply BX-250 foam on LO2 manhole cover, LO2 feedline outlet and area between the cover and fitting
- Added requirement to ensure 1.10" gap exists between SRB beam and LO2 aft dome foam

Increase LO2 Tank Aft Dome Foam Coverage



Increase LO2 Tank Aft Dome Foam Coverage

Basis for Certification:

- Analysis
  - Stress, FS:
    - Required = 1.10
    - Actual = 2.39 (failure mode: bondline delamination)
  - Thermal: Reduces heat leak and provides denser propellant and added performance margin to heated Intertank purge system
  - Propulsion: Additional LO2 load provides potential for increased performance
- Acceptance: Lead in/lead out plug pulls
- Approved by Level II PRCB (S052333JR9) on 4/13/95

Alternate Blowing Agent Foam Usage

Change:

Implement use of alternate blowing agent foams
- ET-86 and subs: NCFI 24-124 on LO2 tank sidewall
- ET-87 and subs: SS-1171 on LO2 aft dome

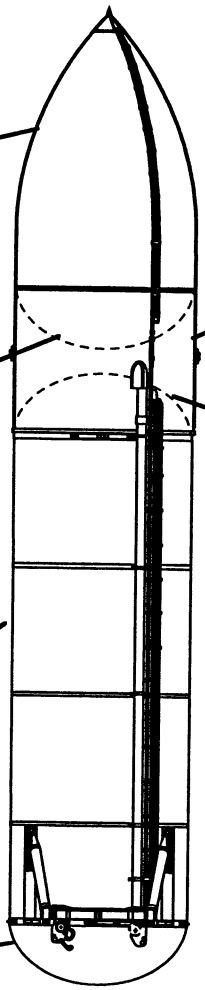
Background/ Reason:

- 1990 Clean Air Act legislated phase out of CFC-11 (freon) due to ozone depletion issue
- Staged implementation of new foams started with STS-78/ET-79
- BX-250 and CPR-488 previously used at these locations
  - Used CFC-11 blowing agent
- HCFC-141b chosen to replace CFC-11 in all ET foams
- First use of NCFI 24-124 foam on ET-85 (STS-84) LH2 tank sidewall - No issues
- First use of SS-1171 foam on ET-82 (STS-79) third hardpoint closeout and repairs at KSC - No issues

Description:

- Replaced CFC-11 in all ET foams with HCFC-141b
  - CPR-488 replaced with similar polyisocyanurate foam NCFI 24-124
  - BX-250 replaced with similar urethane foam SS-1171

Alternate Blowing Agent Foam Implementation



STS-94 (ET-86) and subs
- **NCFI 24-124 on LO2 tank sidewall**

STS-85 (ET-87) and subs
- **SS-1171 on LO2 aft dome**

STS-84 (ET-85) and subs
- **NCFI 24-124 on LH2 tank sidewall**

STS-79 (ET-82) and subs
- **NCFI 24-57 on LH2 aft dome**

STS-86 (ET-88) and subs
- NCFI 24-124 on Intertank sidewall

STS-84 (ET-85) and subs
- **SS-1171 on LH2 tank forward dome**

STS-78 (ET-79) and subs
- **PDL-1034 used for KSC closeouts/repairs**

STS-79 (ET-82) and subs
- **SS-1171 used for third hardpoint closeout and repairs at KSC**

Alternate Blowing Agent Foam Usage

ET-86, LO2 Tank Sidewall - CPR-488 vs NCFI 24-124

	Spec Requirement		Flight Requirement		Typical Property		
Requirement	**CPR**	**NCFI**	**CPR**	**NCFI**	**CPR**	**NCFI**	**Performance**
• Density (pcf)	2.1-2.6	2.0-2.5	Not applicable		2.4	2.2	Not applicable
• Tensile RT (psi)	35 min	30 min	16.2 min	16.2 min	54	44	NCFI has lower strength, FS min = 2.04 (bond adhesion)
• Tensile +300°F (psi)	Not applicable		16.2 min	16.2 min	37	32	NCFI has lower strength, FS min = 1.48 (bond adhesion)
• Compression (psi)	24 min	25 min	Not applicable		40	33	NCFI is less damage tolerant
• Recession rate (in/sec) @ 7 BTU/ft^2-sec	Not applicable		Not applicable		0.0168	0.0094	NCFI has improved recession rate
• Thermal conductivity (BTU/hr-ft-°F) @RT	0.025	0.025	Not applicable		0.0164	0.0164	Same
• Cryo strain (ksi)	59@ -320°F	59@ -320°F	59@ -297°F	59@ -297°F	65@ -320°F	89@ -320°F	Both demonstrated to required stress levels

Alternate Blowing Agent Foam Usage

ET-87, LO2 Tank Aft Dome - BX-250 vs SS-1171

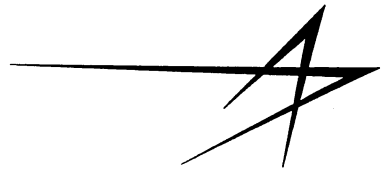
Requirement	Spec Requirement		Flight Requirement		Typical Property		Performance
	BX	SS	BX	SS	BX	SS	
• Density (pcf)	1.8-2.6	1.8-2.6	Not applicable		2.4	2.4	Not applicable
• Tensile RT (psi)	35 min	35 min	16.2 min	16.2 min	75	53	SS has lower strength, FS min = 2.38 (bond adhesion)
• Tensile -297°F (psi)	Not applicable		16.2 min	16.2 min	53	62	SS has higher strength
• Compression (psi)	24 min	24 min	Not applicable		42	30	SS is less damage tolerant
• Recession rate (in/sec) @ 7 BTU/ft^2-sec	Not applicable		Not applicable		0.053	0.031	SS has improved recession rate
• Thermal conductivity (BTU/hr-ft-°F) @RT	0.015	0.015	Not applicable		0.015	0.015	Same
• Cryo strain (ksi)	Not applicable		63@ -297°F	63@ -297°F	85@ -320°F	85@ -320°F	Both demonstrated to required stress levels

Alternate Blowing Agent Foam Usage

Basis for Certification:

- Process development
  - Design of experiment process utilized
    - Room temperature/humidity
    - Component temperature
    - Substrate temperature
    - Gun output
- Tests
  - Physical properties - Density, thermal strain, flammability, corrosion, oxygen index, thermal conductivity
  - Mechanical properties - Compressive/tensile strength, cryoflex, shear
  - Liquid properties
  - Lot to lot variation (3 lots/NCFI 24-124 and 5 lots/SS-1171)
  - Storage life - In process
    - NCFI 24-124 - 1.5 years
    - SS-1171 - 1 year
  - Performance
    - Hot gas - Aero/thermal
    - Plasma arc - Aero/thermal re-entry
    - Wind tunnel - Aero/thermal ascent
    - Combined environments - Acoustic, flight loads, and cryogenic substrate temperature
    - PAL ramp - Cryogenic strain

