FLIGHT READINESS STATEMENT
STS-82/ET-81
EXTERNAL TANK PROJECT
PRE-FLIGHT REVIEW

EXTERNAL TANK ET-81/STS-82, AS IDENTIFIED IN THE EXTERNAL TANK PROJECT PRE-FLIGHT REVIEW DATED JANUARY 24, 1997, IS CONSIDERED READY TO SUPPORT FLIGHT UPON ACCEPTABLE DISPOSITION OF OPEN/PLANNED WORK AND/OR OPEN ACTIONS.

for J. RANDALL/EB01

M. PESSIN/EE31

for P. SCHUERER/EH01

for J. EHL/CR01

J. STRICKLAND/EL01

R. HUMPHRIES/ED01

J. HARBISON/EP41

for M. SMILES/CR70

P. V. COUNTS/SA31, CHAIRMAN

January 24, 1997

Space Shuttle
External Tank

STS-82/ET-81
Pre-Flight Review

LOCKHEED MARTIN

Manned Space Systems

ET81PFR.4250.dd.1/97

Agenda

• ***Overview***	***Jim Feeley***
• ***Prior Mission Performance Summary***	
• ***Mission/External Tank Highlights***	
• ***Changes: No first time 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	
- D: Previously reviewed material	

Overview

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

- This Delta review for STS-82/ET-81 includes:
  - Prior mission performance summary
    - Items not previously addressed at the Block 14 (ETs 81-85) ET Project FRR
    - Items specific to mission STS-82
    - Details of previously presented items are included in the Appendix

- **<u>FRR Series</u>**
  - Block ET Project Review — 8/14/96
  - Mission Specific Reviews
    - ET/SRB Mate — 12/4/96
    - Pre-flight review — 1/24/97
    - Associate Administrator FRR — 1/30/97 (S)
    - Mission Management Team (L-2 Day) — 2/9/97 (S)

Prior Mission Performance Summary

STS-81/ET-83, 1/12/97

System	Performance
OMRSD	No violations
LCC	Nominal
Instrumentation	Nominal
MPS	Nominal
Hazardous Gas	Nominal
TPS	GO2 vent seal adhered to ET topcoat at retraction
ET disposal	Nominal
Orbiter tile damage	Not available 48 hits 14 > 1"
Post flight photo review	Not available

Mission/External Tank Highlights

Mission	**STS-82**
• **Launch**	2/11/97
- Window	0356 - 0457 EST
- Pad	A
- Orbiter	Discovery (OV-103)
- Orbital inclination	28.45° - Insertion at 313 NM
- ET photo coverage	• Umbilical well cameras • Crew photos from cockpit window
• **Primary payload**	Hubble Space Telescope Servicing Mission 2
• **Landing**	2/21/97
- Time	0230 EST
- Location	KSC
External Tank	**ET-81**
• DD250 acceptance	1/19/96
• Shipped to launch site	4/11/96

Added 1/29/97

GO2 Vent Seal Adherence to ET Topcoat

Issue:

- On STS-81/ET-83, the GO2 vent seal pulled off a piece of topcoat (6.0" long x 8.0" wide) with a small piece of CPR foam (1.0" long x 0.375" wide x 0.125" deep) during retraction

Discussion:

- Similar anomaly observed on 6 prior ETs
- Special investigation initiated to determine cause of topcoat loss following STS-71 (ET-70)
  - Investigation revealed no process/material changes since ET-65 (STS-68) and no requirement to control topcoat thickness
    - Requirement was for uniform coverage
  - Most probable cause is multiple topcoat applications/layers
    - Tests showed topcoat thickness > 0.002" exhibits greater tendency for adhesion to GO2 seal material
  - Insignificant TPS loss does not effect thermal capabilities
- Corrective Action implemented
  - ETs 74-87: Topcoat tape test implemented to screen for adequate adhesion
    - Tape applied and removed from GO2 seal land area
      - Removes thick glossy topcoat
    - Thin single layer of topcoat reapplied to exposed areas
  - ETs 88 and subs: Initial topcoat application limited to one thin coat with no touch-up permitted until final shake-down
    - Touch-up overlap controlled to 0.25" max

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Added 1/29/97

GO2 Vent Seal Adherence to ET Topcoat

Rationale for STS-82/ET-81:

- Tape test performed on GO2 seal land area at KSC
  - Topcoat removed from major section of -Y GO2 seal land area along and aft of Station 371
  - Topcoat removed from small section of +Y GO2 seal land area along Station 371
  - Thin single layer of topcoat reapplied to exposed areas
- ET-81 acceptable for flight
  - Topcoat has no flight function
  - Based on tests and post launch inspections adherence of GO2 vent seal to topcoat does not result in unacceptable foam loss

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SRM&QA Assessment

as of 1/16/97

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
- Welded extrusion cracks (S-079) *	• ET-81 meets all requirements

* Included in Appendix D

Agenda

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• ***KSC Processing***	***Brian Knipfing***
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KSC Processing - Status

as of 1/16/97

- **Discrepancy Reports (DRs)/Problem Reports (PRs) Review**
  - All PR/MRB * discrepancies/dispositions similar to previously flown vehicles and are within existing database with exception of noise heard when ET-81 was offloaded from the transporter to the VAB
    - Investigation identified cause as inadequate maintenance procedure on forward hoisting adapters
    - ET-81 re-manifested from STS-80 to STS-82 to support investigation
  - 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

* Included in Appendix C

KSC Processing - Status

as of 1/16/97

- **Changes**
  - ET modifications
    - Mod Kits * — 4
    - DC&R (Discrepancy Check and Report) — 0
    - Bldg 45 — 0
    - FEC (Field Engineering Change) — 0
  - OMRSD — 0
  - Software — 0
    - SIM Load — 1/23/97
    - SIM Launch — 1/29/97

* Included in Appendix C

Agenda

- Overview — Jim Feeley
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- Mission/External Tank Highlights
- Changes: No first time changes
- Senior Management Review NCDs: None
- SRM&QA Assessment — Terry McKeough
- KSC Processing — Brian Knipfing
- ***Verification/Certification*** — ***Jim Feeley***
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Verification/Certification

as of 1/16/97

Item	Status
• **NSTS 07700, Volume X Baseline** - Revision L, Change 224	No constraints
• **Certification documentation** - Hardware Certification Sheets (HCS) - Certificates of Qualification (COQ)	Approved - No issues
• **Waivers/Deviations**	Complete - No issues

Mission Unique Assessment

as of 1/16/97

Category/Item	Status
• **Review of MRB actions using updated loads**	Complete - No issues
• **MPS Preflight Prediction Package**	ECD 1/30/97

Agenda

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Readiness Statement

The External Tank, ET-81 is hereby certified and ready for STS-82 flight pending completion/closure of open and planned work

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

Appendices

- **A: Minor Changes**

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

- **C: KSC Processing**
  - PR/MRB Summaries
  - OMRSD Exceptions/Waivers: None
  - OMRSD Changes (RCNs): None
  - Limited Life Components
  - Modification Summaries/Status
  - Software Changes: None
  - ET-81 Alternate Blowing Agent Usage at KSC

- **D: Previously presented items**
  - ET-81 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 - List

Change No.	Description	Discipline
H35809-609	Revised ET Off-site Acceptance Manual to delete in-process rework criteria for TPS	TPS
H35809-649	Revise vertical strut channel assembly to clarify cable support locator dimension	Structure
H35809-657	Update CIL implementation to correct miscellaneous errata	Systems
H35809-673	Clarify LO2 cable tray cover ablator post installation requirement to inspect for delamination/debond in accessible areas only	Structure

Class II STP/STM/Standards, List

Change No.	Document No.	Description
H35809-625	STP 1503	BX-250 pour - Allow repairs with STP 1532 and/or 1518
H35809-626	STP 1513	BX-250 spray - Allow repairs with STP 1532 and/or 1518
H35809-647	Y1A6 Code sheet/ Code adden	Black ink - Create code sheet for 609 black ink and create code addendum
H35809-648	STP 4501	Identification marking • Add instructions for 609 black ink (Y1A6) to STP • Add cautions to not use marking ink on internal LO2 tank parts/assemblies • Delete obsolete references
H35809-651	Std 41L2	Heat shield • Revise heat shield standard to add 2 new parts - 10.5" ± 0.25" long - 11.5 ± 0.25" long • Add vendor part number for new heat shields

