FLIGHT READINESS STATEMENT
STS-83/ET-84 AND STS-84/ET-85
EXTERNAL TANK PROJECT
PRE-FLIGHT REVIEW

EXTERNAL TANKS ET-84/STS-83 AND ET-85/STS-84, AS IDENTIFIED IN THE EXTERNAL TANK PROJECT PRE-FLIGHT REVIEW DATED MARCH 12, 1997, IS CONSIDERED READY TO SUPPORT FLIGHT UPON ACCEPTABLE DISPOSITION OF OPEN/PLANNED WORK AND/OR OPEN ACTIONS.

E. C. SMITH/EB01

M. A. PESSIN/EE31

A. F. WHITAKER/EH01

FOR A. O. HARRIS/CR01

for G. R. WALLACE/EL01

for W. R. HUMPHRIES/EB01

for S. P. SAUCIER/EP01

M. D. SMILES/CR70

P. V. COUNTS/SA31, CHAIRMAN

March 12, 1997

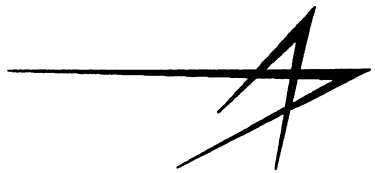
Space Shuttle
External Tank

STS-83/ET-84 and STS-84/ET-85 Pre-Flight Review

LOCKHEED MARTIN

Manned Space Systems

Agenda



- ***Overview*** — ***Jim Feeley***
- ***Prior Mission Performance Summary***
- ***Current Mission/External Tank Highlights***
- Changes — Steve Copsey
- Senior Management Review NCDs
- SRM&QA Assessment — Terry McKeough
- KSC Processing — Doug Powell
- Verification/Certification — Jim Feeley
- Mission Unique Assessment
- Readiness Statement
- Appendices
  - A: SRM&QA Assessment
  - B: KSC Processing
  - C: Previously reviewed material

Overview

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

- This Delta review for STS-83/ET-84 and STS-84/ET-85 includes:
  - Prior mission performance summary
    - Items not previously addressed at the Block 14 (ETs 81-85) ET Project FRR
    - Items specific to mission STS-83 and STS-84
    - Details of previously presented items are included in the Appendix

FRR Series	**ET-84**	**ET-85**
- Block ET Project Review	8/14/96	8/14/96
- Mission Specific Reviews		
• ET/SRB Mate	1/30/97	3/24/97
• Pre-flight review	3/12/97	3/12/97
• Associate Administrator FRR	3/20/97 (S)	5/1/97 (S)
• Mission Management Team (L-2 Day)	4/1/97 (S)	5/13/97 (S)

Prior Mission Performance Summary

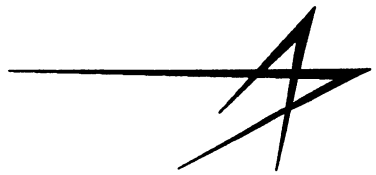
STS-82/ET-81, 2/11/97

System	Performance
OMRSD	No violations
LCC	Nominal
Instrumentation	Nominal
MPS	Nominal
Hazardous Gas	Nominal
TPS	Nominal
ET disposal	Nominal
Orbiter tile damage	Lower surface, below average • Total = 53 • >1" = 14
Post flight photo review	No issues

Mission/External Tank Highlights

Mission	STS-83	STS-84
• **Launch**	4/3/97	5/15/97
- Window	1401 - 1631 EST	0349 - 0449 EDT
- Pad	A	TBD
- Orbiter	Columbia (OV-102)	Atlantis (OV-104)
- Orbital inclination	28.45° - Insertion at 160 NM	51.6° - Insertion at 160 NM
- ET photo coverage	• Umbilical well cameras • Crew photos from cockpit window	• Umbilical well cameras • Crew photos from cockpit window
• **Primary payload**	Microgravity Science Laboratory-1	• 6th MIR docking • Spacehab
• **Landing**	4/19/97	5/25/97
- Time	0737 EDT	0812 EDT
- Location	KSC	KSC
External Tank	**ET-84**	**ET-85**
• DD250 acceptance	6/18/96	8/7/96
• Shipped to launch site	11/7/96	10/23/96

Agenda



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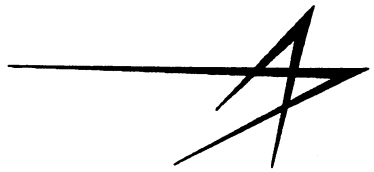
Changes/SMRs - List

Previously presented at the Block 14 FRR, (8/16/96)

