FLIGHT READINESS STATEMENT
STS-86/ET-88
EXTERNAL TANK PROJECT
PRE-FLIGHT REVIEW

EXTERNAL TANK ET-88/STS-86, AS IDENTIFIED IN THE EXTERNAL TANK PROJECT PRE-FLIGHT REVIEW DATED JULY 21, 1997, IS CONSIDERED READY TO SUPPORT FLIGHT UPON ACCEPTABLE DISPOSITION OF OPEN/PLANNED WORK AND/OR OPEN ACTIONS.

E. C. SMITH/EB01

for G. R. WALLACE/EL01

for M. A. PESSIN/EE31

W. R. HUMPHRIES/ED01

A. F. WHITAKER/EH01

S. P. SAUCIER/EP01

FOR A. O. HARRIS/CR01

M. D. SMILES/CR70

P. V. COUNTS/SA31, CHAIRMAN

July 21, 1997

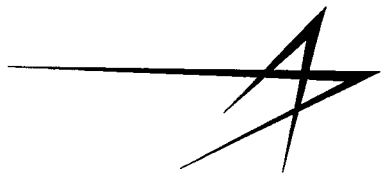
Space Shuttle
External Tank

STS-86/ET-88
Pre-Flight Review

Manned Space Systems

LOCKHEED MARTIN

Agenda



• ***Overview***	***Jim Feeley***
• ***Prior Mission Performance Summary***	
• ***Current Mission/External Tank Highlights***	
• Changes	Steve Copsey
• 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	
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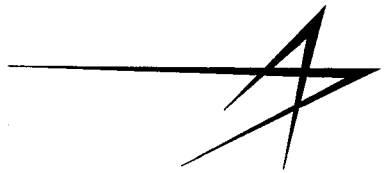
- D: Previously reviewed material	

Overview



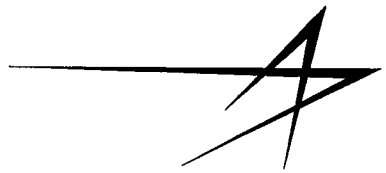
- Review covers changes/differences/non-conformances not previously flown and/or reviewed

- This review for STS-86/ET-88 includes:
  - Prior mission performance summary
  - Items specific to mission STS-86
  - Details of previously presented items are included in the Appendix

- **FRR Series**

- Pre-flight Review	7/21/97
- ET/SRB Mate	7/22/97
- Space Shuttle Vehicle FRR	9/4/97
- Mission Management Team (L-2 Day)	9/16/97

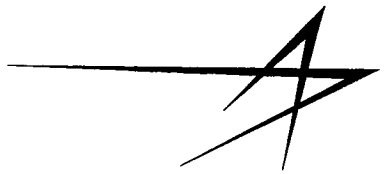
Prior Mission Performance Summary



STS-94/ET-86, 7/1/97

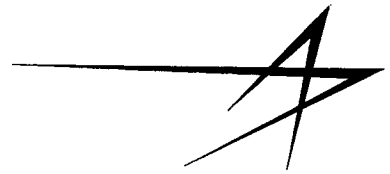
System	Performance
OMRSD	No violations
LCC	Nominal
Instrumentation	Nominal
MPS	Nominal
ET Hazardous Gas	Nominal
TPS	Nominal
ET disposal	Nominal
Orbiter tile damage	Lower surface, below average • > 1" = 11 • Total = 34
Post flight photo review	Not available

Mission/External Tank Highlights



Mission	**STS-86**
• **Launch**	9/18/97
- Window	0139 EDT
- Pad	A
- Orbiter	Atlantis (OV-104)
- Orbital inclination	51.6° - Insertion at 160 NM
- ET photo coverage	• Crew photos from cockpit window • Umbilical well cameras
• **Primary payload**	7th MIR docking
• **Landing**	9/28/97
- Time	0519 EDT
- Location	KSC
External Tank	**ET-88**
• DD250 acceptance	1/17/97
• Shipped to launch site	4/24/97