Alternate Blowing Agent Foam Usage



Basis for Certification:

- Analysis
  - Stress: New foams meet required FS of 1.10
    - ET-86: LO2 tank sidewall (failure mode: bondline delamination)
      - Was: CPR-488 = 1.15
      - Now: NCFI 24-124 = 1.16
    - ET-87: LO2 tank aft dome (failure mode: bondline delamination)
      - Was: BX-250 = 2.39
      - Now: SS-1171 = 2.21
  - Thermal: New foams meet ascent temperature and disposal requirements
- Acceptance
  - NCFI 24-124 on LO2 tank sidewall
    - Lead in cryoflex panel
      - 2 cryoflex
      - 3 density
      - 3 bond tension
    - Lead in/lead out plus 3 intermediate plug pulls
  - SS-1171 on LO2 tank aft dome
    - Lead in/lead out density and plug pulls on dome

Delete LO2 Tank Slosh Baffle Section

Change:

- Deleted slosh baffle section on LO2 tank at Station 780 resulting in change to available damping

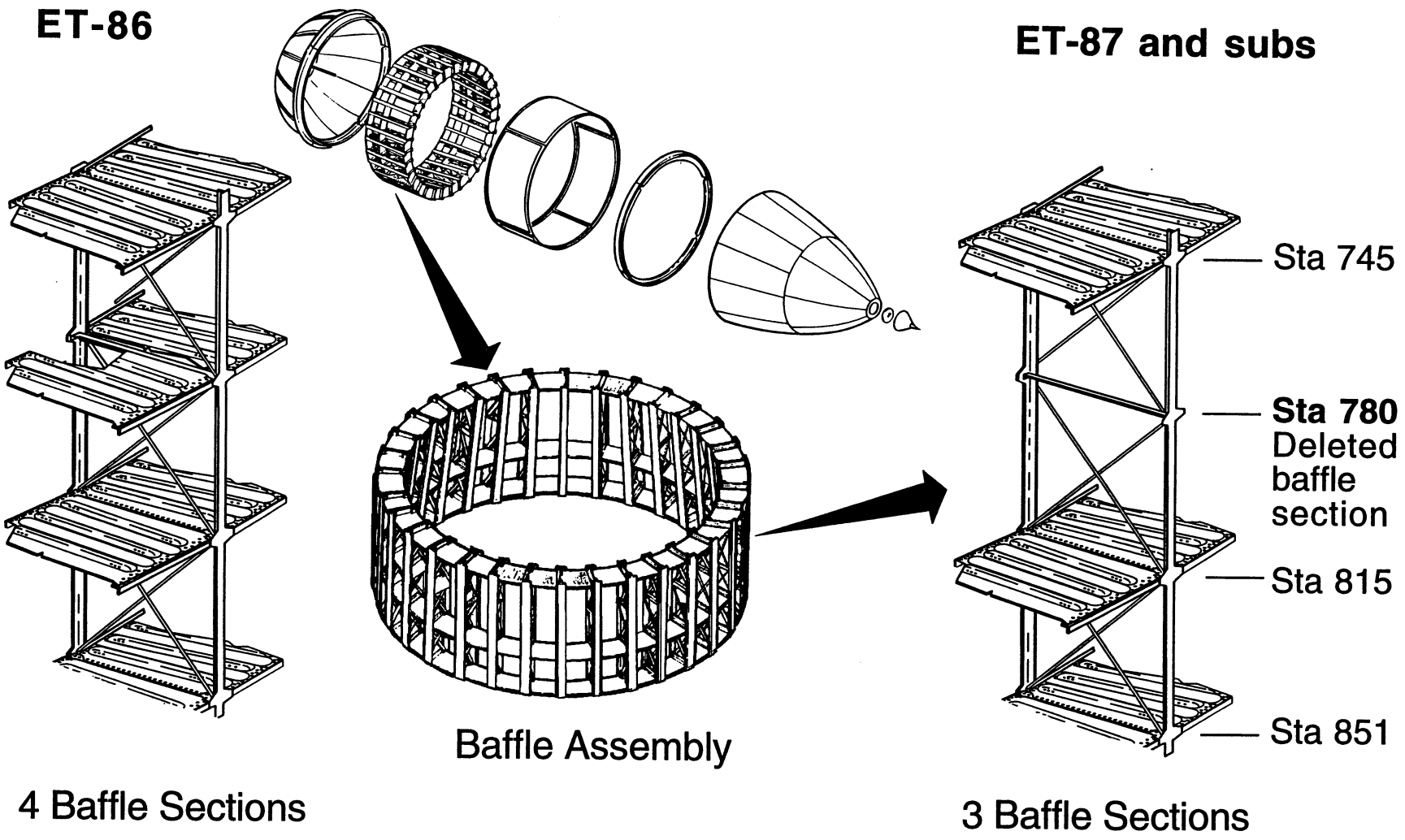
Background/ Reason:

- Removal of one slosh baffle section incorporated as weight savings candidate for SLWT
  - Predicted performance gain of 92 lbs
- Early incorpation of change at ET-87 diminishes number of first time configuration changes for SLWT
  - Approved by Level II (S052333AF)

Description:

- Removed one slosh baffle section at Station 780
  - Was: 4 baffle sections
  - Now: 3 baffle sections