Class II STP/STM/Standards, List

Change No.	Document No.	Description
H35809-654	L1A1 source appdx	PDL-1034 - Reflect vendor name change from PDL to Urethane Technologies
H35809-660	Std 54L4	Vibration isolator - Revise standard to reference MIL-Std-2219 or MIL-W-8611 spec for identification of weld classification
H35809-661	Std 54L10	Vibration isolator - Revise standard to require acceptance test frequencies of 10 to 70 Hz instead of 10 to 100 Hz
H35809-667	B656 Code sheet	Expanded PTFE seal - Add instructions that no cleaning is required for specimens submitted for NHB 8060.1, Test 13, Part 1 oxygen compatibility test
H50001-787	STP 3001	Chem film for Aluminum • Deleted FED Std 141 and add ASTM B117 • Delete call out for specific maskants • Delete requirement for 2219 salt spray tests • Change from 5 minimum rinse to or until pH 5.5 to 8.0 is attained

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-81 DR/PR/OMRSD Waiver/Exception Summary

as of 1/16/97

System	Discrepancy Reports	Problem Reports	MRB Items *	Waivers/ Exceptions
• Electrical	0	0	0	0
• Propulsion/ Pneumatics	0	1	1	0
• Structure	1	7	1	0
• Thermal (TPS)	1	14	9	0
Total	**2**	**22**	**10**	**0**

* See subsequent charts for details

ET-81 PR/MRB Summary

PR No.	Description	Disposition
Structure		
PET-81-ST-0002	Raised metal on third hardpoint attach pads	• Use as is - 10x inspection revealed no crack-like indications - Non-verification of remaining part thickness accepted
Thermal		
PET-81-TS-0002	Foam overspray on GH2 pressure line guide rail and support	• Use as repaired - Overflow removed from envelope of pressure line movement - Remaining residue acceptable
PET-81-TS-0003	Damaged foam on top surface of LH2 umbilical cable tray fairing closeout, +Y side	• Use as repaired - Area sanded and blended - Remaining foam thickness sufficient to prevent ice/frost formation

ET-81 PR/MRB Summary

PR No.	Description	Disposition
Thermal		
PET-81-TS-0004	Two areas of damaged foam on +Y vertical strut cable tray cover closeout, -Z side	• Use as repaired - Damaged areas trimmed out and repaired with PDL-1034 - Bondline configuration change only
PET-81-TS-0006	SLA on inboard side of +Y vertical strut cable tray support bracket exceeds max drawing thickness requirements	• Use as is - No interference issue as result of additional foam - Additional thickness does not adversely affect thermal capabilities
PET-81-TS-0007	Foam adjacent to +Y and -Y attach pads and aft of Sta 2058 is less than 1.25" requirement	• Use as is - Localized areas of low foam will not increase structural temperature during ascent/re-entry - Remaining foam thickness will prevent ice/frost formation during cryo load

ET-81 PR/MRB Summary

PR No.	Description	Disposition
Thermal		
PET-81-TS-0009	Debonded foam on LO2 umbilical cable tray to EO-3 fitting support	• Use as repaired - Debonded foam trimmed out - Localized areas with no evidence of collateral damage - Not a debris or ice/frost concern
PET-81-TS-0010	Teflon tape applied to epoxy primed LO2 umbilical substrate extending under foam around periphery of the LO2 flapper valve actuator closeout area	• Use as repaired - Foam trimmed to remove tape - Closeout area dimensions acceptable - Slightly larger closeout will not affect thermal performance of umbilical TPS

ET-81 PR/MRB Summary

PR No.	Description	Disposition
Thermal		
PET-81-TS-0013	-Y aft fairing TPS closeout has multiple voids and one area of underfill	• Use as repaired - Rework performed consistent with validated process - Additional bondlines will not affect performance of closeout
PET-81-TS-0014	GFP LO2 umbilical overflow interferes with LO2 pyro can mechanical installation (2 areas each on the upper inboard and outboard cutouts)	• Use as is (Boeing North American) - TPS interference sanded to allow installation of jack bolt assembly - Two small areas of missing MBO resin accepted • Sufficient resin remains to ensure adequate MBO foam adhesion