Agenda



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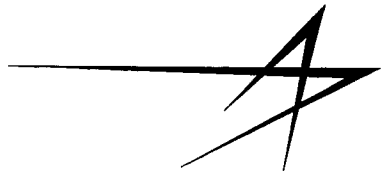
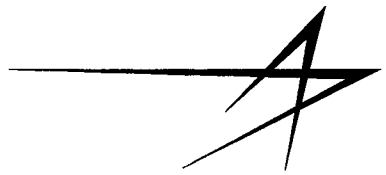
Changes - List



Description (Change No.)	Effectivity
• Composite nose cone implementation (B01775D)	ET-88
• Alternate blowing agent foam usage - NCFI 24-124 on Intertank sidewall (B01987F)	ET-88 and subs
• Thick/thin TPS on LH2 tank barrel (B01982/B02005)	ET-88 and subs

Composite Nose Cone Implementation



Change:

- Implementation of composite nose cone

Background/ Reason:

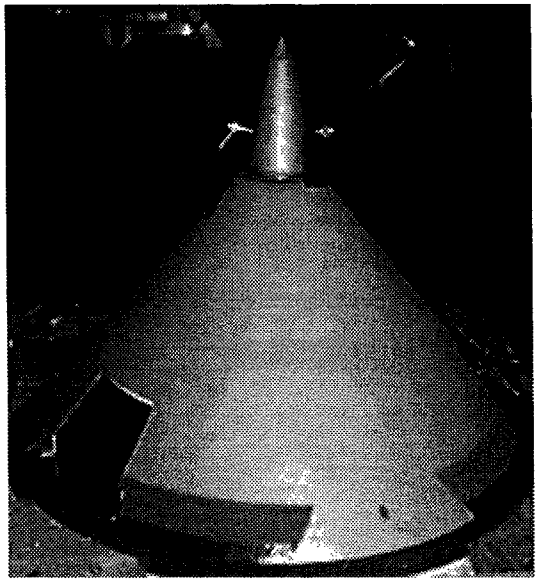
- Program established for development and verification of composite structures for ET application
  - Emphasis on enhanced reliability/performance
    - TPS debris potential eliminated
- Early incorporation of change on ET-88 diminishes number of first time configuration changes for SLWT

Description:

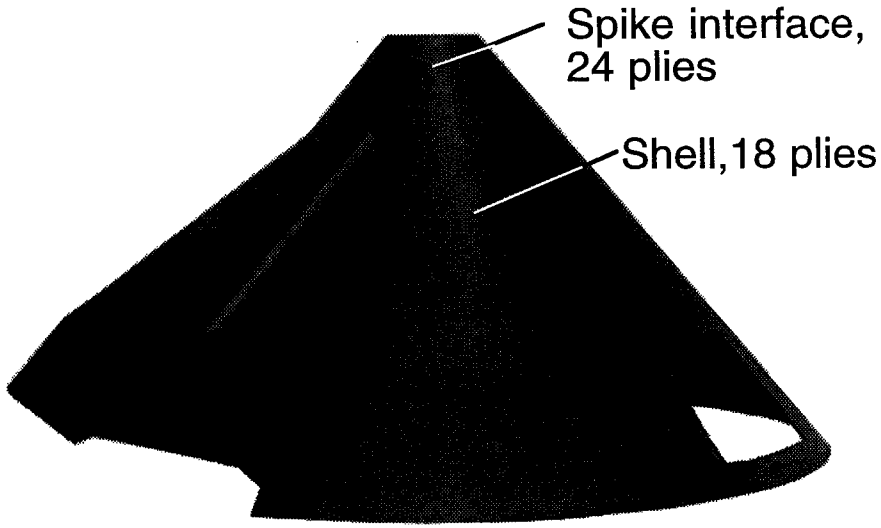
- Incorporated use of composite nose cone

Composite Nose Cone Implementation

ET-87: Metal Nose Cone

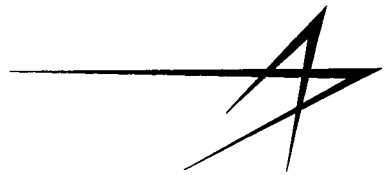


ET-88: Composite Nose Cone



Material	• Al 2024 skin/fairing/frames • Al 6061 mounting frame • SLA-561S, SLA-561M	• Graphite/Phenolic shell • Ti-6-4V attachment brackets
Parts	81	29
Fasteners	1117	56
Weight	116.2 lbs	105.2 lbs