- **Changes**
  - ET-84 *
    - Eliminate GSE desiccant breathers and pressurization system prior to marine shipment (B01992)
  - ET-85
    - Alternate blowing agent foams
      - SS-1171 on the LH2 forward dome (B01987B)
      - NCFI 24-124 on LH2 tank sidewall (B01987F)
    - Delete in-process rework from KSC off-site acceptance manual
- **Senior Management Review NCDs** *
  - ET-84: None
  - ET-85
    - LO2 tank O-1 weld lack of fusion (N014273)

* Included in Appendix C

Alternate Blowing Agent Foams



Change:

- SS-1171 on LH2 tank forward dome
- NCFI 24-124 on LH2 tank sidewall

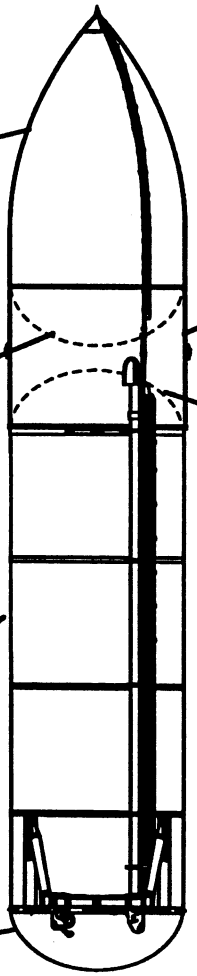
Background/ Reason:

- 1990 Clean Air Act dictated phase out of CFC-11 (ozone depletion issue)
- Staged implementation of new foams started with STS-82/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 SS-1171 foam on STS-79/ET-82 third hardpoint closeout

Description:

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

Alternate Blowing Agent Foam Implementation



STS-85 (ET-86) and subs
- NCFI 24-124 on LO2 tank sidewall

STS-86 (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-87 (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 Foams

LH2 Tank Sidewall - CPR-488 vs NCFI 24-124

Requirement	Spec Requirement		Flight Requirement		Typical Property		Performance
	CPR	NCFI	CPR	NCFI	CPR	NCFI	
• 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	19 min	19 min	54	44	NCFI has lower strength, FS min = 1.57 (bond adhesion)
• Tensile -423°F (psi)	Not applicable		19 min	19 min	41	34	NCFI has lower strength, FS min = 1.21 (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)	61@ -423°F	61@ -423°F	61@ -423°F	61@ -423°F	65@ -423°F	65@ -423°F	Both demonstrated to required stress levels

Alternate Blowing Agent Foams

LH2 Forward 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	19 min	19 min	75	53	SS has lower strength, FS min = 1.84 (bond adhesion)
• Tensile -423°F (psi)	Not applicable		19 min	19 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		56@ -423°F	56@ -423°F	65@ -423°F	65@ -423°F	Both demonstrated to required stress levels

Alternate Blowing Agent Foams

Basis for Certification:

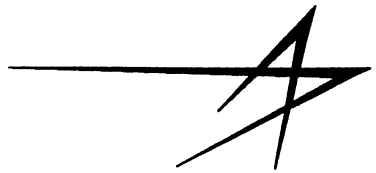
- Process development
  - Design of experiment process utilized
    - Room temperature/humidity
    - Component temperature
    - Substrate temperature
    - Gun output
- Tests
  - Physical properties - Density, thermal strain, flammability, corrosion, oxygen index, thermal conductivity
  - Mechanical 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 Foams

Basis for Certification:

- Analysis
  - Stress: New foams meet required FS of 1.10
    - SS-1171 on LH2 forward dome FS = 1.89 (bondline delamination)
    - NCFI 24-124 on LH2 tank sidewall FS = 1.13 (bondline delamination)
  - Thermal: New foams meet ascent temperature and disposal requirements
- Acceptance
  - SS-1171 on LH2 tank forward dome
    - Lead in/lead out density and plug pulls on dome
  - NCFI 24-124 on LH2 tank sidewall
    - Lead in cryoflex panel
      - 2 cryoflex
      - 3 density
      - 3 bond tension
    - Lead in/lead out plus 5 intermediate plug pulls

Deleted In-Process Rework



Change:

- Deleted TPS in-process rework from KSC off-site acceptance manual

Background/ Reason:

- In-process rework criteria developed in 1983 to allow material substitutions for specific TPS rework at KSC
- New ET foams implemented as result of 1990 Clean Air Act
  - Invalidated data base due to different process characteristics of new foams

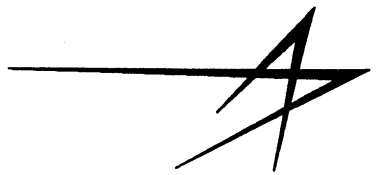
Description:

- Revise ET Post Build Acceptance and In-Process Rework Manual to delete the following
  - Foam partial rework application criteria
  - Foam and ablator defect in-process rework instructions
  - Foam application instructions
  - Foam defect removal process instructions
  - Ablator in-process rework instructions

