STS-60/ET-61 ET PROJECT
FLIGHT READINESS STATEMENT

EXTERNAL TANK ET-61, AS IDENTIFIED IN THE FLIGHT READINESS REVIEW DATED DECEMBER 16, 1993, IS CONSIDERED READY TO SUPPORT FLIGHT UPON ACCEPTABLE DISPOSITION OF OPEN WORK AND/OR OPEN ACTIONS.

for H. GARRETT/EB21

M. PESSIN/EE31

for C. KEY/EH01

for H. SMYLY/EP01

J. MITCHELL/EL01

R. JACKSON/CP11

R. BLEDSOE/CQ21

R. RYAN/ED01

for P. V. COUNTS/SA31, CHAIRMAN

December 16, 1993

Space Shuttle
External Tank

ET Project

Block 10 and STS-60/ET-61 Flight Readiness Review

MARTIN MARIETTA
MANNED SPACE SYSTEMS

Blk10C/P.3000.12/93.1

Agenda

• ***Introduction***	***Dennis Deel***
• Mission Performance Summaries	
• Block 10 (ETs 61-65) Items	See Block 10 Agenda
• Mission STS-60 Items	See Mission STS-60 Agenda
• Appendices - A: Minor Changes - B: KSC Processing - C: Previously addressed material	

Introduction

- Review covers changes/differences/non-conformances not previously flown and/or reviewed
  - ET items for Block 10 (ETs 61-65)
    - Changes
    - SMRs
  - Missions specific items for STS-60 (ET-61)

- Delta reviews will be scheduled on a mission-by-mission basis and include:
  - List of previously discussed items as applicable to the specific ET
    - Details of previously addressed items will be available in appendix
  - New items since Block Review
  - Performance summary of the previous flight
  - Mission specific items

Agenda

• *Introduction*	***Dennis Deel***
• **Mission Performance Summaries**	
• Block 10 (ETs 61-65) Items	See Block 10 Agenda
• Mission STS-60 Items	See Mission STS-60 Agenda
• Appendices - A: Minor Changes - B: KSC Processing - C: Previously addressed material	

Mission STS-61/ET-60 Performance Summary

System	Performance Scrub, 12/1/93 (T-5 minutes due to RTLS weather)	Launch, 12/2/93
OMRSD/LCC	No ET violations	No ET violations
Instrumentation	• During drain, ET LH2 5% liquid level measurement indicated dry, then wet before returning to a dry indication 30 minutes later (IPR 61V-0147) - Used for loading only - Not flight critical (crit 3) • OMRSD exception generated to waive requirement to verify 5% sensor wet	Nominal - 5% sensor/ measurement performed correctly
MPS	Nominal	Nominal
Hazardous Gas	Nominal	Nominal
TPS	Nominal	Nominal
ET Disposal	Not applicable	No issues
Orbiter Tile Damage	Not applicable	Lower surface • >1" = 13, below average • Total=120, below average

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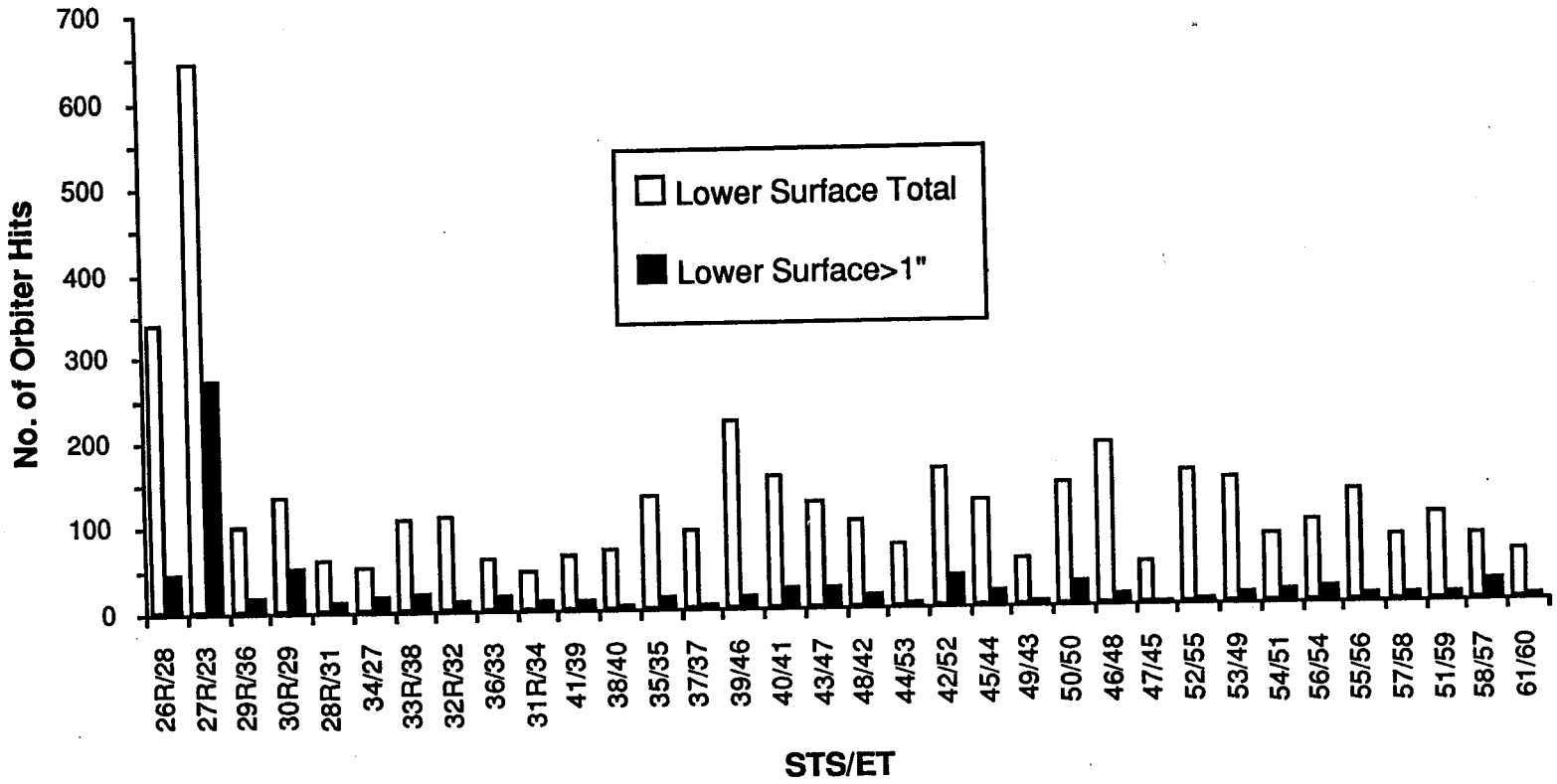
MANNED SPACE SYSTEMS

Mission STS-61/ET-60 Performance Summary



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Mission STS-58/ET-57 Performance Summary

Item:

- Post separation photos (Orbiter umbilical well cameras) showed areas of missing foam (IFA STS58-T-1)
  - Both 4" x 4" Orbiter jack pad closeouts
  - 28" x 3" strip on Intertank at Station 990

Discussion/ Status:

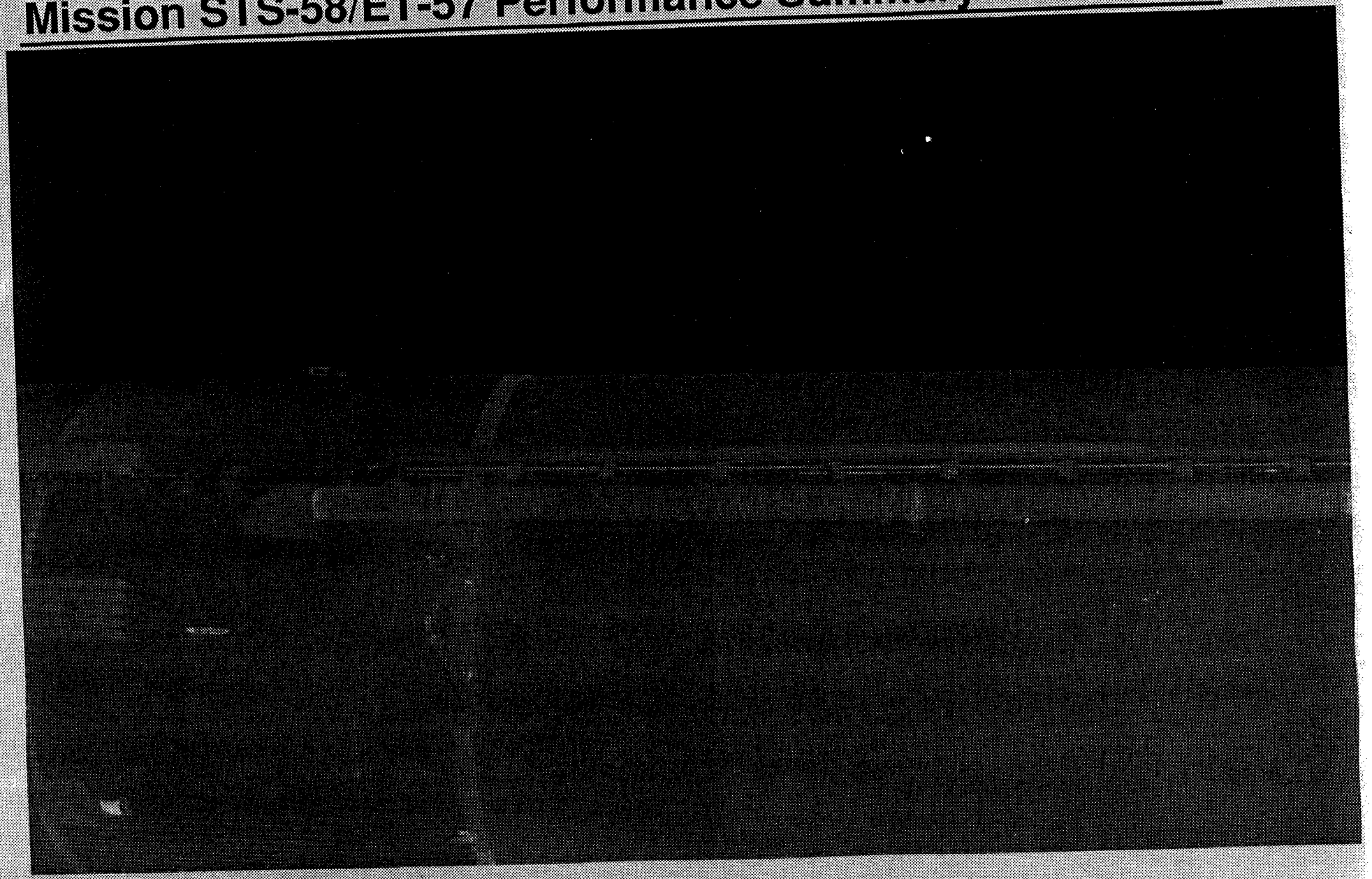
- Localized areas of missing foam is within flight experience base
- Prior cause investigations resulted in corrective actions
  - Jack pad closeout enhancements implemented
    - Cleaning/priming requirements increased
    - Beveled front edge of cavity to reduce entrapped air/voids
    - Two step closeout - Fill insert holes with PDL
    - Developed specialized operation training techniques to minimize process anomalies
  - Intertank spray process enhancements in work
    - Optimize spray gun insert and tip to stabilize spray pattern
    - Demonstrate full scale spray on GVTA Intertank
    - Earliest implementation, ET-77
- Teams formed at KSC and MAF to determine cause of STS-58 items
  - Build paper and processing review in work
  - No conclusions to date

Mission STS-58/ET-57 Performance Summary

Flight Rationale:

- Analysis shows increased aeroheating from localized foam loss not ET structural concern
- Orbiter tile damage within family for STS-58 and other missions with observed ET foam loss
- Program has accepted low density foam loss as no flight constraint

Mission STS-58/ET-57 Performance Summary



Agenda

• Introduction	Dennis Deel
• Mission Performance Summaries	
• ***Block 10 (ETs 61-65) Items***	***See Block 10 Agenda***
• Mission STS-60 Items	See Mission STS-60 Agenda
• Appendices - A: Minor Changes - B: KSC Processing - C: Previously addressed material	

MARTIN MARIETTA
MANNED SPACE SYSTEMS

Agenda - Block 10 (ETs 61-65) Items

• ***Overview***	***Dennis Deel***
• Changes	
- Documentation	Al Listemaa
- Requirements	Al Listemaa/Eugene Sweet/ Leed Colon
- Configuration	
- Process	Tom Conrad/Mike Javery
• Senior Management Review MARS	Diane Lowe/Al Listemaa

Overview (ETs 61-65)

STS	ET	DD250 Date	Shipped to KSC	Scheduled Launch Date	Predicted Age at Launch (months)	Current Location
60	61	10/15/91	6/17/93	1/27/94	27	KSC
62	62	1/21/92	10/1/93	3/3/94	25	KSC
59	63	4/21/92	11/11/93	4/7/94	23	KSC
63	64	7/20/92	1/5/94	5/19/94	22	MAF
65	65	11/2/92	2/24/94	7/8/94	20	MAF

Agenda - Block 10 (ETs 61-65) Items

• Overview	***Dennis Deel***
• ***Changes***	
- ***Documentation***	Al Listemaa
- Requirements	Al Listemaa/Eugene Sweet/ Leed Colon
- Configuration	Tom Conrad/Mike Javery
- Process	
• Senior Management Review MARS	Diane Lowe/Al Listemaa

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MANNED SPACE SYSTEMS

Documentation Changes*, List

Description (Change No.)	Effectivity	First Flown on ET-61
• Incorporate 7" QD (Quick Disconnect) into MMMSS drawing system (J31135)	APP	
• GO2/GH2 pressure line ICD/drawing clarification (B01936)	ET-61 & subs	X
• Implement Revision G of Pyrotechnic Specification (B01984)	ET-61 & subs	X
• Forward LH2 PAL ramp installation (B01867)	ET-61 & subs	X
• Pyro connector procurement - CFE vs GFP - B01570A - B01570B	ETs 61-63 ET-64 & subs	X
• Implement Shuttle Connector Analysis Network (SCAN) to ET Project (B01941)	ET-63 & subs	

* **Included in Appendix A, Minor Changes**

MARTIN MARIETTA
MANNED SPACE SYSTEMS

Agenda - Block 10 (ETs 61-65) Items

• Overview	Dennis Deel
• ***Changes***	
- Documentation	
- ***Requirements***	***Al Listemaa***
- Configuration	Al Listemaa/Eugene Sweet/ Leed Colon
- Process	Tom Conrad/Mike Javery
• Senior Management Review MARS	Diane Lowe/Al Listemaa

Requirements Changes - List

Description (Change No.)	Effectivity	First Flown on ET-61
• GH2 pressure line post proof inspection (B01854A)	**ET-61 & subs**	**X**
• LO2 feedline BSTRA 100% proof test (B01846)	**ET-61 & subs**	**X**
• Delete LO2 aft hardware heater tests at MAF (B01937A)	ET-64 & subs	
• Delete Tavis transducer 50 VDC isolation resistance test (B01971)	ET-65 & subs	

Bold - To be presented
Plain - Included in Appendix A, Minor Changes

MARTIN MARIETTA
MANNED SPACE SYSTEMS

GH2 Pressure Line Post Proof Inspection (B01854A)

Background/ Reason:

- Stress analysis revisions caused by IVBC-3 loads increases resulted in identification of (4) GH2 pressure line assemblies as inadequately proofed
  - Fracture Control (MMC-ET-SE-13) requires post proof x-ray inspection of highly stressed inadequately proofed welds
  - DAR 177 approved use of prior built assemblies based on pre proof x-ray

Description:

- No configuration change

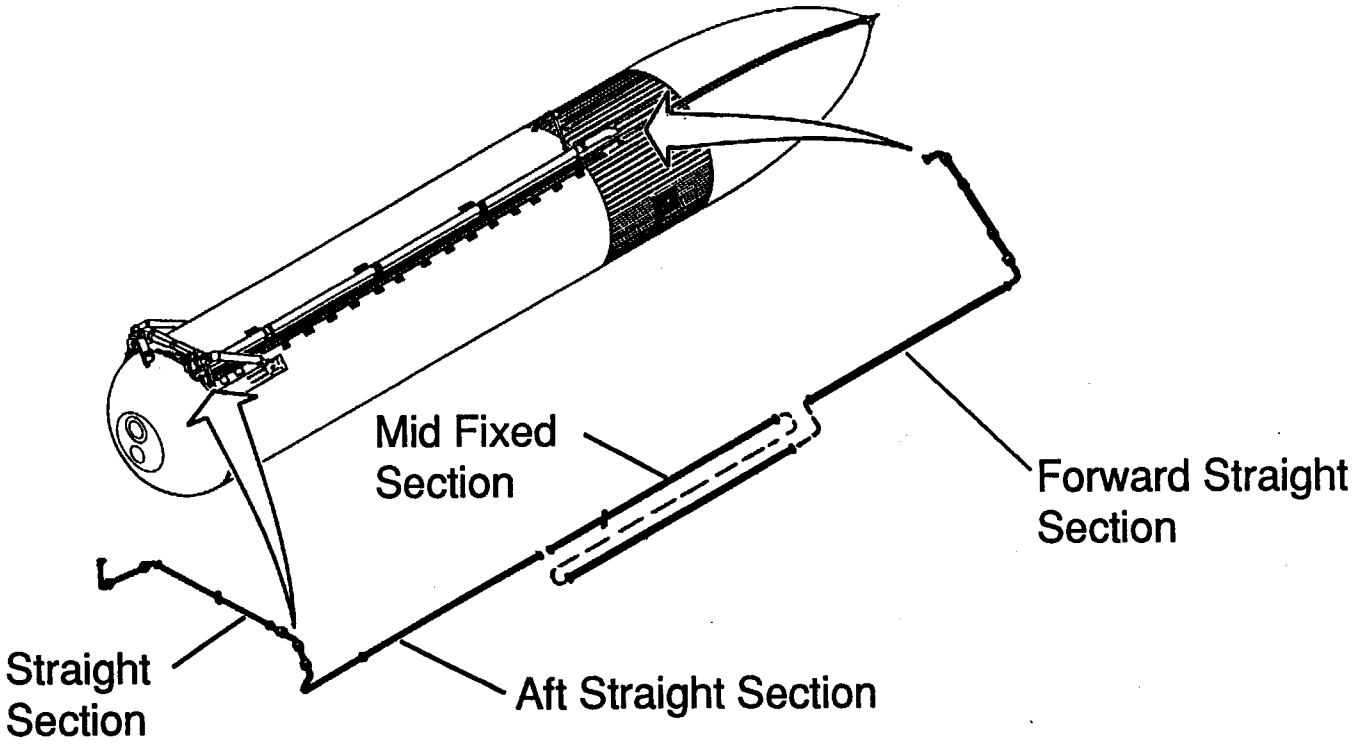
- Requirements
  - Revised PD to add requirement to perform post proof x-ray inspection on 4 GH2 pressure line assemblies
    - Not feasible to perform adequate proof test to simulate flight load conditions