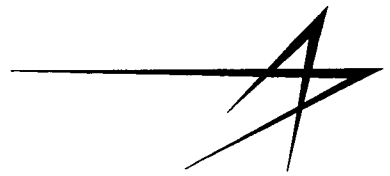
Composite Nose Cone Implementation



Basis for Certification:

- Material development program
  - Mechanical properties from -295°F to 1000°F
  - Thermal properties - Conductivity/specific heat
  - Bolt bearing and pull through for attachment points
  - Damage data base - Compression after impact
  - Hot gas/wind tunnel ablation performance tests
- Major tests/articles
  - Static load
  - Vibration
  - Acoustic
  - Full scale article cut-up, Physical and mechanical property tests
  - LETF performance - GO2 vent system
  - Damage tolerance
  - Lightning and ESD
- Analyses
  - Stress: Meets required FS (1.40)
    - Was: Metal nose cone = 2.07
    - Now: Composite nose cone = 1.68 (failure mode: direct strain)
  - Thermal: Temperatures within mechanical property and ablation test data base
- Inspection: Controlled by STM and STP
  - Material RAP test
  - Tag end coupon material properties and permeability
  - 100% Non-Destructive Evaluation (thermography)

Alternate Blowing Agent Foam Usage



Change:

Implement use of alternate blowing agent foams
- NCFI 24-124 on Intertank sidewall

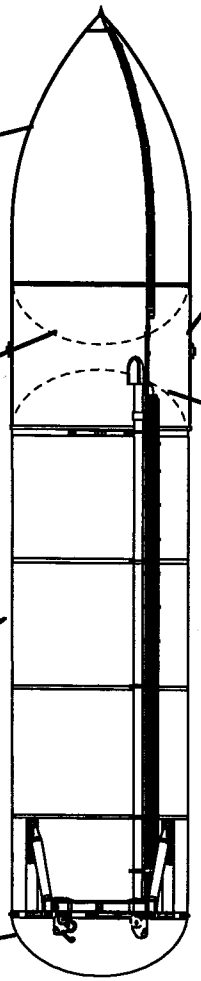
Background/ Reason:

- 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
  - 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

Description:

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

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-88, Interank 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 -423°F (psi)	Not applicable		16.2 min	16.2 min	41	34	**NCFI has lower strength, FS min = 1.58 (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)	Not applicable		22@ -250°F	22@ -250°F	65@ -423°F	89@ -423°F	Both demonstrated to required stress levels

Alternate Blowing Agent Foam Usage

Basis for Certification:

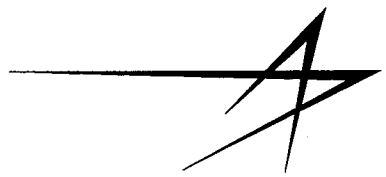
- Process development
  - Design of experiment process utilized
    - Room temperature/humidity
    - Component temperature
    - Substrate temperature
    - Gun output
- Tests
  - Physical properties - Density, thermal strain, flammability, corrosion, oxygen index, thermal conductivity
  - Mechanical properties - Compressive/tensile strength, cryoflex, shear
  - Liquid properties
  - Lot to lot variation (3 lots)
  - Storage life - In process
    - 1.5 years
  - 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 (failure mode: bondline delamination)
    - Was: CPR-488 = 1.42
    - Now: NCFI 24-124 = 1.21
  - Thermal: New foams meet ascent temperature and disposal requirements
- Inspection: Verifies proper application of foam
  - Lead in/lead out plus 6 additional plug pulls

Thick/Thin TPS on LH2 Tank Barrel



Change:

- Implemented thick/thin TPS configuration on the LH2 tank barrel

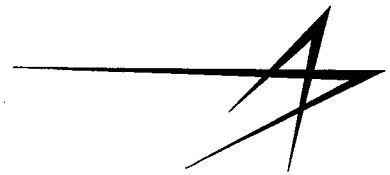
Background/ Reason:

- TPS thickness reduction identified as 260 lb weight savings candidate for SLWT
  - Different applied thicknesses to +/-Z side of tank
- Early incorporation of change on ET-88 diminishes number of first time configuration changes for SLWT
- Previously LWT spray system applied a constant foam thickness for entire tank circumference
  - LWT TPS spray targeted the +Z side of tank where higher ascent heating environments set TPS thickness
- New Delivery System (NDS) equipment with Tapered Plug Valve (TPV) guns allowed thick/thin application

Description:

- Hardware
  - TPS reduction encompasses five circumferential thickness bands on LH2 tank barrel
    - Control within specific band results in a thick/thin configuration
- Manufacturing
  - Implemented use of NDS to control foam thickness to tighter tolerance and tailored thicknesses

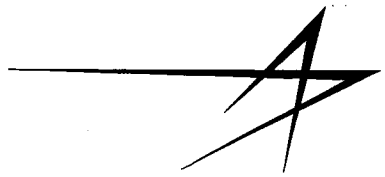
Thick/Thin TPS on LH2 Tank Barrel



Basis for Certification:

- Process Development
  - Developmental Variable Output Spray (VOPS) equipment fabricated in Huntsville foam development laboratory
    - VOPS units used for alternate foam blowing agent development and qualification (NCFI 24-124 and NCFI 24-57)
  - Team assembled to design and fabricate production NDS units
  - Thick/thin developmental/ sprays conducted in material science spray booth
  - Development/validation sprays conducted in production cell
    - Assessed thickness, tensile strength, density, cryoflex
  - NDS equipment uses more instrumentation and diagnostics than previous system
    - Utilizes built in statistical process controls
  - ETs 85 thru 87 sprayed with NDS system
- Analysis
  - Stress: New spray configuration meet required FS of 1.10 (failure mode: bondline delamination)
    - FS unchanged = 1.32
  - Thermal: New thickness meets all propellant/ice frost/structural temperature requirements
  - Propulsion: Negligible impact to LH2 propellant inventory
- Inspection: Verifies proper application of foam
  - Lead in/lead out plus 6 additional plug pulls

Agenda



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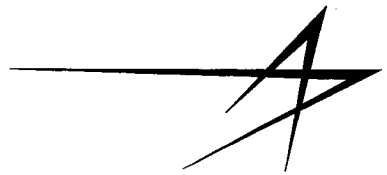
SRM&QA Assessment

as of 7/17/97

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

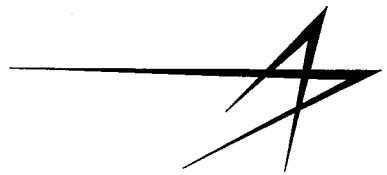
as of 7/17/97

- **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 modifications	None
- OMRSD *	1
- Software	None
• SIM Load	8/29/97
• SIM Launch	8/13/97

* Included in Appendix C

Agenda



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Verification/Certification

as of 7/17/97

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

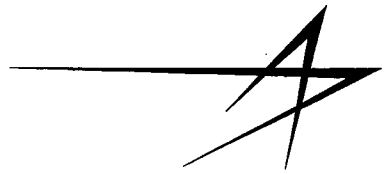
* Included in Appendix D

Mission Unique Assessment

as of 7/17/97

Category/Item	STS-86
• Review of MRB actions using updated loads	ECD 9/8/97
• MPS Preflight Prediction Package	ECD 9/8/97

Agenda



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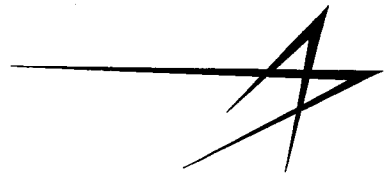
Readiness Statement



The External Tank, ET-88 is hereby certified and ready for STS-86 flight pending completion/closure of open and planned work

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

Appendices

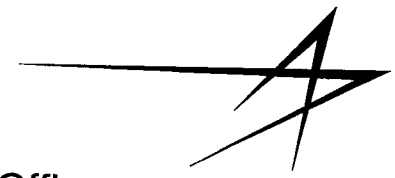
- **A: Minor Changes**

- **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)
    - ET weighing requirement (MT13115M)