Delete LO2 Tank Slosh Baffle Section



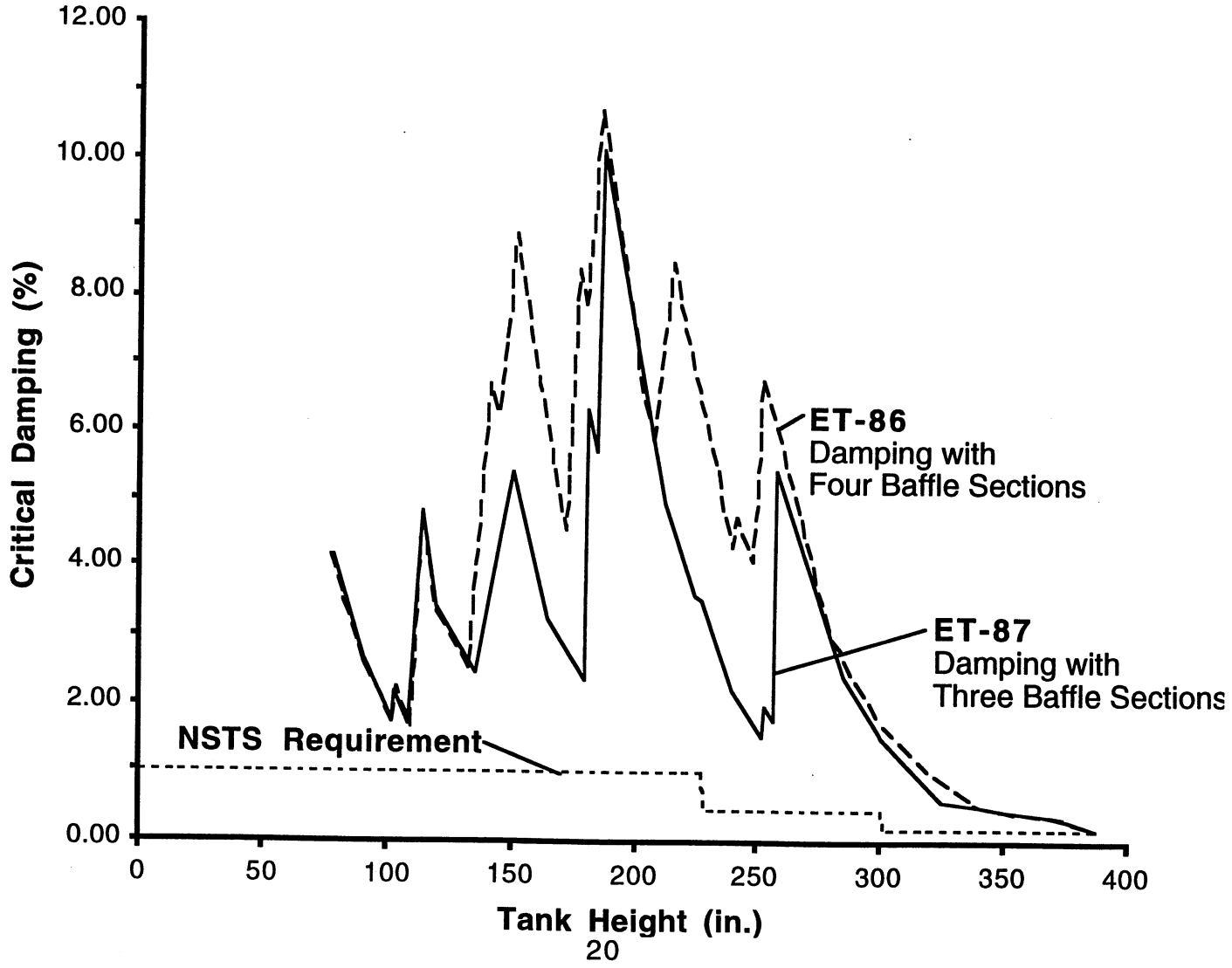
Delete LO2 Tank Slosh Baffle Section

Basis for Certification:

- Analysis
  - Dynamics: Damping available for flight control remains within requirements
  - Propulsion:
    - Normal mission and RTLS tank ullage predictions remain within ICD limits
  - Stress: Meets required FS of 1.40
    - ET-86 with 4 baffle sections: FS = 3.35
    - ET-87 with 3 baffle sections: FS = 2.02 (failure mode: column buckling inboard stringer)
- CR S052333BM approved by Level II

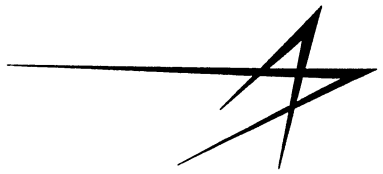
Delete LO2 Tank Slosh Baffle Section

Critical Damping - Four Baffle Sections vs Three Baffle Sections



ET86/87PFR.4250.6/97.dd

Agenda



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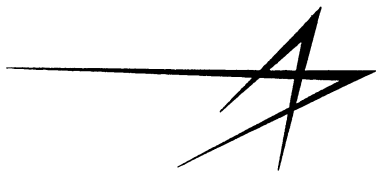
SRM&QA Assessment

as of 6/4/97

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)**	None open

Agenda



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KSC Processing - Status

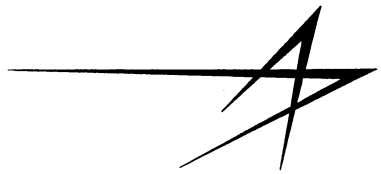
as of 6/4/97

- **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
- **Changes**

	ET-86	ET-87
- ET modifications		
• Mod Kits *	4	0
• DC&R (Discrepancy Check and Report)	0	0
• Bldg 45	0	0
• FEC (Field Engineering Change)	0	0
- OMRSD	0	0
- Software	0	0
• SIM Load	6/20/97	7/25/97
• SIM Launch	6/5/97	7/7/97

* Included in Appendix C

Agenda



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Verification/Certification

as of 6/4/97

Item	Status
• **NSTS 07700, Volume X Baseline** - Revision L, Change 231	No constraints
• **Certification documentation** - Hardware Certification Sheets (HCS) - Certificates of Qualification (COQ)	Approved - No issues
• **Waivers/Deviations** *	Approved - No issues

* Included in Appendix D

Mission Unique Assessment

as of 6/4/97

Category/Item	STS-94	STS-85
• **Review of MRB actions using updated loads**	Complete - No issues	Complete - No issues
• **MPS Preflight Prediction Package**	ECD 6/20/97	ECD 7/28/97

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Added 6/16

LO2 Feedline Bracket Bearing Proof Test

Issue:

- Staked bearing in LO2 feedline support bracket at Station 1973 was not proof loaded as required by STP

Background:

- Change processed to STP in 1991 to transfer proof test requirements from STP 2010 for Type II bearings to the installation drawing
  - Drawing was not updated because it was thought that no Type II bearings were installed on ET
- Previous supplier performed proof test of 60 parts per STP requirement without failure
- New vendor was given contract for 40 parts (ETs 81 - 120) under the revised STP
  - Vendor installed bearings with a 6-point stake
  - No proof test was performed on completed assemblies because detailed requirements were not provided on drawing or STP
- Vendor submitted an NCD recently for a dimensional discrepancy
  - NCD dispositioned "use as is" after successful proof test
  - Vendor replied that proof test was not planned

MAF/MSR

P.03

LO2 Feedline Bracket Bearing Proof Test

Discussion:

- Analysis was performed to predict loads on bearing
  - Axial thrust loads on bearing result from secondary effects
  - Load estimated at less than 100 lb
  - Design is fail-safe since bearing is contained by clevis
- Status of 40 parts on current contract
  - 21 details were removed from inventory stores
    - 21 parts successfully completed the required proof test to 350 lb
    - 1 of the 21 parts was tested to capability of 848 lb
  - 3 parts have TPS and are staged for installation
  - 6 parts are at supplier pending completion - Will be proof tested
  - 5 parts have been installed on completed ETs
  - 5 parts have previously flown

Rationale for Acceptance:

- Bearing experiences less than 100 lb axial load
- 53% sampling of lot withstood 350 lb proof test
- One part demonstrated a force of 850 lb required to dislodge the bearing
- Bearing can not come out of housing because of restriction from strut clevis and is capable of carrying limit load in the extreme position

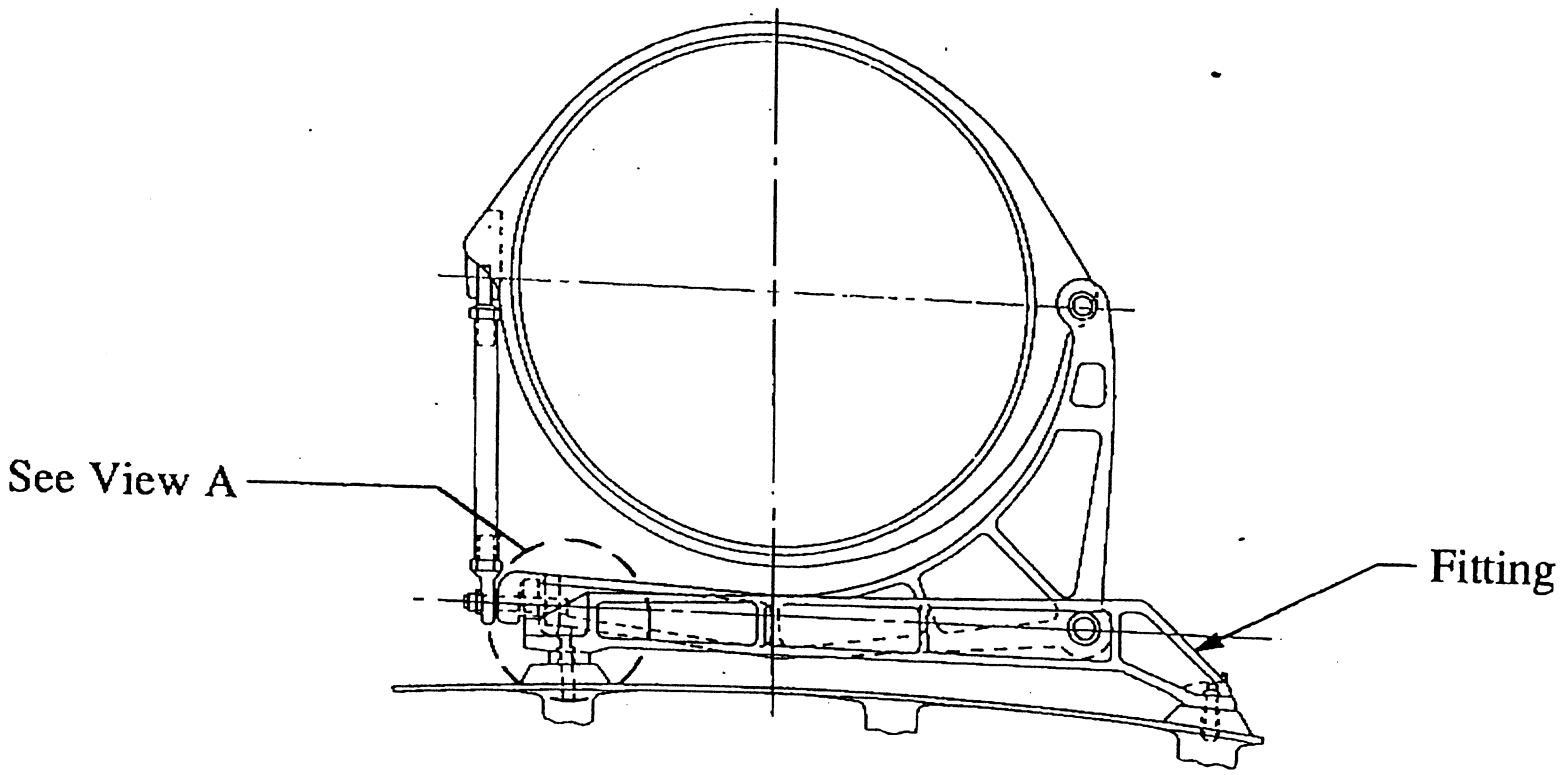
Added 6/10.

LO2 Feedline Bracket Bearing Proof Test

Corrective Actions:

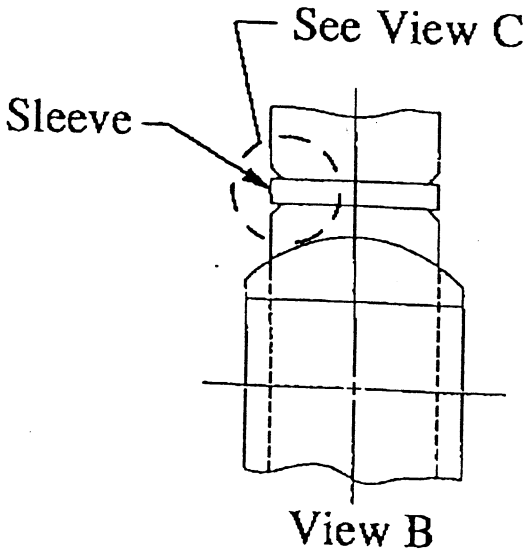
- No additional STP 2010 Type II bearing installations on ET
- STP revision in work to correct callout
- Improved discipline and technical review for all drawing and STP changes implemented in 1996
  - Concurrent engineering Table Top Review prior to release
  - Expanded engineering review for process changes
- Search in work to assure no other 'escapes' of this nature have occurred