ET-81 Limited Life Components

Cycle Sensitive

Description	Part No.	Serial No.	Limit	Required	Remaining
LH2 Manhole Cover Assy	80914081488-019	000173910	100	1	100
LO2 Tank Mechanical Assy	80912002000-019	000165480	100	1	100
LH2 Tank Mechanical Assy	80914002000-009	000168250	100	1	100
LO2 Manhole Cover Assy	80911001205-010	000260410	100	1	100
LO2 Fwd Ogive Cover Plate	80911001207-029	000187120	100	1	100
LH2 Manhole Cover Assy (Aft Dome)	80911001444-010	000171560	100	1	100
		000191160	100	1	100

ET-81 Limited Life Components

Age Sensitive

Description	Part No.	Serial No.	Limit	Initiation	Expiration
External Tank	80901000000-270	00000074	6 Yrs	1/96	1/2002

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	0000841	5/96	5/99
Cartridge Assy	PD5000020-030	AAF	70016	5/96	5/99
		AAF	70017	5/96	5/99

ET-81 Modification Summary

No.	Description	Status
Mod Kits		
E146/B02010	Remove ET RSS	Complete - No issues
E150/B02010	Limit GUCP RSS tear-away installation	Complete - No issues
B158/B01987G	Authorize use of PDL-1034	Complete - No issues
E164/B02014	Improved ET/SRB fairing closeout	Complete - No issues

ET-81 Alternate Blowing Agent Usage at KSC

(PDL-1034/SS-1171)

Foam	Document	Description	Location	Size
SS-1171	T5141	Aft hardpoint closeout	Sta 1973-2076, 180°	4410 sq. in.
PDL-1034	PR-TS-0004	+Y vertical strut cable tray cover	Sta 2058, 32°	5 sq. in.
PDL-1034	PR-TS-0005	LH2 feedline bellows, -Z	Sta 2058, 337°	1 sq. in.
PDL-1034	T5002	Aft hardpoint pads	Sta 1973-2058, 180°	106 sq. in.
PDL-1034	T5249	ET/SRB aft fairing closeout	Sta 2058, 40°/ 320°	240 sq. in.
PDL-1034	T5244	ET/Orbiter jack pad closeout	Sta 1129, 12°/ 348°	9 sq. in.

ET-81 Welded Extrusion Assessment

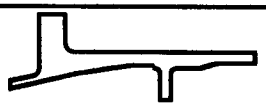
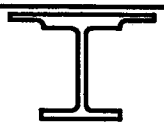
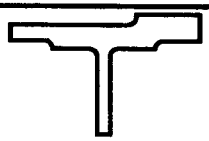
STS-82

- Extrusions on ET-81 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

- ET-81 meets all requirements and is acceptable for STS-82 flight

ET-81 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	35.77 29.37	26.47 19.49	36.40 36.40	1.31 1.31	1.35 1.62	1.08 1.03
851 Dome Chord		O5 OAF	23.23 32.33	17.38 30.39	36.40 37.70	1.33 1.35	2.09 1.58	1.28 1.32
1129 Dome Chord		HFF H8	34.82 23.20	34.26 26.47	38.76 33.70	1.25 1.26	1.39 1.83	1.09 1.35
1377 & 1624 Frames		H7 H6 H5 H4	33.68 25.90 24.81 21.87	29.83 23.99 20.19 22.41	39.80 39.80 39.80 33.70	1.26 1.26 1.30 1.25	1.49 1.94 2.08 1.93	1.30 1.38 1.25 1.25
1871 Frame Chord		H3 H2	36.46 35.57	26.41 25.90	36.60 36.60	1.26 1.26	1.26 1.30	1.10 1.10
2058 Dome Chord		H1 HAF	36.15 41.82	29.04 34.80	39.80 45.60	1.32 1.31	1.45 1.43	1.17 1.26

Level II Waivers - Baseline

Document/ Requirement	Authority	Paragraph	Waiver No.	Effectivity
NSTS 07700 Vol. V - Information Management Requirements				
Generic part name, type, common designation, and part manufacturer H4 code are not required for EEE parts status 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 - Baseline

Document/ Requirement	Authority	Paragraph	Waiver No.	Effectivity
NSTS 07700 Vol. X - Space Shuttle Flight and Ground System Specification , Book 1 Requirements				
Electrical wiring of redundant systems NSTS 08080-1, 20A/4B	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 - Baseline

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 - Baseline

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

Level II Waivers - Baseline

Document/ Requirement	Authority	Paragraph	Waiver No.	Effectivity
NSTS 08060, Rev. F - System Pyrotechnic Specification				
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
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