Basis for Certification:

- Replaces pre-approved in-process rework with required MRB approval
  - Future revision will re-instate in-process rework when data base is sufficient

Agenda



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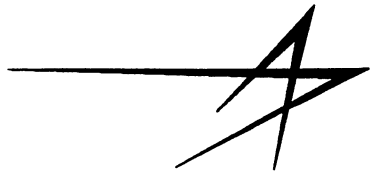
SRM&QA Assessment

as of 3/6/97

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)**	
- LH2 Gulton ullage pressure transducer failed calibration test at vendor (E-162)	• All ETs successfully passed ATP • Adequate tests of transducers performed at vendor, MAF and KSC to assure performance • Pending closure at MSFC
- Welded extrusion cracks (S-079) *	• ETs 84 and 85 meet all requirements • Pending closure at MAF

* Included in Appendix C

Agenda



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KSC Processing - Status

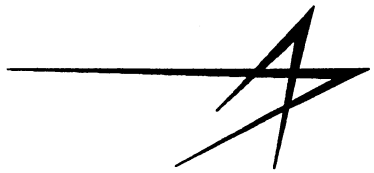
as of 3/6/97

- **Discrepancy Reports (DRs)/Problem Reports (PRs) Review**
  - All PR/MRB * discrepancies/dispositions similar to previously flown vehicles and are within existing database
  - 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-84**	**ET-85**
- ET modifications		
• Mod Kits *	5	4
• 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	3/20/97	TBD
• SIM Launch	3/3/97	TBD

* Included in Appendix B

Agenda



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Verification/Certification

as of 3/6/97

Item	Status
• **NSTS 07700, Volume X Baseline** - Revision L, Change 229	No constraints
• **Certification documentation** - Hardware Certification Sheets (HCS) - Certificates of Qualification (COQ)	Approved - No issues
• **Waivers/Deviations** * - ET-84: No first time items	Approved - No issues
- ET-85: One first time waiver/deviation • Potential debris violation of EIS and NSTS 07700, Vol X due to metal particles in ET aft crossbeam SLA - DAR 220 - Waiver 668	Approved by Level II PRCB (S082962) on 6/11/96

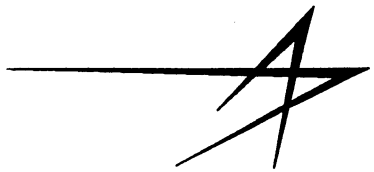
* Included in Appendix C

Mission Unique Assessment

as of 3/6/97

Category/Item	STS-83	STS-84
• **Review of MRB actions using updated loads**	ECD 3/12/97	ECD 3/19/97
• **MPS Preflight Prediction Package**	ECD 3/24/97	ECD 5/5/97

Agenda



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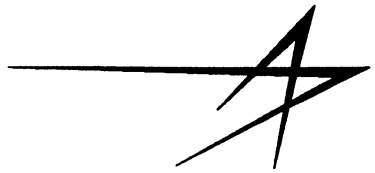
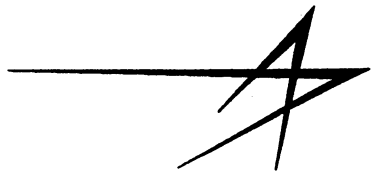


The External Tank, ET-84 is hereby certified and ready for STS-83 flight pending completion/closure of open and planned work

Dennis R. Deel
Manager, External Tank Project
Lockheed Martin Manned Space Systems

Readiness Statement



The External Tank, ET-85 is hereby certified and ready for STS-84 flight pending completion/closure of open and planned work

Dennis R. Deel
Manager, External Tank Project
Lockheed Martin Manned Space Systems

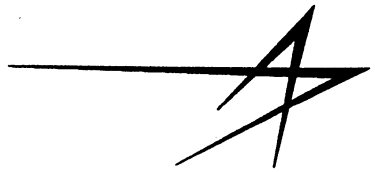
Appendices

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

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

- **C: Previously presented items**
  - Changes
  - Senior Management Review NCDs
  - ET-84/85 Welded Extrusion Assessment
  - Level II/III Waivers

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-84 DR/PR/OMRSD Waiver/Exception Summary

as of 3/6/97

System	Discrepancy Reports	Problem Reports	MRB Items *	Waivers/ Exceptions
• Electrical	0	0	0	0
• Propulsion/ Pneumatics	1	1	0	0
• Structure	1	8	0	0
• Thermal (TPS)	0	13	4	0
Total	**2**	**22**	**4**	**0**