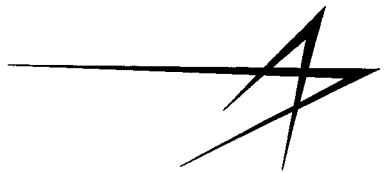
- **D: Previously presented items**
  - ET-88 Welded Extrusion Assessment
  - Level II Waivers

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)

Class I/II or JS/DCN Changes



Change No.	Description
Electrical	
H35809-584	Revise nose cone electrical installation to reinstate flag note erroneously omitted from sheet 1 drawing (PDS data base load error)
Propulsion	
H35809-406 H35809-407 H35809-409 H35809-410 H35809-411 H35809-412 H35809-423	Revise 0.25" and .0375" stainless steel tubing proof pressure test value to a standard 5600 to 6000 psig
H35809-438	Revise LH2 proof pressure requirements to specify psig instead of percentages. Revise the maximum load tolerance on jacks 7 and 8 from +750 KIPS/-250 KIPS to ±750 KIPS
H35809-476 H35809-480	Revise GO2/GH2 vent valve drawing to add latest casting Mil specifications

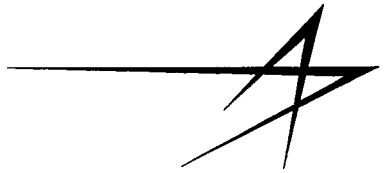
Class I/II or JS/DCN Changes

Change No.	Description
Propulsion	
H35809-652	Revise length of LO2 transducer hose heat shield to prevent icing during prelaunch
Structure	
H35809-048	Revised aft crossbeam bracket dimensions and graphics to clarify design and aid manufacturing
H50001-761/A	Revise upper aft SRB fairing to allow material thickness reduction at upper bell
TPS	
H35809-522	Add clearance requirement between the GO2 pressure line flange and ice frost ramps to prevent interference during ascent environments
H35809-565	Revise upper SRB fairing TPS trim due revise LH2 tank acreage foam (thick/thin)

Class I/II or JS/DCN Changes

Change No.	Description
TPS	
H35809-568	Revise SLA trim on vertical strut to crossbeam fairing to preclude damage during fastener torque
H35809-636	Revise LO2 feedline yoke TPS closeout to add dimensional callout at Station 1129
H35809-668	Revise vertical strut fitting and SRB cable tray foam closeout bondline

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-88 DR/PR/OMRSD Waiver/Exception Summary

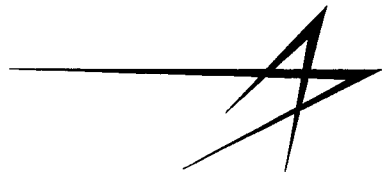
as of 7/17/97

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

ET-88 PR/MRBs - Summary, Propulsion

PR No./Status	Title/Description	Disposition
PET-88-FP-0001	GFP LH2 4" disconnect has raised metal on rack gear tooth at drilled hole location	• Use as is - Raised metal is result of machining - Affected pinion gear teeth are 180° from rack in the closed position • As disconnect opens, the pinion gear rotates approximately 90° • Affected teeth will not contact rack and will not affect opening of disconnect
PET-88-FP-0004	GFP LH2 17" disconnect flapper fairing cover had depression with raised metal	• Use as repaired - Raised metal removed and surface finish restored

ET-88 PR/MRBs - Summary, Propulsion



PR No./Status	Title/Description	Disposition
PET-88-FP-0005	GFP LH2 17" disconnect roller arm housing foam exposed during roller arm 0.003" clearance verification	• Use as is - 0.003" clearance is required between roller arm and roller can for proper operation - Roller can provides barrier around roller arm during umbilical foam operations

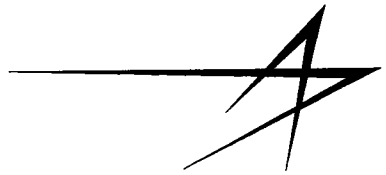
ET-88 PR/MRBs - Summary, Structures

PR No./Status	Title/Description	Disposition
PET-88-ST-0002	Bipod adjustable strut has primer on flange	• Use as is - Primer overspray on flange was < 0.15 sq. in. and limited to area adjacent to faying surface - Primer will not affect lightning bond path
PET-88-ST-0008	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 0.001" deep - MRB accepts defects without metal thickness verification