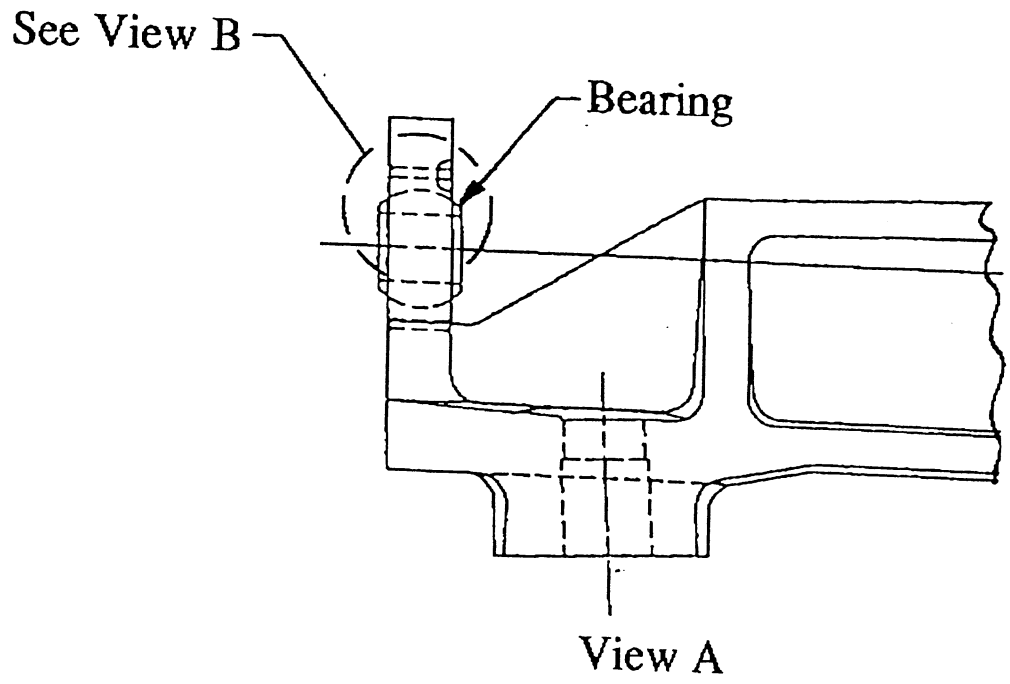
LO2 Feedline Bracket Bearing Proof Test

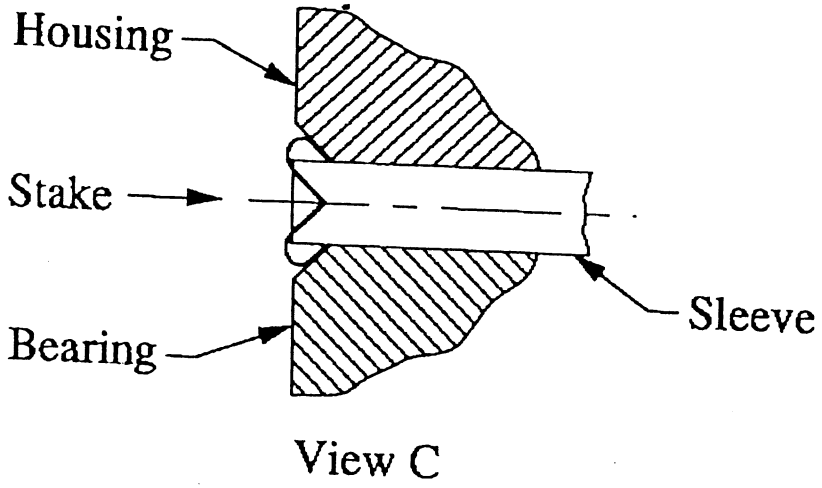


Feedline Support Fitting
LH2 Tank
Sta 1973

LO2 Feedline Bracket Bearing Proof Test







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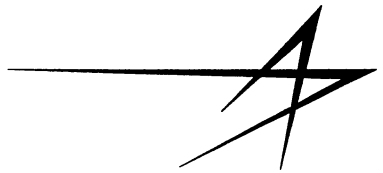

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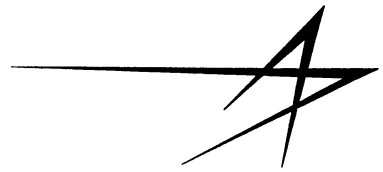
Readiness Statement

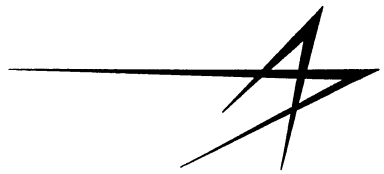


The External Tank, ET-86 is hereby certified and ready for STS-94 flight pending completion/closure of open and planned work

_____

Terry L. Hibbard
Vice President, External Tank Project
Lockheed Martin Manned Space Systems

Readiness Statement



The External Tank, ET-87 is hereby certified and ready for STS-85 flight pending completion/closure of open and planned work

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Terry L. Hibbard
Vice President, External Tank Project
Lockheed Martin Manned Space Systems

Appendices

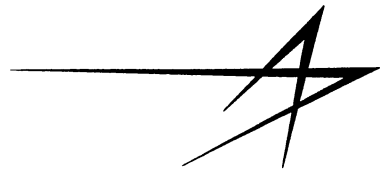
- **A: Minor Changes**

- **B: SRM&QA Assessment**
  - NCD Assessment Criteria

- **C: KSC Processing**
  - Limited Life Components
  - Modification Summaries/Status
  - Alternate Blowing Agent Usage at KSC
  - Software Changes: None
  - OMRSD Exceptions/Waivers: None
  - OMRSD Changes (RCNs): None

- **D: Previously presented items**
  - ET-86/87 Welded Extrusion Assessment
  - Level II Waivers

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)

GFP LO2/LH2 Umbilical Part Number Change

Change:

- Updated ET drawing to reflect revised GFP umbilical part numbers

Background/ Reason:

- BNA revised part numbers for LO2 and LH2 umbilicals for ET-86 and subs
  - Redesigned lightning contact strips
  - Added fiberglass/resin band around ET umbilical to contain any cracked/loose foam

Basis for Certification:

- Simarity - Function of umbilical unchanged

Class I/II or JS/DCN Changes - Propulsion

Change No.	Description	Effectivity
H35809-400	Revised part number marking method from vibrator marking to ink stamp after finish coating	ET-86 and subs
H35809-402	Revised part number marking method from vibrator marking to ink stamp after finish coating	ET-86 and subs
H35809-413	Revised SS tubing proof pressure test value to a standard 5600/6000 psig for all 0.25" and 0.375" OD flared tubes to assure min. FS	ET-86 and subs
H35809-619	Revised pyro separator assembly drawing to update cleaning and clarify material certification requirements	ET-86 and subs
H35809-642	Clarified pyro separator cleaning and test requirements	ET-86 and subs
H35809-707	Clarified tube use of solid film lubricant on sliding tube support	ET Project
J31146-901	Corrected effectivity on drawing sheet from ET-81 and up to ET-87 and up	ET-87 and subs