- Documentation
  - Revised COQ and EIS, Part II to reflect new part numbers
  - Revised CIL to reflect new part numbers and method of qualification

Basis for Certification:

- COQ
  - Stress analysis, FS = 2.43
  - Similarity to previously flown hardware

GH2 Pressure Line Post Proof Inspection (B01854A)



LO2 Feedline BSTRA 100% Proof Test (B01846)

Background/ Reason:

- Return to flight review of weld X-rays revealed 'crack-like' indications at LO2 feedline BSTRA pad to housing fillet welds
- Loads/stress and fracture mechanics analysis confirmed indications were acceptable for flight but indicated BSTRA pad to housing welds were not receiving 100% proof acceptance test

Description:

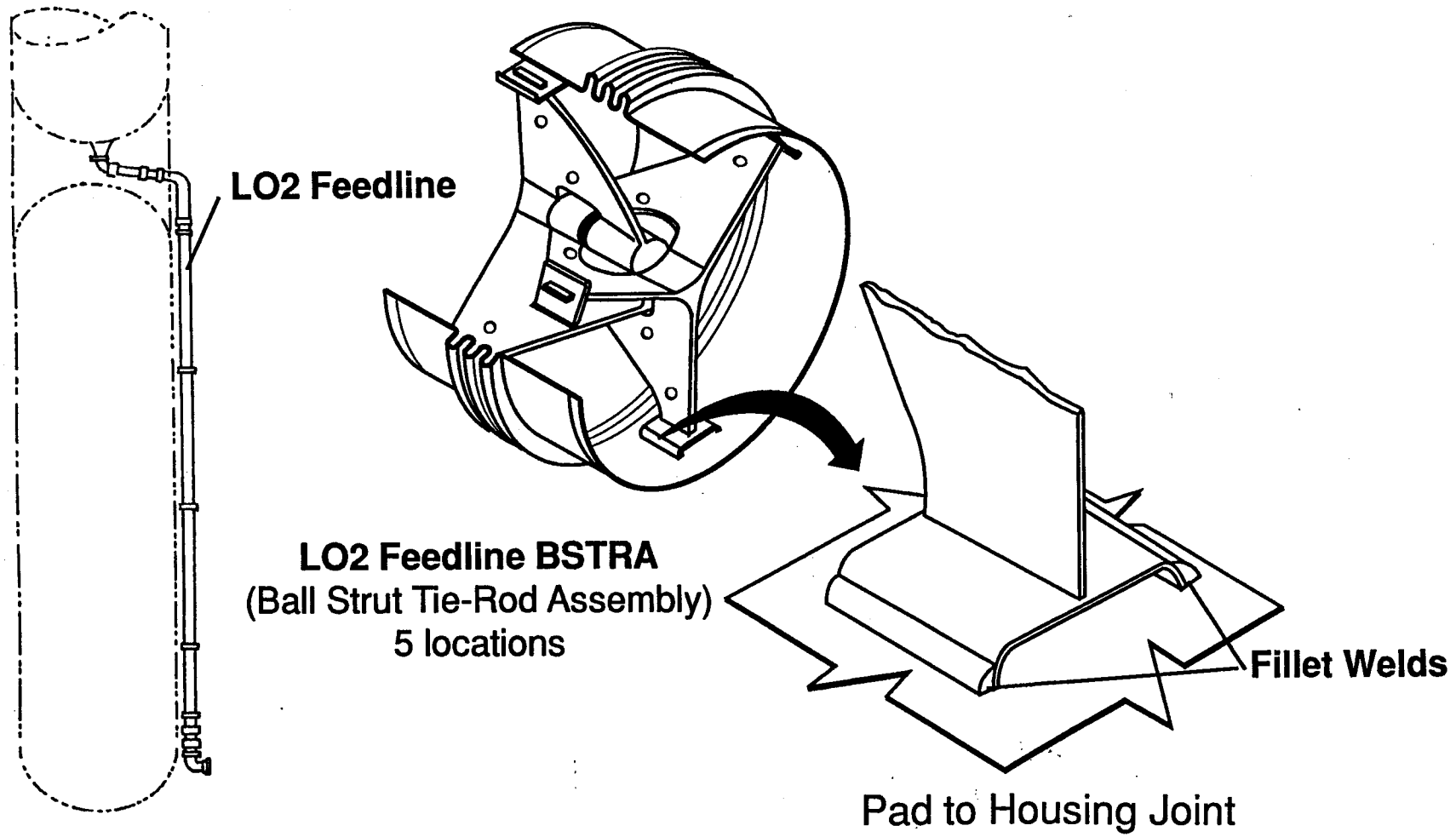
No configuration change

- Requirements
  - Revised acceptance proof test to achieve 100% proof of all BSTRA pad fillet weld
- Documentation
  - Developed workmanship standard in supplier's welding specification that allowed indications without MRB
  - Revised CIL to include test/inspection as retention rationale

Basis for Certification:

- 100% proof acceptance test of all flight articles
- Stress analysis, FS 1.58 (unchanged)

LO2 Feedline BSTRA 100% Proof Test (B01846)



MARTIN MARIETTA
MANNED SPACE SYSTEMS

Agenda - Block 10 (ETs 61-65) Items

• Overview	Dennis Deel
• ***Changes***	
- Documentation	Al Listemaa
- Requirements	***Al Listemaa/Eugene Sweet/***
- ***Configuration***	***Leed Colon***
- Process	Tom Conrad/Mike Javery
• Senior Management Review MARS	Diane Lowe/Al Listemaa

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MANNED SPACE SYSTEMS

Configuration Changes - List

Description (Change No.)	Effectivity	First Flown on ET-61
• **Structure**		
- Revise bolt grip lengths (B01777)	ET-61 & subs	X
• **System**		
- Mark/inspect ET pyrotechnic hardware (B01923)	ET-61 & subs	X
- **Tumble system deletion, Phase II (B01865M)**	**ET-65 & subs**	
- **LH2 tank RSS deletion, Phase II (B01948)**	**ET-65 & subs**	
• **TPS**		
- **Vertical strut foam application (B01650S)**	**ET-61 & subs**	**X**
- **Increase clearance for GUCP installation (B01875)**	**ET-61 & subs**	**X**

Bold - To be presented
Plain - Included in Appendix A, Minor Changes

MARTIN MARIETTA
MANNED SPACE SYSTEMS

Tumble System Deletion, Phase II (B01865M)

Background:

- Prior missions demonstrate ET rupture point and footprint can be controlled by trajectory shaping alone
- ET tumble system disabled since STS-30
- Tumble system deletion implemented in 4 phases
  - Phase I, ETs 54 thru 64 (previously presented at Block 9 FRR, 10/91)
    - Remove Nose Cone connector and pyro cartridge
  - **Phase II, ETs 65-74 (to be presented)**
  - Phase III, ETs 75-80
    - Remove tumble valve mounting provisions from forward ogive fitting
  - Phase IV, ET-81 and subs
    - Remove Intertank wiring and switch module
    - Add permanent bulkhead to cable tray fairing bracket to support level sensor mast

Tumble System Deletion, Phase II (B01865M)

Reason:

- Reliability enhancement - Eliminate 2 tumble valve leakage failure modes/items

Description:

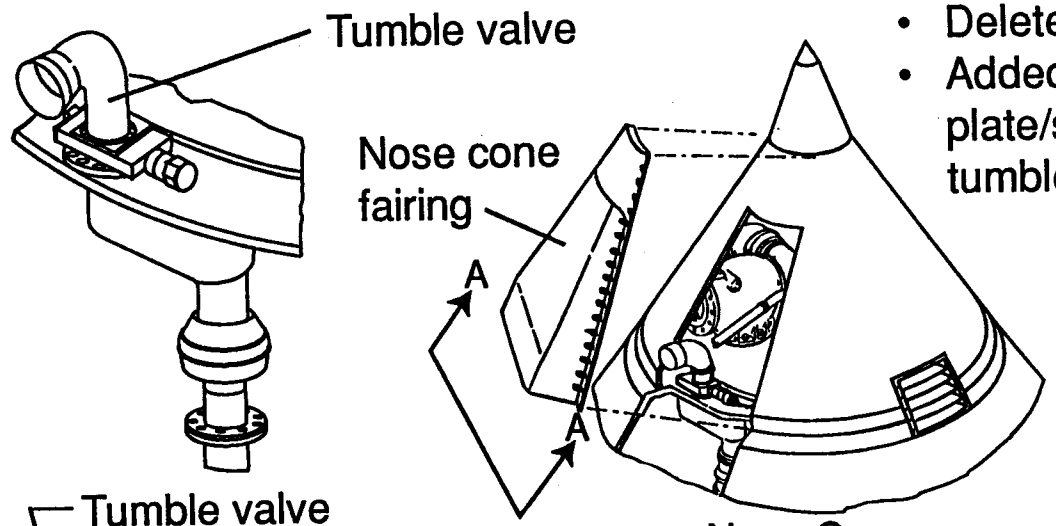
- Hardware
  - Replaced tumble valve with blank-off plate/seal
  - Added closure patch to cable tray fairing bulkhead
  - Removed associated cabling from Nose Cone to Intertank and aft umbilical disconnect to Intertank
- Documentation
  - Revised CIL to eliminate 2 critical GO2 leakage failure modes
  - Revised MAF TM04k-B to add leak check of cover plate/seal and delete electrical verification tests of tumble valve cabling