ET-88 PR/MRBs - Summary, Thermal

PR No./Status	Title/Description	Disposition
PET-88-TS-0001	Two areas of delaminated SLA on -Y/+Z side of forward and aft corners of crossbeam	• Use as repaired - Delaminated SLA was trimmed and repaired using SLA Type I
PET-88-TS-0002	Chipped in SLA around bolts holes of LH2 umbilical cable tray support fitting	• Use as repaired - Removed chipped SLA down to substrate and repair using SLA Type I

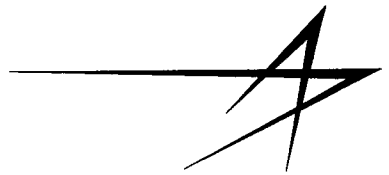
ET-88 Limited Life Components



Cycle Sensitive

Description	Part No.	Serial No.	Limit	Required	Remaining
LO2 Fwd Ogive Cover Plate	80911001207-029	000381920	100	1	100
LO2 Tank Mechanical Assy	80912002000-019	000331380	100	1	100
LO2 Manhole Cover Assy	80911001205-010	000424300	100	1	100
LH2 Manhole Cover Assy	80914081488-019	000391230	100	1	100
LH2 Tank Mechanical Assy	80914002000-009	000317530	100	1	100
LH2 Manhole Cover Assy (Aft Dome)	80911001444-010	000365680	100	1	100
		000408630	100	1	100

ET-88 Limited Life Components



Age Sensitive

Description	Part No.	Serial No.	Limit	Initiation	Expiration
External Tank	80901000000-270	00000081	6 Yrs	1/97	1/2003

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	0001121	12/96	12/2000
Cartridge Assy	PD5000020-030	AAG	0001202	11/96	11/2000
		AAG	0001203	11/96	11/2000

ET-88 Alternate Blowing Agent Usage at KSC

as of 7/17/97

Foam	Document	Description	Location	Size
SS-1171	T5141	Aft hardpoint closeout	Sta 1973 - 2076, 180°	4410 sq. in.

OMRSD File IV Change

RCN MT13115

Description

- Revised requirement to measure tank pressure within 72 hrs of weighing operation to facilitate gage installation
- Revised requirement to verify that pressure gages used for ET weighing operations at KSC be within 0.25% accuracy full scale

Reason

- ET pressure gages identified as potential contributor of inaccurate data
  - Gages were designed to verify positive pressure not measure tank pressure (calibrated 0.5% full scale accuracy)
  - 1 psi difference in pressure results in approximately 300 lb weight delta

ET-88 Welded Extrusion Assessment

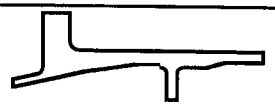
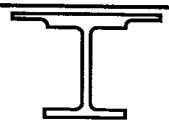
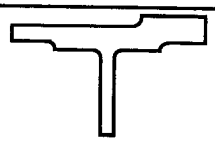
STS-86

- Extrusions on ET-88 does 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

- ET-88 met all requirements and is acceptable for STS-86 flight

ET-88 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	36.09 30.33	26.22 20.31	36.40 36.40	1.31 1.31	1.32 1.57	1.05 1.03
851 Dome Chord		O5 OAF	22.18 30.80	14.43 28.70	36.40 37.70	1.32 1.35	2.16 1.65	1.14 1.31
1129 Dome Chord		HFF H8	30.30 33.42	27.84 29.04	45.60 33.70	1.25 1.27	1.875 1.28	1.07 1.22
1377 & 1624 Frames		H7 H6 H5 H4	30.23 31.28 28.24 27.82	26.56 27.62 22.61 22.16	39.80 39.80 39.80 33.70	1.26 1.26 1.31 1.31	1.66 1.60 1.85 1.59	1.32 1.32 1.23 1.22
1871 Frame Chord		H3 H2	36.47 35.02	26.17 25.50	36.60 36.60	1.26 1.26	1.26 1.32	1.08 1.10
2058 Dome Chord		H1 HAF	33.96 40.69	26.82 31.28	39.80 45.60	1.26 1.31	1.47 1.47	1.14 1.18

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