Class I/II or JS/DCN Changes - Structure

Change No.	Description	Effectivity
H35809-034	Reverse direction of Hi-lok installation pictorially so that collars face aft to prevent interference with previously installed fasteners	ET-86 and subs
H35809-081	Correct quantity of XAS-6 rivets - Actual usage of rivets on the assembly is 3 less than the requirement	ET-86 and subs
H35809-085	Add XE-8-6 fastener callout on field of drawing that was inadvertently omitted	ET-86 and subs
H35809-087	Revise rivet callout from 161 required to 162 required - Callout on drawing differs from actual rivet quantity	ET-86 and subs
H35809-223	Revise maximum allowable definitions of LH2 tank during proof pressure test	ET-86 and subs
H35809-375	Add sealing surface requirement to test port	ET-86 and subs
H35809-598	Revise drawing to delete requirement to remove topcoat from thrust strut - Topcoat does not exist on this area	ET-86 and subs
H35809-653	Delete solution heat treat requirement because is not required prior to straightening cable tray extrusions	ET-86 and subs
H35809-700	Delete STP 2501 penetrant inspection	ET Project
H35809-736	Clarify hole callout due incorrect callout at conversion from manual to CAD drawing	ET Project
H50001-785	Clarify parallel bond jumper resistance measurement requirements	ET Project

Class I/II or JS/DCN Changes - System

Change No.	Description	Effectivity
H35809-600	Revised ET protective requirements document to reflect item callout number for ET transporter	ET-86 and sub

Class I/II or JS/DCN Changes - TPS

Change No.	Description	Effectivity
H35809-267/A	Increased manufacturing optional manual foam spray area to include entire LO2 aft dome cap in lieu of non-conforming automated spray	ET-86 and subs
H35809-299	Revised LO2 aft dome apex foam trims to eliminate interferences with LO2 feedline support tooling and installation hardware. Enhance foam trims by making them perpendicular rather than angular	ETs 87 - 95
H35809-372	Revised flag note to inspect for 1.00 min gap between LO2 aft dome and SRB crossbeam. If min gap exists then no foam trim required. If gap does not exist, trim foam to dimensions given	ET-86 and subs
H35809-541	Revised drawing to add void criteria to the -Y upper SRB fitting foam closeout trim at Station 2058	ET-87 and subs
H35809-581	Increased angular ablator trim on outboard side of aft interferface of LH2 umbilical cable tray to eliminate interference with -Y ball fitting during assembly	ET-87 and subs
H35809-705	Corrected upper SRB fairing drain hole pictorial view - Drain hole continuation through TPS shown in wrong view	ET-87 and subs

Class I/II or JS/DCN Changes - TPS

Change No.	Description	Effectivity
H35809-710	Removed dimensions and flag notes from previous multiple dash number drawing. Remnants of old drawings were left in new drawing	ET-87 and subs
H35809-714	Added net sprayed nodule defects and loose foam removal requirements to NCFI 24-124 acceptance manuals	ET-87 and subs

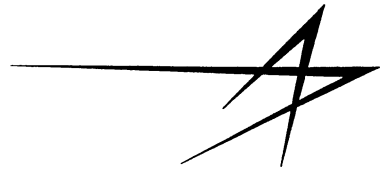
Class Changes - STPs/STMs /STDs/AVL

Change No.	Document	Description
H35809-663	STP 3003/3004	Raised upper temperature limit from 100°F to 105°F for primer applications. Deleted requirement for witness panels
H35809-682	STP 5012	Added proper reference and combine similar statements concerning use of HEPA (High Efficiency Particulate Air) filter
H35809-683	STP 5009	Added requirement to re-run cleaning cycle if facility/tooling anomaly occurs during cleaning cycle
H35809-685	STM E657	Changed line-to-line capacitance requirement from 18-23 pf/ft to 16-23 pf/ft and line-to-shield capacitance requirement from 32-40 pf/ft to 26-40 pf/ft
H35809-686	STM E300	Changed filler from Teflon impregnated glass fibers to TFE Teflon tubing and remove NHB 8060.1 flammability acceptance test requirement
H35809-693	AVL 34L4, 5, 6 and 7	Added J. O. King, Inc. to the Approved Vendor Lists
H35809-694	K969/STP 5006	Deleted Wyandotte from caustic etch material name

Class Changes - STPs/STMs /STDs/AVL

Change No.	Document	Description
H35809-704	STP 2013	Allowed safety wire spans of more than 6 inches when approved by Stress, Thermal and Material Sciences if wire is encapsulated
H35809-719	STP 1503	Added MEK as alternate cleaning solvent
H35809-728	AVL 26L30	Added Voi-shan part numbers
H50001-787	STP 3001	• Deleted FED Std 141 and added ASTM B117 • Deleted callout for specific maskants • Deleted requirement for 2219 salt spray test • Changed from 5 minute minimum rinse to or until Ph 5.5 - 8.0 is attained
H50001-788	STP 6511	Provided instructions for measuring resistance for parallel configuration bond jumpers

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-86 DR/PR/OMRSD Waiver/Exception Summary

as of 6/4/97

System	Discrepancy	Problem	MRB Items	Exceptions/ Waivers
• Electrical	**0**	**0**	0	**0**
• Propulsion/ Pneumatics	**0**	**2**	0	**0**
• Structures	**1**	**8**	0	**0**
• Thermal (TPS)	**0**	**9**	6	**0**
Total	**1**	**19**	**6**	**0**

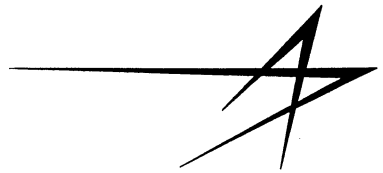
ET-86 PR/MRBs - Summary, Thermal

PR No./Status	Title/Description	Disposition
PET-86-TS-0001	Divot in LO2 tank foam (0.8" L x 0.7" W x 0.1" D) at Station 377	Use as is • All loose material removed • Remaining TPS is sufficient to prevent ice/frost formation • Defect is not subject to direct aero impingement • Defect is outside the of the GO2 vent seal area
PET-86-TS-0003	Three localized areas of low foam (SS-1171) on aft hardpoint near Station 2058 - Worst case = 0.21" deep	Use as is • No ice/frost concerns - Areas are slightly below the minimum requirement and are outside the critical ice/frost debris zone • No ascent heating concerns - Underlying thick metal substrate has a cryogenic backface for most of flight