Basis for Certification:

- Tests
  - Leak check of cover plate/seal
  - Continuity
  - Insulation resistance
- Stress analysis
  - Vibration responses and loads unchanged
  - Minimum FS=1.53, unchanged

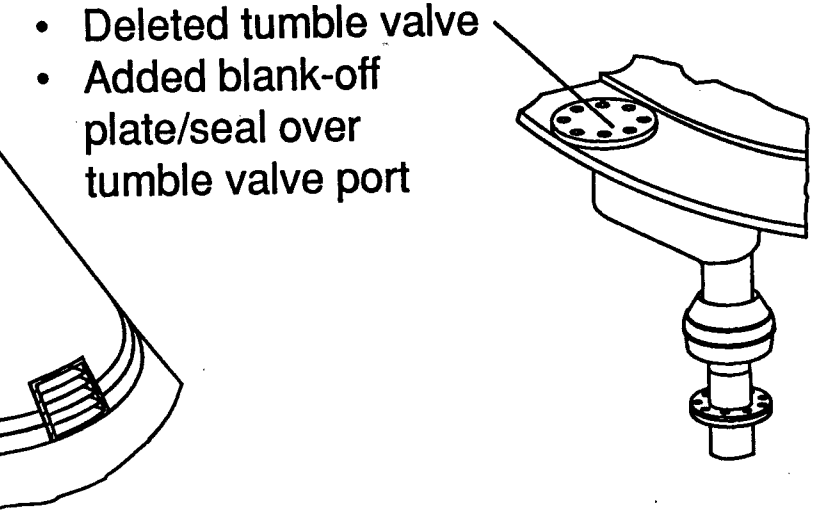
Tumble System Deletion, Phase II (B01865M)

ETs 54-64



ET-65 and subs

- Deleted tumble valve
- Added blank-off plate/seal over tumble valve port



Vent areas

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MANNED SPACE SYSTEMS

LH2 Tank RSS Deletion, Phase II (B01948/B)

Background/ Reason:

- Extensive Level II studies indicated that ET LH2 tank ordnance could be deleted
  - During first stage flight, destruct action of the SRM will assure destruction of the LH2 tank
  - During second stage, after SRB separation and destruct action of the LO2 tank , subsequent aerodynamic loading will destroy the LH2 tank
- ET LH2 tank RSS disabled since STS-50 (ETs 45, 48-51, 54 and up)
- LH2 tank RSS deletion implemented in 2 phases
  - Phase I, ETs 45, 48-51 and 54-64 (presented at STS-50/ET-50 FRR, 5/92)
    - Deleted Linear Shaped Charge from LH2 tank
    - Replaced LH2 tank cable tray rubber dam
    - Installed (2) brackets to support CDF connectors
  - **Phase II, ET-65 and subs** (to be presented)

LH2 Tank RSS Deletion, Phase II (B01948/B)

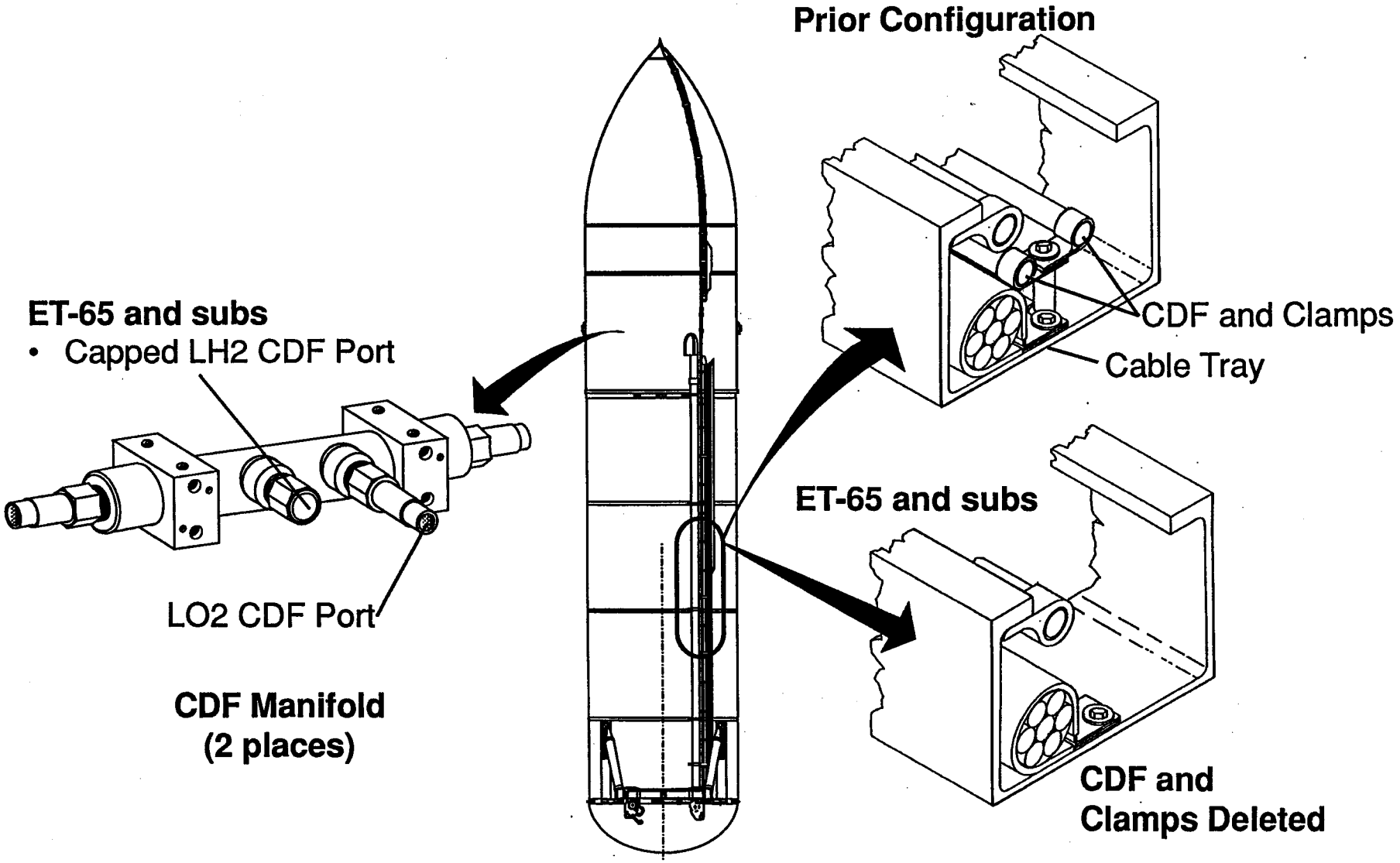
Description:

- Hardware
  - Installed new GFP CDF manifold with permanently capped LH2 port (2 places)
  - LH2 CDF deleted from cable tray to CDF manifold and from Intertank to CDF manifold
  - Cable tray cover and gap closures now installed at MAF
- Documentation
  - Revised CIL to reflect updated cable tray cover/gap closure part numbers and relocated cable tray inspection rationale from KSC to MAF

Basis for Certification:

- Structural analysis
  - Updated vibration responses and loads unchanged
  - Minimum FS = 2.11, unchanged
- Inspection
  - Verify CDF with capped port installed
  - Verify cable tray and gap closures installed at MAF

ET LH2 Tank RSS Deletion, Phase II (B01948/B)



MARTIN MARIETTA
MANNED SPACE SYSTEMS

Vertical Strut Foam Application (B01650S)

Background/ Reason:

- Productivity enhancement/cost savings - Eliminate redundant/time consuming 2 step foam applications at detail level