* See subsequent charts for details

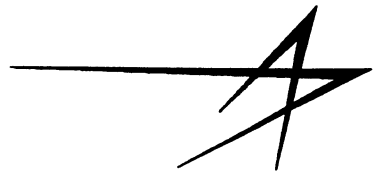
ET-84 PR/MRB Summary

PR No.	Description	Disposition
Thermal		
PET-84-TS-0004	Delaminated SLA on lower inboard corner of LH2 cable tray	• Use as repaired - All loose material removed - Area not subject to direct aero impingement
PET-84-TS-0010	Knit line delamination located in third hardpoint closeout	• Use as repaired - Delamination found to be localized and was completely removed - Test panels met engineering requirements - Additional bondlines will not affect performance of the closeout

ET-84 PR/MRB Summary

PR No.	Description	Disposition
Thermal		
PET-84-TS-0011	Voids/excessive porosity in -Y aft fairing periphery closeout	• Use as repaired - Voids/porosity removed - Remaining TPS closeout meets requirements - Additional bondlines will not affect performance of closeout - Rework performed consistent with validated process
PET-84-TS-0012	Overtrim in +Y aft fairing periphery closeout located along the -Z end	• Use as repaired - Additional bondlines will not affect performance of closeout - Rework performed consistent with validated process

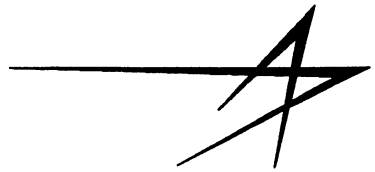
ET-84 Limited Life Components



Cycle Sensitive

Description	Part No.	Serial No.	Limit	Required	Remaining
LH2 Manhole Cover Assy	80914081488-019	000248070	100	1	100
LO2 Tank Mechanical Assy	80912002000-019	000225680	100	1	100
LH2 Tank Mechanical Assy	80914002000-009	000243760	100	1	100
LO2 Manhole Cover Assy	80911001205-010	000336910	100	1	100
LO2 Fwd Ogive Cover Plate	80911001207-029	000273680	100	1	100
LH2 Manhole Cover Assy (Aft Dome)	80911001444-010	000247170	100	1	100
		000294000	100	1	100

ET-84 Limited Life Components



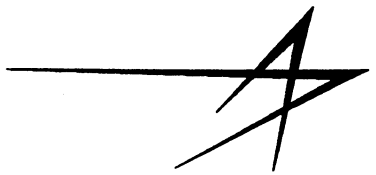
Age Sensitive

Description	Part No.	Serial No.	Limit	Initiation	Expiration
External Tank	80901000000-270	00000077	6 Yrs	6/96	6/2002

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	0000848	5/96	5/99
Cartridge Assy	PD5000020-030	AAF	70032	5/96	5/99
		AAF	70036	5/96	5/99

ET-84 Modification Summary



No.	Description	Status
B521/B521E1 B02010	Remove ET RSS	Complete - No issues
E148/B02010	Limit GUCP RSS tear-away installation	To be worked at KSC
B525/B01987G	Authorize use of PDL-1034	To be worked at KSC
B586/B02014	Improved ET/SRB fairing closeout	Complete - No issues
E160/B02002A	Modify LH2 umbilical leak test port closeout	Complete - No issues

ET-84 Alternate Blowing Agent Usage at KSC

(PDL-1034/SS-1171)

Foam	Document	Description	Location	Size
PDL-1034	PR-TS-0007	LH2 recirc line	Sta 2103, 340°	1 sq in.
PDL-1034	PR-TS-0002	LH2 umbilical cable tray fairing	Sta 2090, 340°	2 sq in.
PDL-1034	PR-TS-0008	LO2 tank ogive	Sta 378, 270°	3 sq in.
SS-1171	T5141	Aft hardpoint closeout	Sta 1973-2076, 180°	4410 sq. in.
PDL-1034	T5249	ET/SRB aft fairing closeout	Sta 2058, 40°/ 320°	240 sq. in.

ET-85 DR/PR/OMRSD Waiver/Exception Summary

as of 3/6/97

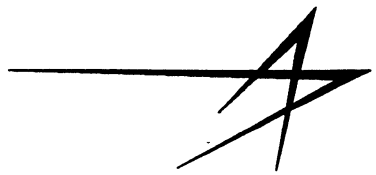
System	Discrepancy Reports	Problem Reports	MRB Items *	Waivers/ Exceptions
• Electrical	0	0	0	0
• Propulsion/ Pneumatics	0	1	0	0
• Structure	1	5	1	0
• Thermal (TPS)	0	11	0	0
Total	**1**	**17**	**1**	**0**

* See subsequent chart for details

ET-85 PR/MRB Summary

PR No.	Description	Disposition
Structure		
PET-85-ST-0006	Raised metal on aft hard point pad	• Use as repaired - Removed raised metal - All defects less than 0.002" deep - MRB affects defects without metal thickness verification