ET-86 PR/MRBs - Summary, Thermal

PR No./Status	Title/Description	Disposition
PET-86-TS-0006	PDL underfill occurred during closeout of +Y ET/SRB aft fairing	Use as repaired • Applied PDL to 2.0" Lx 1.0"W x 0.75" D area • Additional PDL bondline will not affect closeout performance • Visual inspection of closeout revealed adequate material to maintain thermal protection
PET-86-TS-0007	Gouge in foam on aft corner of -Y ET/SRB aft fairing. Measures 1.30 L x 0.5" W x 0.375" D following removal of loose material	Use as is • Remaining TPS will provide adequate thermal protection for ET cryo load and SSV ascent • Defect not subject to direct aero impingement
PET-86-TS-0008	Gouge in foam on aft corner of -Y ET/SRB aft fairing. Measures 1.40" L x 0.68" W x 0.50" D following removal of loose material	Use as is • Remaining TPS will provide adequate thermal protection for ET cryo load and SSV ascent • Defect not subject to direct aero impingement

ET-86 PR/MRBs - Summary, Thermal



PR No./Status	Title/Description	Disposition
PET-86-TS-0009	Foam damage in 3 areas around the -Y bipod spindle foam closeout • Area 1 = 0.50" L x 0.02" W x 0.30" D • Area 2 = 1.00" L x 0.75" W x 0.65" D • Area 3 = 3.20" L x 1.30" W x 0.25" D	Use as is • Some damage is in or adjacent to an accepted ice/frost formation area • Remaining defect areas outside of accepted ice/frost area but adequate foam exists to maintain thermal protection

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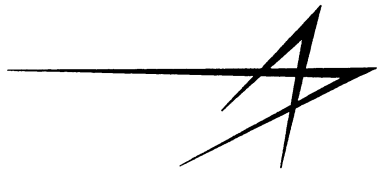
ET-86 PR/MRBs - Summary, Electrical

Added 6/10/97

PR No./Status	Title/Description	Disposition
ET-86-EL-0001	During ET/Orbiter electrical mate the alignment keys on the shell of the Orbiter connector were not properly aligned with the keyways in the shell of the ET 303W12-J16 electrical connector • 3 of 4 Orbiter connector small keys were sheared off • Orbiter connector main key and 1 small key was not sheared off - Remaining keys prevented damage to connector pins/insert • Misaligned keys translated to ET connector as gouges on the connector shell edge • Orbiter connector replaced	Use as is • Borescope examination of ET connector pins and insert verified no damage • Connector mated properly after Orbiter connector replacement • Successful checkout of SRB electrical subsystems during Shuttle Interface Test ensured proper function of connectors

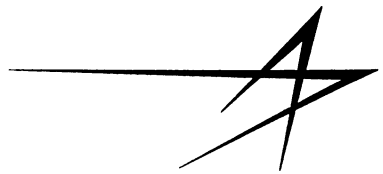
ET-86 Limited Life Components



Cycle Sensitive

Description	Part No.	Serial No.	Limit	Required	Remaining
LO2 Fwd Ogive Cover Plate	80911001207-029	000294300	100	1	100
LO2 Tank Mechanical Assy	80912002000-019	000281360	100	1	100
LO2 Manhole Cover Assy	80911001205-010	000387850	100	1	100
LH2 Manhole Cover Assy	80914081488-019	000334170	100	1	100
LH2 Tank Mechanical Assy	80914002000-009	000275910	100	1	100
LH2 Manhole Cover Assy (Aft Dome)	80911001444-010	000299240	100	1	100
		000332950	100	1	100

ET-86 Limited Life Components



Age Sensitive

Description	Part No.	Serial No.	Limit	Initiation	Expiration
External Tank	80901000000-270	00000079	6 Yrs	10/96	10/2002

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	PD5000020-059	AAF	0000852	5/96	5/99
Cartridge Assy	PD5000020-030	AAF	0070043	5/96	5/99
		AAF	0070044	5/96	5/99

ET-86 Modification Summary

as of 6/4/97

No.	Description	Status
B524/B02010	Remove ET RSS	Complete - No issues
B524 E1/B02010	Remove ET RSS	Complete - No issues
B587/B02014	Improved ET/SRB fairing closeout	Complete - No issues
B527/B02002A	Modify LH2 umbilical leak test port closeout	Complete - No issues

ET-86 Alternate Blowing Agent Usage at KSC

as of 6/4/97

Foam	Document	Description	Location	Size
SS-1171	T5141	Aft hardpoint closeout	Sta 1973 - 2076, 180°	4410 sq. in.
PDL-1034	T5249	ET/SRB aft fairing closeout	Sta 2058, 70°/ 290°	240 sq. in

ET-87 DR/PR/OMRSD Waiver/Exception Summaries

as of 5/29/97

System	Discrepancy	Problem	MRB Items	Exceptions/ Waivers
• Electrical	0	0	**0**	0
• Propulsion/ Pneumatics	0	3	**0**	0
• Structures	0	5	**1**	0
• Thermal (TPS)	1	7	**2**	0
Total	**1**	**15**	**3**	**0**

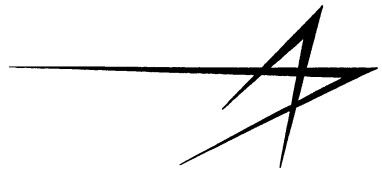
ET-87 PR/MRBs - Summary, Structure

PR No./Status	Title/Description	Disposition
ET-87-ST-0003	Unable to verify remaining part thickness of scratch/raised metal on -Y aft hard point pad	Use as is • Raised metal removed • Defect less than 0.003" deep - MRB accepts defects without metal thickness verification

ET-87 PR/MRBs - Summary, TPS

PR No./Status	Title/Description	Disposition
ET-87-TS-0002	Divot in SLA on the -Y side of -Y ET/SRB cable tray	Use as is • Defect is located under SRB fairing and remaining SLA will provide protection from ascent heating
ET-87-TS-0004	Small notch on the forward face of aft hard point foam perimeter	Use as is. • MRB accepted defect based on rationale that notch is within closeout envelope and does not compromise or interfere with the closeout

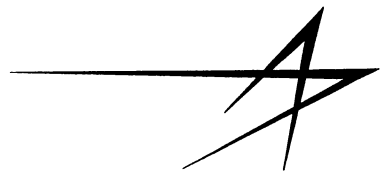
ET-87 Limited Life Components



Cycle Sensitive

Description	Part No.	Serial No.	Limit	Required	Remaining
LO2 Fwd Ogive Cover Plate	80911001207-029	000322150	100	1	100
LO2 Tank Mechanical Assy	80912002000-019	000308920	100	1	100
LO2 Manhole Cover Assy	80911001205-010	000397620	100	1	100
LH2 Manhole Cover Assy	80914081488-019	000361430	100	1	100
LH2 Tank Mechanical Assy	80914002000-009	000295510	100	1	100
LH2 Manhole Cover Assy (Aft Dome)	80911001444-010	000329290	100	1	100
		000384910	100	1	100

ET-87 Limited Life Components



Age Sensitive

Description	Part No.	Serial No.	Limit	Initiation	Expiration
External Tank	80901000000-270	00000080	6 Yrs	11/96	11/2002

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	PD5000020-059	AAG	0001119	12/96	12/2000
Cartridge Assy	PD5000020-030	AAG	0001197 0001198	11/96 11/96	11/2000 11/2000

ET-87 Alternate Blowing Agent Usage at KSC

as of 6/4/97

Foam	Document	Description	Location	Size
SS-1171	TS-0004	Notched area at aft third hardpoint	Sta 1973-2076, 180°	1 sq. in.
SS-1171	T5141	Aft hardpoint closeout	Sta 1973-2076, 180°	4410 sq. in.