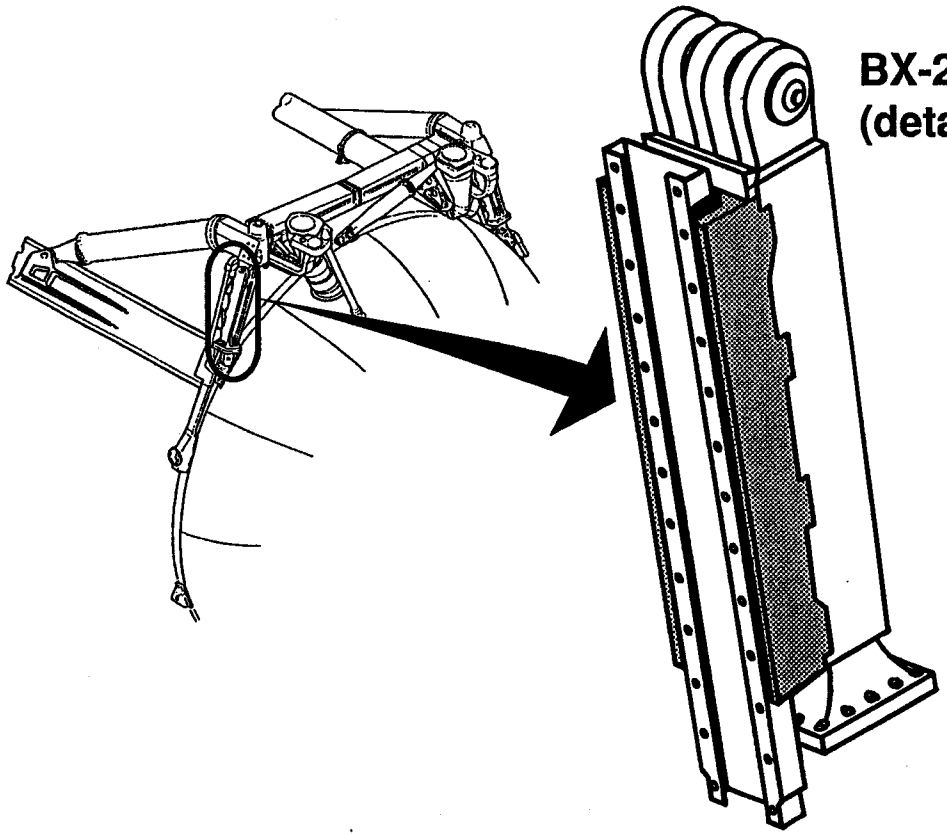
Description:

- Hardware
  - Delete foam application to vertical strut cable tray at detail level
  - Delete intricate foam machining of vertical strut forward face
  - Apply foam to cable tray and cavity
- Documentation
  - Revised CIL, HCS and EIS, Part II to update TPS part numbers

Basis for Certification:

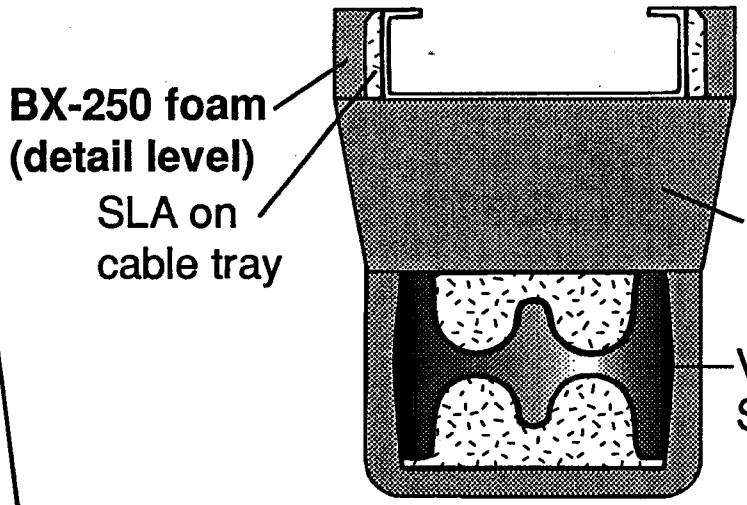
- Stress analysis, FS=1.95 (unchanged)
- Similarity to BX-250 foam detail parts

Vertical Strut Foam Application (B01650S)

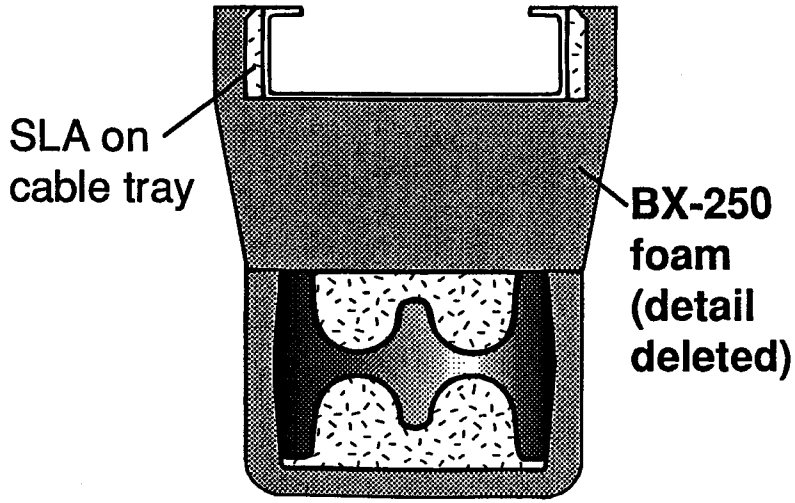


Vertical Strut/
Cable Tray

Prior Configuration



ET-61 and subs



Increase Clearance for GUCP Installation (B01875)

Background:

- Minor TPS defects occur during Ground Umbilical Carrier Plate (GUCP) installation at KSC
  - Defects require rework/repair

Reason:

- Enhance processing at KSC by reducing PRs and rework

Description:

- Hardware
  - Enlarge existing TPS trim to eliminate potential foam damage during installation of GUCP
- Documentation
  - Revised CIL and Hardware Certification Sheet (HCS) to update TPS part numbers

Basis for Certification:

- Thermal Analysis
  - Low heating area/heavy structure
  - Thermal protection maintained
    - Factor of Safety
      - Was: 3.38
      - Now: 3.11

Configuration Changes - List

Description (Change No.)	Effectivity	First Flown on ET-61
• **Electrical**		
- Change LO2 internal harness sleeving (J31097)	ET-61 & subs	X
- Larger diameter clamp insert for LO2 internal harness (B01927)	ET-61 & subs	X
- **LO2 and LH2 ullage temperature sensors (B01850)**	**ET-61 & subs**	**X**
- **Delete LH2 feedline support bracket heaters (B01650N)**	**ET-61 & subs**	**X**
- **Tavis LO2 ullage pressure transducers (B01773A)**	**ET-64 & subs**	
- **Electrical monoball rotation markings (B01884A)**	**ET-65 & subs**	

Bold - To be presented
Plain - Included in Appendix A, Minor Changes

LO2 and LH2 Ullage Temperature Sensors (B01850)

Background/ Reason:

- Hy-Cal (original supplier) of LO2 and LH2 ullage temperature sensors no longer supplies hardware
  - Rosemount selected as new supplier for Nose Cone and Intertank purge temperature sensors (presented at STS-53/ ET-49 FRR, 10/92) and LO2/LH2 ullage temperature sensors
  - Sensors used for evaluation of ullage thermal dynamics
    - Not critical

Description:

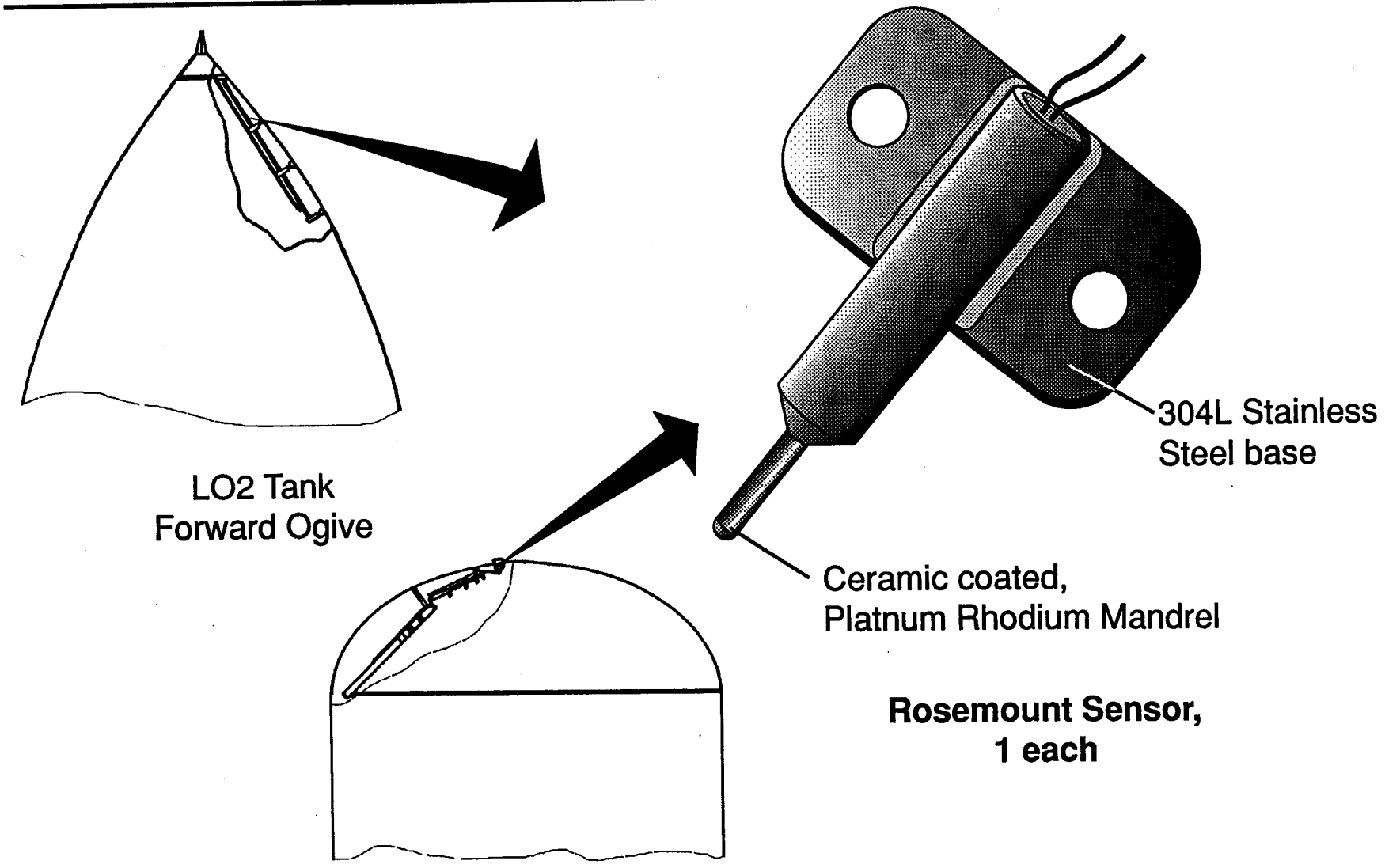
- Hardware

- Implement Rosemount ullage temperature sensors
  - Parts are physically/functionally interchangeable with Hy-Cal
  - Installation unchanged
  - Rosemount sensor probe less susceptible to damage due to stronger Platinum-Rhodium mandrel

Basis for Certification:

- Tests
  - Qualification
    - Thermal
    - Acoustics
    - Vibration
  - Acceptance
    - Random vibration
    - Insulation resistance
    - Functional calibration
- Similar sensors flown in Nose Cone and Intertank locations on ETs 49, 51, 54 and subs
  - No flight issues

LO2 and LH2 Ullage Temperature Sensors (B01850)



Rosemount Sensor,
1 each

Delete Aft LH2 Feedline Bracket Heaters (B01650N)

Background/ Reason:

- Productivity enhancement
  - Initial design required heaters on aft LH2 feedline suppport brackets to prevent ice formation
  - Subsequent thermal analysis indicated that ice would not form on brackets
    - Confirmed by thermal data from 25 shuttle flights and MPTA
  - Aft LH2 feedline bracket heaters not activated since STS-34

Description:

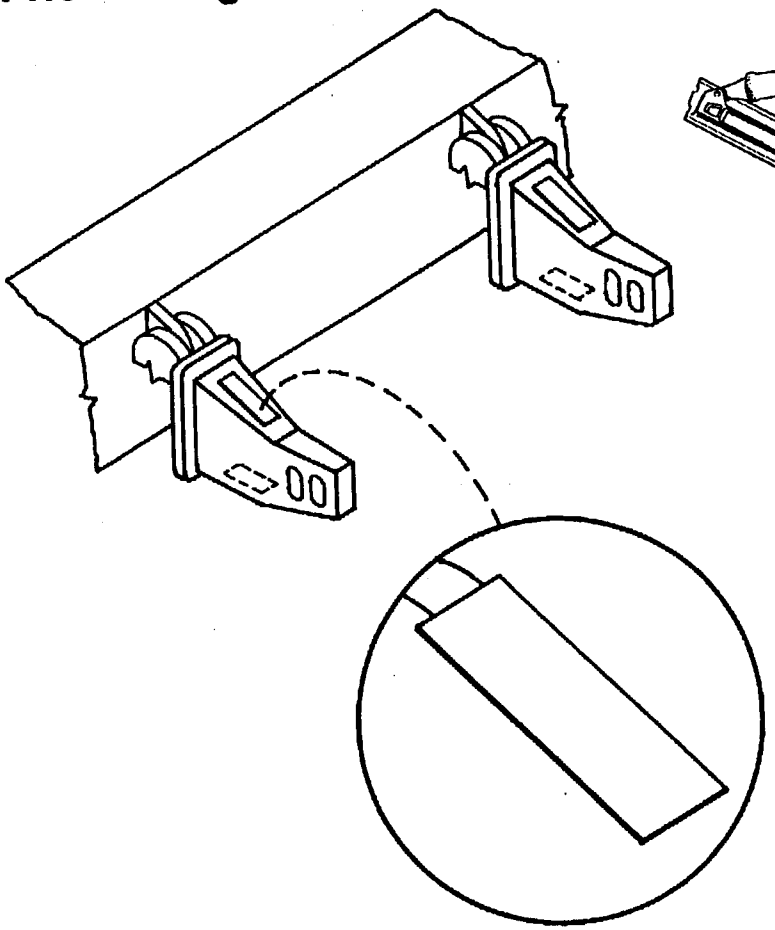
- Hardware
  - Deleted bonded strip heaters (4) on LH2 aft feedline support brackets and associated cabling from umbilical to heaters
  - Revised crossbeam TPS applications reflecting heater deletions
- Documentation
  - Revised ICD to delete connector interface requirements
  - Revised MAF TMO4k-B, OMRSD Files IV and II to delete checkout requirements
  - Revised Hazard Analysis Report to reflect heater deletion
  - Revised CIL to update TPS part numbers

Basis for Certification:

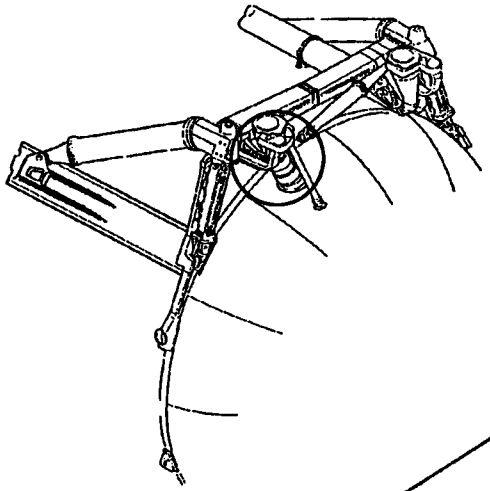
- Thermal analysis - Confirmed by flight data

Delete Aft LH2 Feedline Bracket Heaters (B01650N)

Prior Configuration

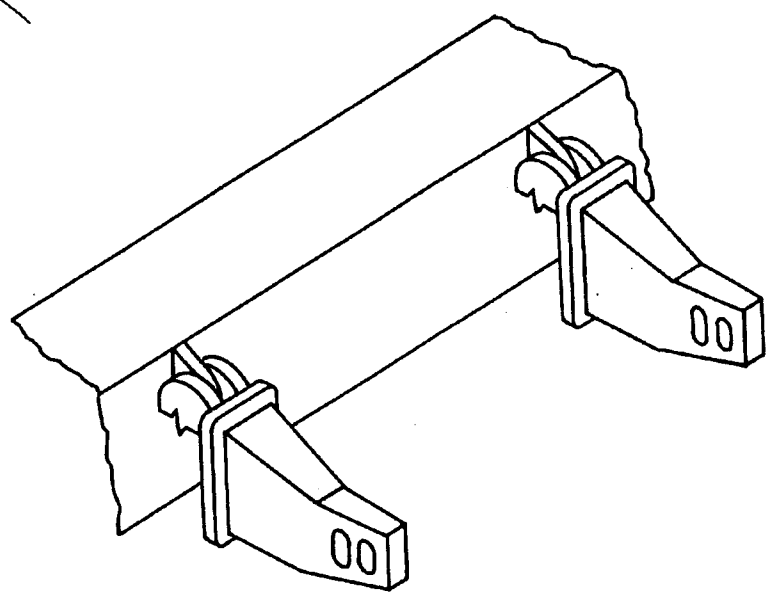


Film Strip Heater, 2 each bracket



ET-61 and subs

- Deleted aft LH2 feedline bracket heaters



Tavis LO2 Ullage Pressure Transducers (B01773A)

Background:

- Gulton (pot type) transducers may be susceptible to response delay (stiction) and vibroacoustics (dropouts and shorted windings)
- Gulton transducers flight rationale
  - Predictable failure modes
  - Redundancy and spare switch in capability
  - No history of impact to flight performance

Reason:

- Reliability - Eliminate/reduces potential problems associated with pot type transducers

Description:

- Hardware
  - Replace crit 3 Gulton pot type LO2 ullage pressure transducer with Tavis electronic type
    - Revise mounting bracketry
    - Replace splices with cable connector
  - Implementation
    - ETs 64-67: 4 transducers
      - 3 operational
      - 1 spare
    - ET-67 and subs: 3 transducers
      - 3 operational
      - 1 mass simulator

Tavis LO2 Ullage Pressure Transducers (B01773A)

- Documentation
  - New COQ to document qualification of unit and installation
  - Revised ICD to reflect non-functional mass simulator
  - Revised Hazard Analysis Report to reflect effectivity of Tavis transducers
  - Revised EIS to reflect qualification of new hardware
  - Revised CIL to reflect TPS application differences
  - Revised MAF TMO4k-B, OMRSD Files IV and II to specify new checkout requirements