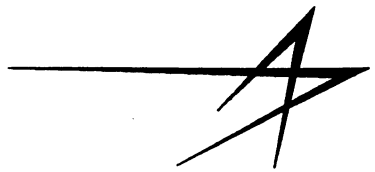
ET-85 Limited Life Components



Cycle Sensitive

Description	Part No.	Serial No.	Limit	Required	Remaining
LH2 Manhole Cover Assy	80914081488-019	000275140	100	1	100
LO2 Tank Mechanical Assy	80912002000-019	000252560	100	1	100
LH2 Tank Mechanical Assy	80914002000-009	000258600	100	1	100
LO2 Manhole Cover Assy	80911001205-010	000363530	100	1	100
LO2 Fwd Ogive Cover Plate	80911001207-029	000279750	100	1	100
LH2 Manhole Cover Assy (Aft Dome)	80911001444-010	000264610	100	1	100
		000323060	100	1	100

ET-85 Limited Life Components



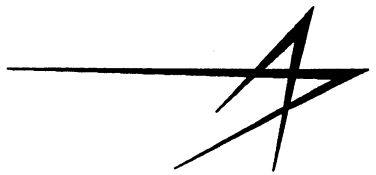
Age Sensitive

Description	Part No.	Serial No.	Limit	Initiation	Expiration
External Tank	80901000000-270	00000078	6 Yrs	8/96	8/2002

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	0001118	12/96	12/2000
Cartridge Assy	PD5000020-030	AAG	0001194	12/96	12/2000
			0001195	12/96	12/2000

ET-85 Modification Summary



No.	Description	Status
B523/B523 E1 B02010	Remove ET RSS	Complete - No issues
B526/B01987G	Authorize use of PDL-1034	To be worked at KSC
B587/B02014	Improved ET/SRB fairing closeout	To be worked at KSC
E163/B02002A	Modified LH2 umbilical leak test port closeout	Complete - No issues

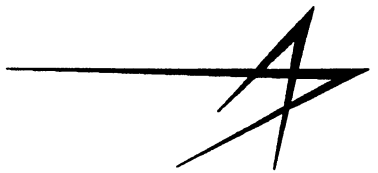
ET-85 Alternate Blowing Agent Usage at KSC

(PDL-1034/SS-1171)

Foam	Document	Description	Location	Size

No usage to date
(as of 3/6/97)

Eliminate GSE Pressurization System



Change:

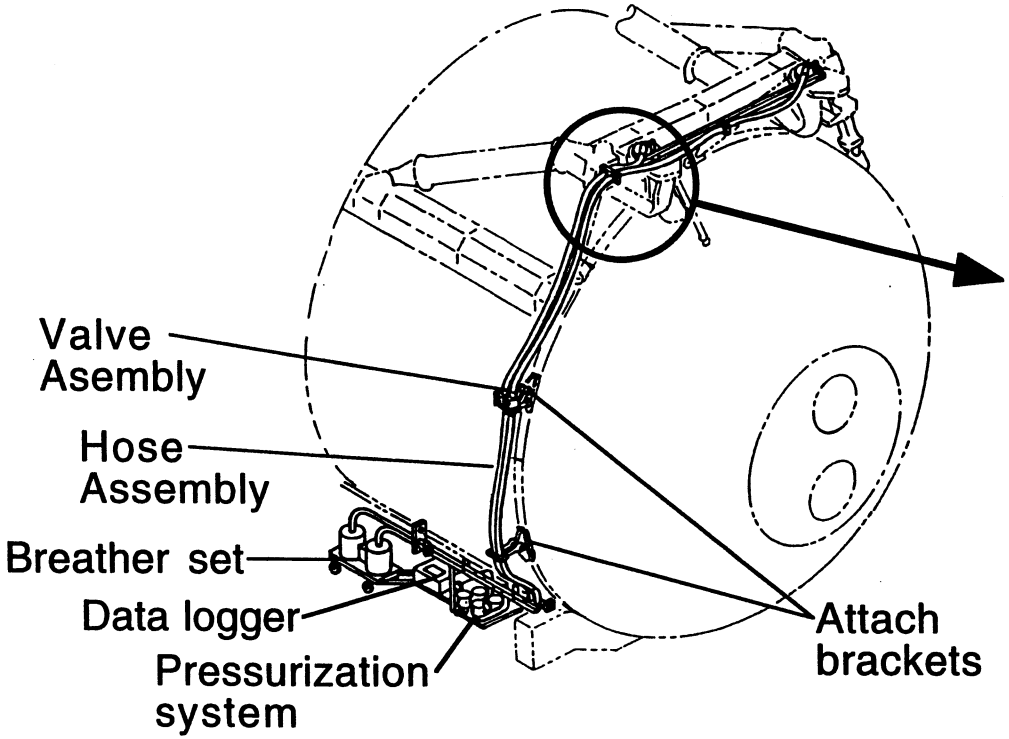
- Remove GSE desiccant breathers and pressurization system equipment prior to marine shipment for ET-84 and subs