ETs 86 and 87 Welded Extrusion Assessment

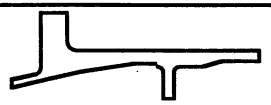
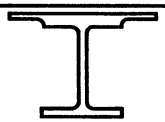
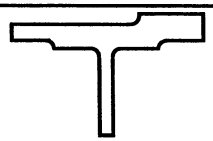
STS-94 and STS-85

- Extrusions on ETs 86 and 87 do not exhibit the adverse grain orientation and grain size found on ET-89 and ET-90 Station 1871 frame
- All extrusion welds have positive margins of safety using
  - "As-built" peaking and mismatch
  - Reduced weld strength from recent test program
  - Allowable methodology 99% reliability/95% confidence per Mil-Hdbk-5F
- All welds are demonstrated to 100% of limit flight loads or greater by proof test
  - Includes effect of reduced cryogenic enhancement of strength
  - Approximately 70% of weld length is demonstrated to ultimate design load (limit x SF) by proof test
- All x-rays (pre and post proof test) have been re-reviewed - No indication changes resulted
- All MRB actions re-reviewed - Positive margins are shown

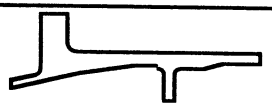
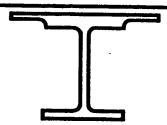
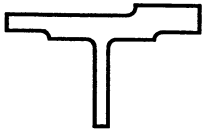
Conclusions

- ETs 86 and 87 meet all requirements and are acceptable for STS-94 and STS-85 flight

ET-86 Welded Extrusion Assessment

			Ultimate Stress (ksi)			Factor of Safety		
Location	Shape	Weld Code	Flight	Proof	Allowable Stress (ksi)	Required	Actual	Proof Test Demonstrated
744 T-ring		O3 O4	36.14 31.37	25.74 20.83	36.40 36.40	1.31 1.31	1.32 1.52	1.04 1.03
851 Dome Chord		O5 OAF	21.82 30.78	14.55 28.76	36.40 37.70	1.32 1.35	2.20 1.65	1.16 1.32
1129 Dome Chord		HFF H8	33.23 18.60	32.54 21.64	38.00 33.70	1.25 1.26	1.43 2.28	1.09 1.49
1377 & 1624 Frames		H7 H6 H5 H4	37.51 29.98 21.24 29.85	33.42 26.80 17.79 24.12	39.80 39.80 39.80 33.70	1.26 1.26 1.29 1.30	1.34 1.68 2.41 1.47	1.33 1.33 1.29 1.23
1871 Frame Chord		H3 H2	36.33 36.10	25.89 26.28	36.60 36.60	1.26 1.26	1.27 1.27	1.08 1.10
2058 Dome Chord		H1 HAF	31.37 42.25	25.42 32.48	39.80 45.60	1.32 1.31	1.68 1.41	1.18 1.18

ET-87 Welded Extrusion Assessment

			Ultimate Stress (ksi)			Factor of Safety		
Location	Shape	Weld Code	Flight	Proof	Allowable Stress (ksi)	Required	Actual	Proof Test Demonstrated
744 T-ring		O3 O4	36.95 28.67	26.72 19.13	36.40 36.40	1.22 1.31	1.22 1.66	1.07 1.03
851 Dome Chord		O5 OAF	20.40 31.76	16.20 29.25	36.40 37.70	1.32 1.35	2.35 1.61	1.44 1.30
1129 Dome Chord		HFF H8	30.48 24.73	28.93 27.76	38.00 33.70	1.25 1.26	1.56 1.71	1.14 1.35
1377 & 1624 Frames		H7 H6 H5 H4	33.76 31.73 29.75 31.05	29.87 28.20 23.83 26.57	39.80 39.80 39.80 33.70	1.26 1.26 1.31 1.26	1.49 1.58 1.76 1.37	1.32 1.32 1.23 1.27
1871 Frame Chord		H3 H2	36.01 35.50	25.73 25.85	36.60 36.60	1.26 1.26	1.30 1.29	1.08 1.10
2058 Dome Chord		H1 HAF	32.90 42.92	25.98 32.31	39.80 45.60	1.26 1.32	1.52 1.40	1.14 1.16

Level II Waivers

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 printout	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

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	S40732G 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 & 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

Level II Waivers

Document/ Requirement	Authority	Paragraph	Waiver No.	Effectivity
NSTS 07700 Vol. X - Space Shuttle Flight and Ground System Specification , Book 1 Requirements				
CIL fail safe and redundancy requirements	S040201E 4/3/87	3.5.1.1.1 Thru 3.5.1.1.3	401	ETs 23, 27-29, 31 & up
2058 Frame, Bearing Stress	S40793H, H-R1 11/22/88	3.2.2.1.5.2	452	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

Document/ Requirement	Authority	Paragraph	Waiver No.	Effectivity
NSTS 08060, Rev. F - System Pyrotechnic Specification				
Use 40M36298 connectors	S040732F 6/24/88	3.4.1	61	ETs 23,27-29, 31 & up
Prevent adverse effects of common mode currents	S040732F 6/24/88	8.2.1	64	ETs 23, 27-29, 31 & up
Fire circuit wiring shall be routed separately	S040732F 6/24/88	8.2.3	65	ETs 23, 27-29, 31 & up
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 08123, Rev. B - Certification of Flexible Hoses and Bellows				
LH2 feedline bellows	S0052023G-R1 8/2/91	1.2	3	ETs 42 - 45, 47 & up

Level II Waivers

Document/ Requirement	Authority	Paragraph	Waiver No.	Effectivity
SL-E-0001 - Specification Electromagnetic Compatibility Requirement				
Wire marking is not applicable to the ET	S40732K 9/27/88	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	3.4.2.1	21	ETs 23, 27-29, 31 & up