Background/ Reason:

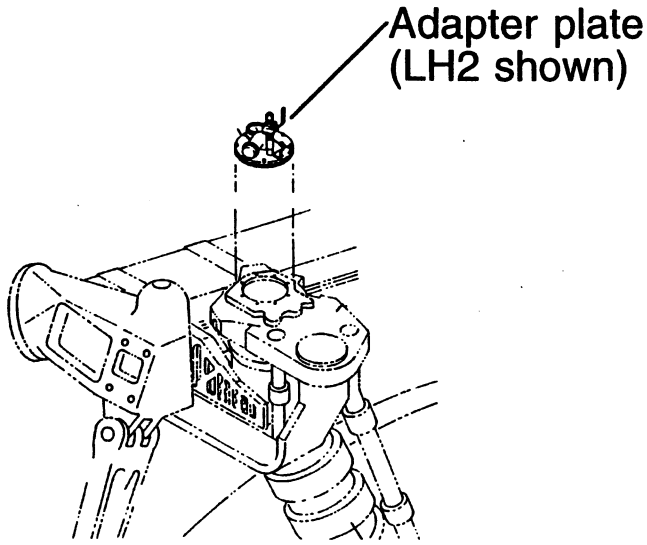
- KSC process enhancement for Ship and Stack
  - Eliminates need for removal at KSC
- Desiccant breathers/pressurization system provided a contingency back-up system to prohibit contamination from entering the ET during marine shipment in the event of leakage
  - No use of desiccant breathers required since implementation
  - Barge personnel required to install desiccant
  - ETs 49, 51, 54 and subs shipped on unmanned NASA barge

Eliminate GSE Pressurization System

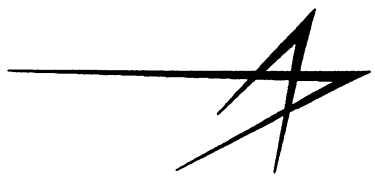
ET-83



ET-84 and subs



Eliminate GSE Pressurization System



Description:

- Hardware
  - No flight hardware impact
    - GSE pressurization system redesigned for MAF use
    - Remove GSE prior to ET roll out to NASA barge
- Documentation
  - Revised current MMC-ET-SE42 ET Long Term Storage requirement
    - Was: Verify ET pressure (6.0± 0.5 psig) at barge departure
    - Now: Verify ET pressure a maximum of 7 days prior to departure from dock
  - Revised Receiving Inspection, Storage and Checkout ICD to remove contingency pressurization ports

Basis for Certification:

- Reliability Analysis
  - Spec leakage would not violate minimum ET pressure requirements during marine shipment
  - Deletion of GSE eliminates potential leak source

ET-85 LO2 Tank O-1 Weld Lack of Fusion

NCD N014273

Issue:

- 1.25 inch long lack of fusion in ET-85 O-1 weld detected by post proof test radiography

Background:

- Radiographic indication observed prior to proof test after repair
  - Interpreted as no defect (macro segregation)
- OSL and ISL penetrant inspection after proof testing
  - No indications
- Review of pre and post proof test radiographs
  - No demonstrated growth in defect

Cause:

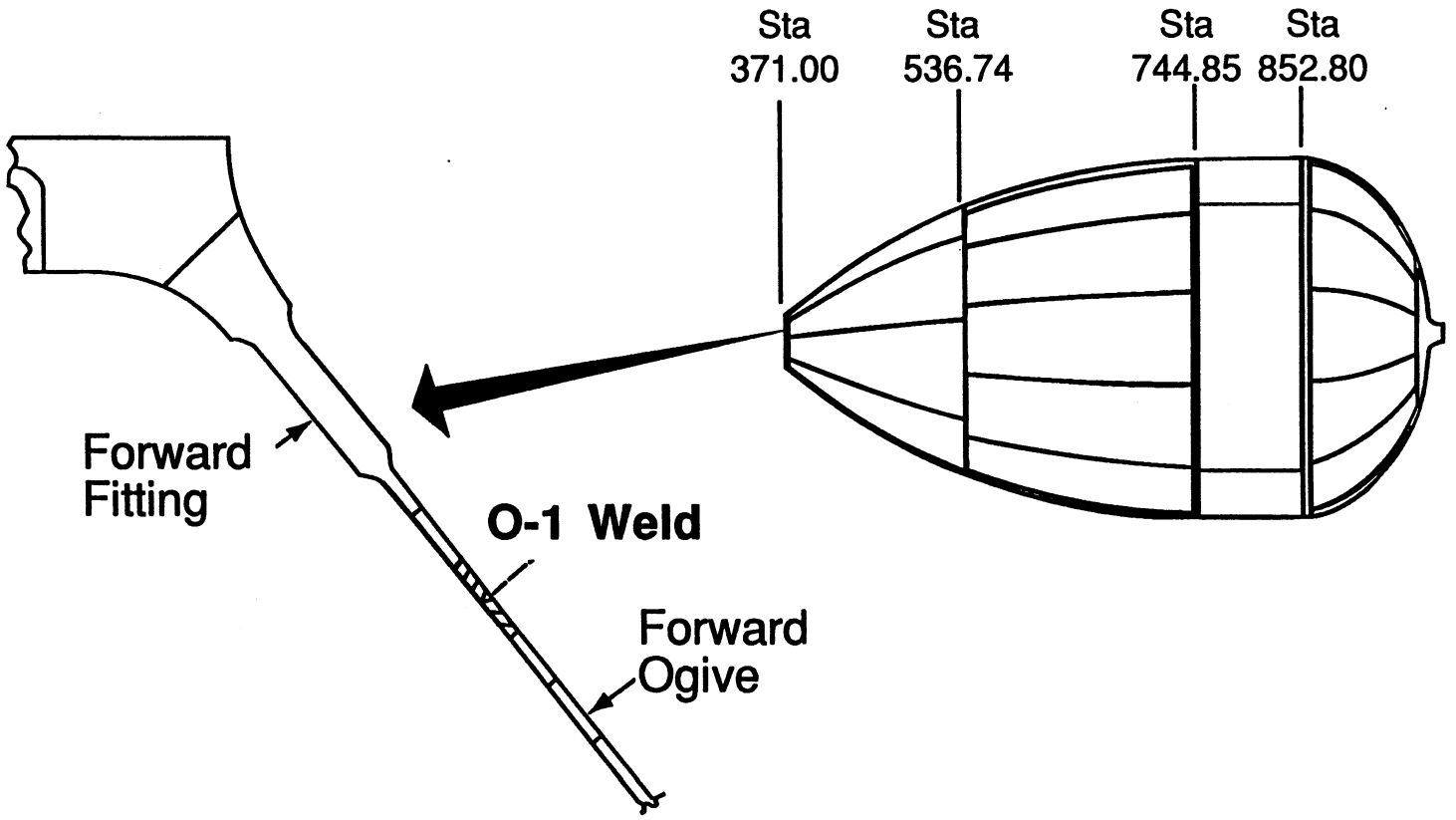
- Lack of fusion defect was result of heat repair accomplished for lack of fusion, porosity and oxide inclusion
  - Misinterpretation of pre proof test radiographic indication as alloy segregation

Corrective Action:

- Radiographic interpreters instructed to reject this type of indication as lack of fusion

ET-85 LO2 Tank O-1 Weld Lack of Fusion

NCD N014273



ET-85 LO2 Tank O-1 Weld Lack of Fusion

NCD N014273

Disposition:

- Use as is

Rationale for Flight:

- No defects detected by visual and penetrant inspections
- Review of pre and post proof radiographic demonstrate no detectable flaw growth
- FS = 4.92, unchanged
- Weld significantly over-proofed for strength and fracture
- Fracture mechanics analysis
  - Conservative flaw size assumption
  - Fatigue life within database
    - Missions to leak = 72
    - Missions to burst = 1436

ETs 84 and 85 Welded Extrusion Assessment

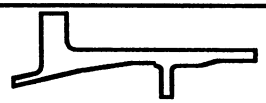
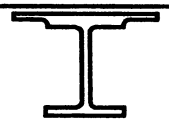
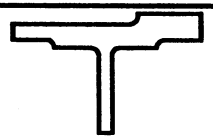
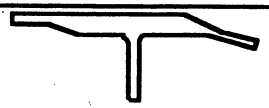
STS-83 and STS-84

- Extrusions on ETs 84 and 85 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

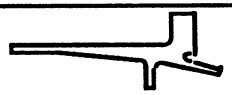
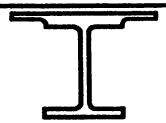
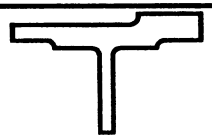
Conclusions

- ETs 84 and 85 meet all requirements and are acceptable for STS-83 and STS-84 flight

ET-84 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	34.88 28.29	25.90 19.43	36.40 36.40	1.32 1.33	1.37 1.72	1.09 1.08
851 Dome Chord		O5 OAF	19.34 30.37	16.05 28.43	36.40 37.70	1.32 1.35	2.48 1.67	1.44 1.33
1129 Dome Chord		HFF H8	26.95 34.94	25.63 29.74	38.00 39.80	1.25 1.27	1.76 1.45	1.10 1.26
1377 & 1624 Frames		H7 H6 H5 H4	32.85 25.65 21.10 22.05	29.26 22.79 21.74 22.58	39.80 39.80 33.70 33.70	1.26 1.26 1.25 1.25	1.52 1.95 2.00 1.91	1.33 1.33 1.26 1.25
1871 Frame Chord		H3 H2	35.77 35.02	25.60 25.50	36.60 36.60	1.26 1.26	1.32 1.29	1.08 1.10
2058 Dome Chord		H1 HAF	32.16 43.44	23.96 32.62	39.80 45.60	1.25 1.32	1.55 1.39	1.11 1.14

ET-85 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	31.87 23.93	23.57 19.96	36.40 36.40	1.32 1.31	1.50 1.99	1.08 1.29
851 Dome Chord		O5 OAF	18.44 33.34	14.03 33.08	36.40 37.70	1.32 1.35	2.60 1.53	1.44 1.31
1129 Dome Chord		HFF H8	27.37 22.94	28.03 26.21	38.00 33.70	1.25 1.26	1.74 1.85	1.16 1.36
1377 & 1624 Frames		H7 H6 H5 H4	32.61 34.49 25.26 21.77	29.25 30.83 20.55 22.28	39.80 39.80 39.80 33.70	1.26 1.26 1.30 1.25	1.54 1.45 2.05 1.94	1.34 1.33 1.25 1.25
1871 Frame Chord		H3 H2	36.76 36.27	26.27 26.41	36.60 36.60	1.26 1.26	1.27 1.26	1.08 1.10
2058 Dome Chord		H1 HAF	35.68 37.03	28.49 32.54	39.80 45.60	1.26 1.30	1.41 1.60	1.14 1.35

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
Debris prevention	S082962 6/11/96	3.2.1.2.14	668	ET-85

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

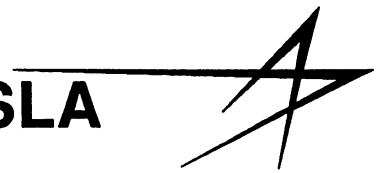
Level II Waivers

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

Level III Deviation

Document/Requirement	Paragraph	Deviation No.	Effectivity
CPTO1M09A, External Tank Contract End Item Specification			
ET aft cross beam SLA is suspected to be contaminated with metal particles that may cause debris • Metal particles, if present, have no effect on material performance	3.2.1.1.17	220	ET-85

Metal Particles in ET-85 Aft Crossbeam SLA



Issue:

- Sprayed SLA-561 ablator on the aft crossbeam of ET-85 may contain small metallic particles
  - Potential debris violates ET EIS and NSTS 07700, Vol X requirements

Discussion:

- Metallic sliver (0.050" x 1.0") was discovered during machining of sprayed SLA-561 on a cable tray cover
- Source of sliver traced to Jaygo mixer stainless steel bearing housing interference with loose collar
  - Mixer used to apply epoxy coating to cork particles for sprayed SLA and Hand Pack Type II
  - Bearing last replaced January 1995
  - Total mass loss of bearing and collar approximately 70 grams (0.15 lbs)
  - Four batches of cork (~ 720 lbs) treated prior to problem discovery - Used to make ~ 3300 lbs SLA
  - SLA with suspect cork sprayed on ~ 700 parts on ETs
  - X-Ray examination of selected parts showed some particles present
- Metal slivers/particles not an issue with mechanical performance of the SLA
  - Test samples fabricated with suspect material and additional metal particles
  - Mechanical property testing (bond tension and cryoflex) showed no effect on performance

Metal Particles in ET-85 Aft Crossbeam SLA

Discussion:

- Debris generation during ascent heating/ablation only issue identified
  - Hot gas facility ablation tests showed ablative performance not affected
  - Tests did show particles near surface could become debris
- Majority of parts stripped and new material applied to minimize use of suspect material
  - Applications aft of ET station 2058 not stripped and not a debris issue:
    - Closeouts on aft dome manhole covers and apex - Covered with foam
    - Recirculation line closeout - Covered with foam
    - ET-83 LH2 feedline - In/near accepted ice area
  - Applications forward of 2058 not stripped:
    - Bipod heater wire closeouts--covered with foam Intertank splice closeout and bipod ramps and analysis that ablation temperatures not reached and not a debris issue
    - ET-85 crossbeam assembly is large/complex configuration
- Debris issue discussed with RI/Downey Aerodynamics/Debris personnel
  - Potential debris of this magnitude and location not a concern

ET-85 Clearance:

- Approved by PRCB (S082962) on 6/11/96
  - EIS DAR 220
  - NSTS 07700, Vol X Waiver 668
- Mechanical/ablative properties of SLA-561 not affected
- Orbiter Project concurs debris of this magnitude and locations not a safety of flight issue