Basis for Certification:

- Tests
  - Qualification
    - Functional
    - EMI
    - Thermal
    - Acoustics
    - Sine and random vibration
  - Acceptance
    - Random vibration
    - Functional calibration across temperature range
- No impact to other Shuttle elements
- Input/output electrical characteristics compatible with Gulton transducers

Tavis LO2 Ullage Pressure Transducers (B01773A)

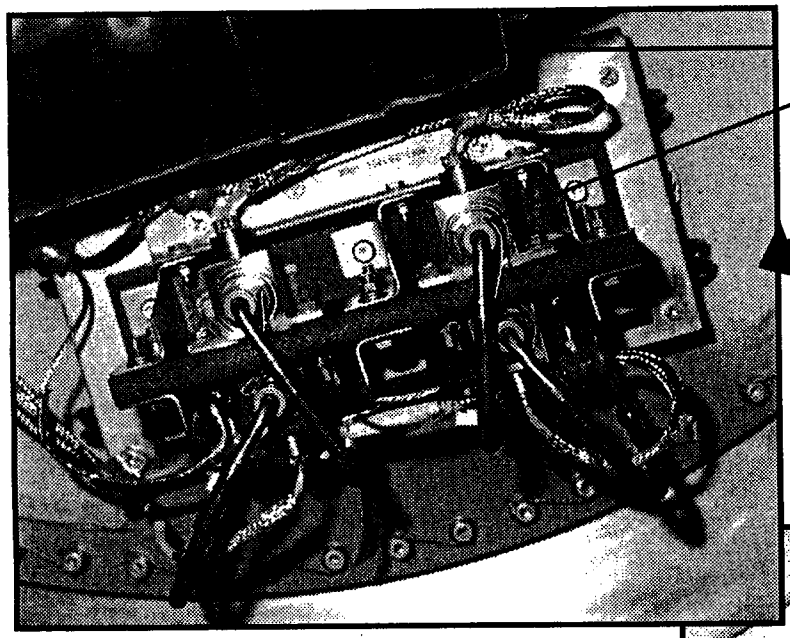
Issues:

- Failure of ET-65 acceptance test at MAF isolated to failed Tavis ullage pressure transducer (CAPS E-152)
  - Failure analysis identified moisture in transistor
- 21 LO2 transducers installed (ETs 64-69)
  - Vendor acceptance vs MAF acceptance show all within specification
- Not used on LH2 tank
- Test of 82 uninstalled transducers and 19 individual transistors showed no lot related problems
- Isolated occurrence - Moisture not generic
- No impact to qualification
  - Design specification, MAF and KSC test tolerances sufficient to assure performance
- 2 failures during retest
  - 1 LO2, unsoldered terminal
  - 1 LH2, failure analysis in progress
- 13 (10 LO2/3 LH2) transducers exhibited minor drift

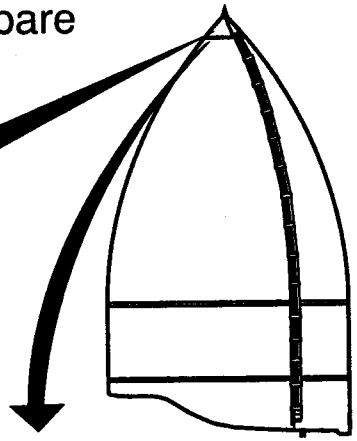
Actions in progress:

- Verify design specification long term stability determination
  - 10 LH2 transducers
    - Baseline tests complete, 9/15/93
    - Tests 12/15/93 and 3/15/94 (prior to first flight, ET-64)
    - Test at 180 intervals, 6/15/93 to 12/15/96
- No impact to ETs 64 and 65 flight usage

Tavis LO2 Ullage Pressure Transducers (B01773A)



Spare



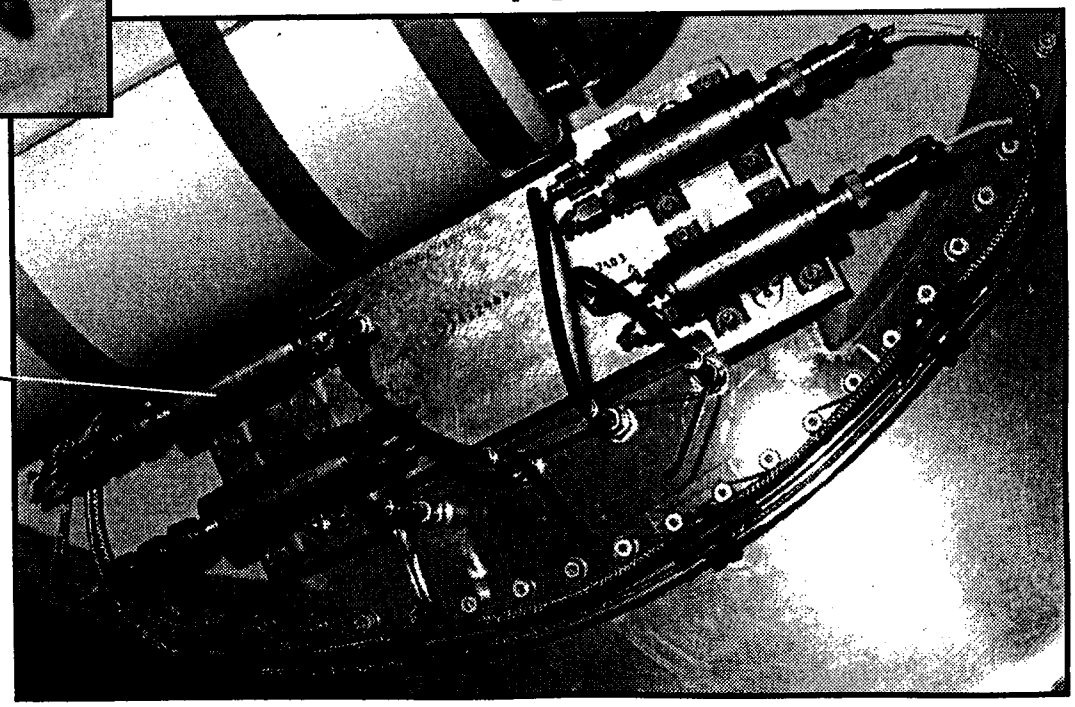
ET-64 and subs

- Tavis Pressure Transducers

Prior configuration

- Gulton Pressure Transducers

- Spare (ETs 64-66)
- Mass simulator (ET-67 and subs)



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Electrical Monoball Rotation Markings (B01884A)

Background:

- LO2 electrical monoball inadvertently rotated 45° from nominal position during ET-31 Orbiter mate
  - Resulted in investigation of stresses applied to cables in LO2 and LH2 electrical monoballs
    - Analysis of as-built hardware showed 10 of 11 connectors had sufficient length so that no load was applied to any contact crimp joint
    - Single connector that did not show adequate length was rotated to +45° and performed electrical continuity test
      - No anomalies

Reason:

- Productivity enhancement - Control rotation of LO2 and LH2 electrical monoballs and prevent unnecessary stresses on cables

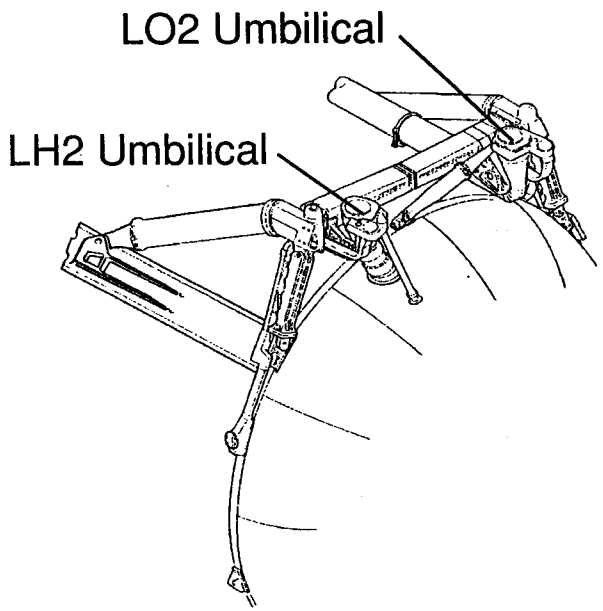
Description:

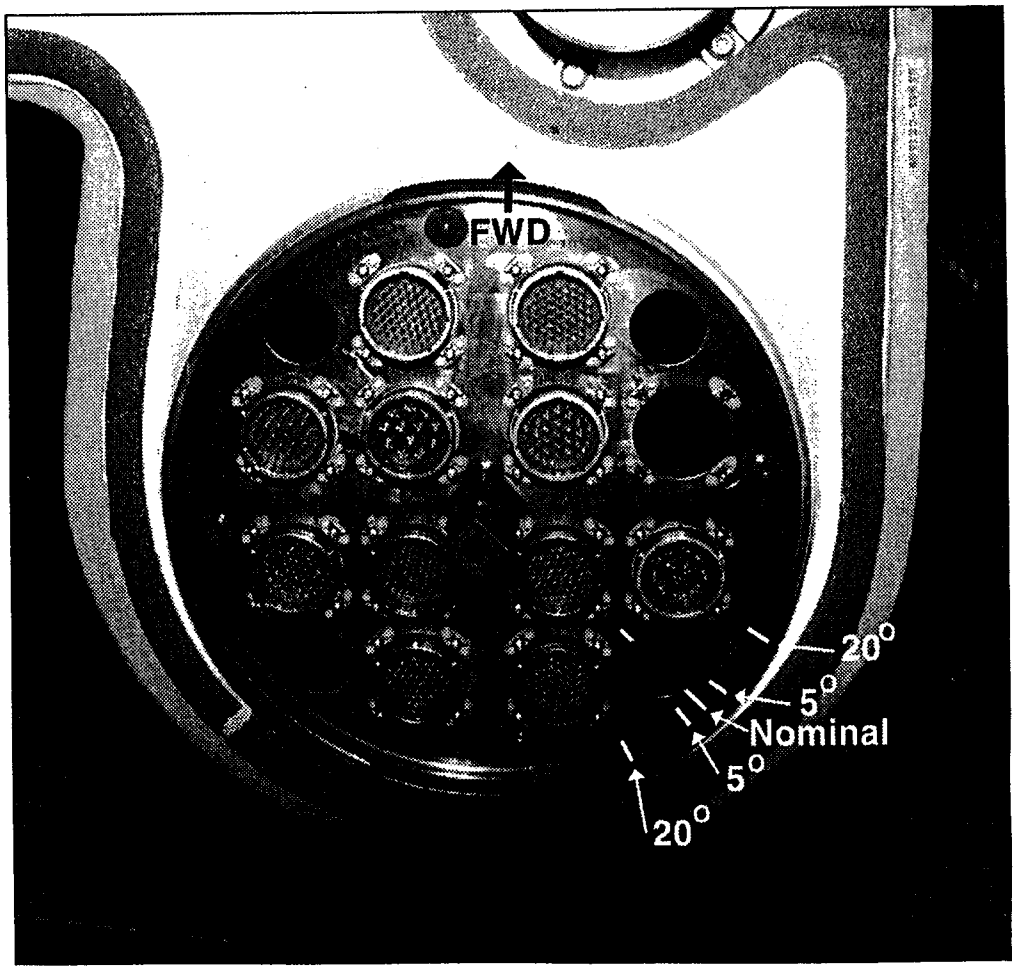
- Hardware
  - Add angular reference markings to monoballs
    - Nominal, ±5° and ±20°
  - Verify cable slack for ±20° rotation
- Documentation
  - Revised OMRSD Files IV and II to incorporate use of markings to verify monoball position

Basis for Certification:

- Design analysis demonstrates harness slack capability at ±20° rotation
- Visual inspection - Harness slack is verified at ± 20° rotation

Electrical Monoball Rotation Markings (B01884A)





Electrical Monoball
(LO2 Shown)

Agenda - Block 10 (ETs 61-65) Items

• Overview	Dennis Deel
• ***Changes***	
- Documentation	Al Listemaa
- Requirements	Al Listemaa/Eugene Sweet/ Leed Colon
- Configuration	
- ***Process***	***Tom Conrad/Mike Javery***
• Senior Management Review MARS	Diane Lowe/Al Listemaa

Process Changes - List

Description (Change No.)	Effectivity	First Flown on ET-61
• **Process**		
- Implement VPPA welding on H-2 weld (B01650U)	ET-61 & subs	X
- **Enhance aft crossbeam producibility (B01819)**	**ET-61 & subs**	**X**
- **LO2 tank/Intertank ice/frost ramp SOFI closeouts (B01787/J30884)**	**ET-62 & subs**	
- **Intertank/LH2 tank flange closeout process certification**	**ET-63 & subs**	

Bold - Presentation Item
Plain - Appendix A, Minor Change

Enhance Aft Crossbeam Producibility (B01819)

Background:
- Crossbeam assembly sequence specified machining of fittings prior to and after weld to crossbeam
  - Caused twist and misalignment during crossbeam assembly which resulted in problems at aft interface hardware installation

Reason:
- Productivity enhancement - Reduce MARS/rework activity

Description:

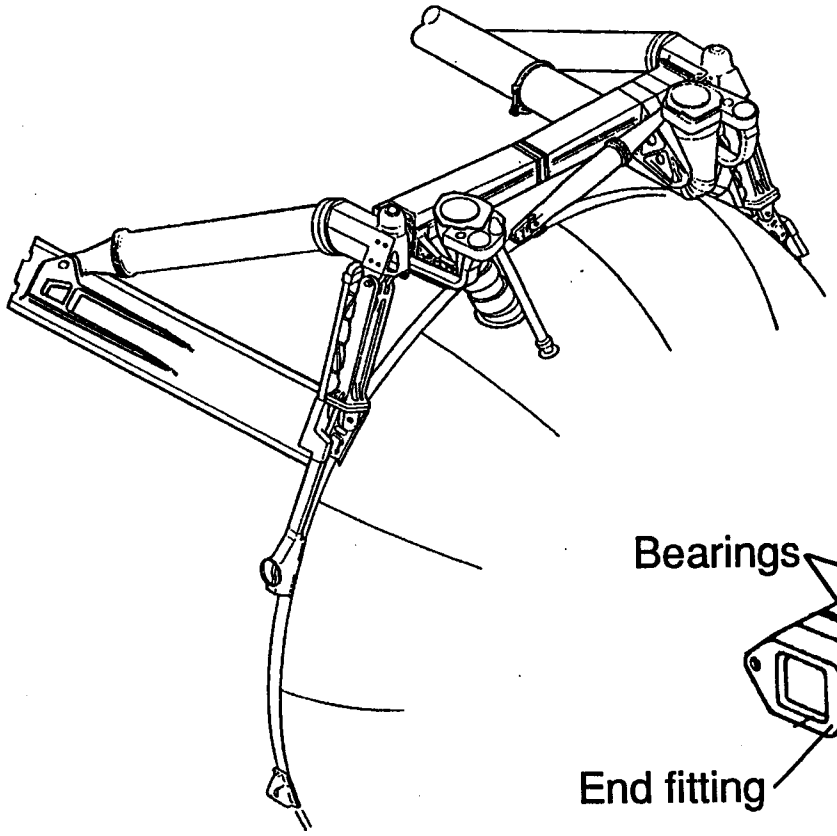
- Hardware
  - Increased material thickness of crossbeam end/support fittings
  - Reversed bearing installation
  - Machined fittings to crossbeam assembly after final weld
- Manufacturing
  - Added new aft crossbeam machining fixture
  - Developed numerically controlled machining process

Basis for Certification:
- Verification of numerically controlled programs
- System validation with pathfinder test article
- Validation of production parts program (ETs 61-64)
- Final thickness of fittings unaffected
  - Minimum FS = 2.17, unchanged

Enhance Aft Crossbeam Producibility (B01819)

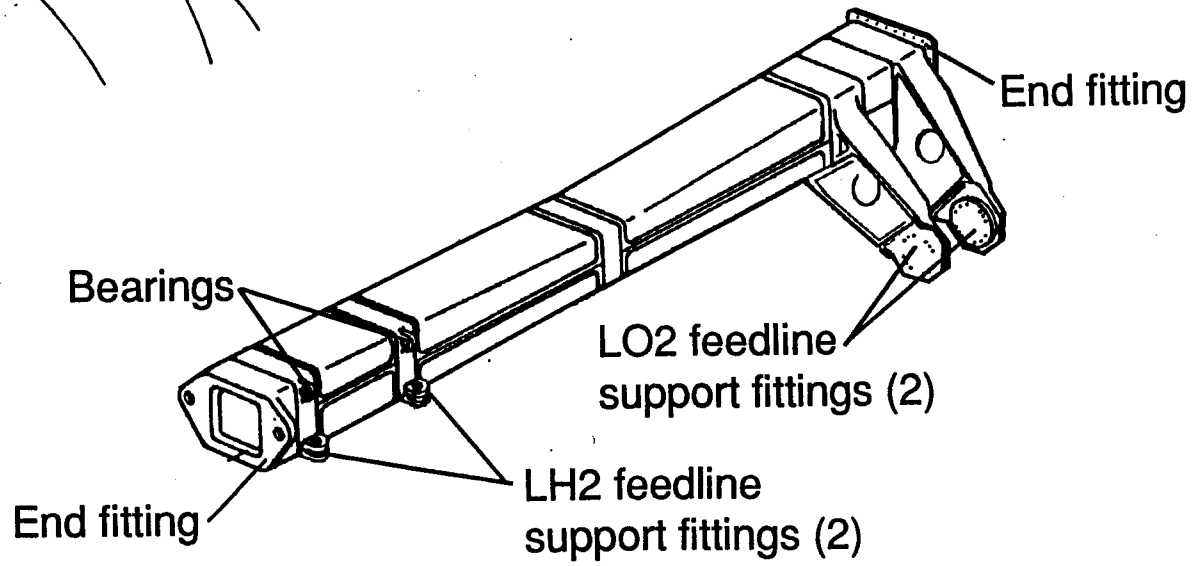
Prior Configuration

- Machined critical interface areas prior to assembly weld



ET-61 and subs

- Increased material thickness
  - End fittings
  - LO2 and LH2 feedline support fittings (2 each)
- Reversed bearing installation
- Machined fittings/crossbeam assembly after final weld



RIM Pour Process on SOFI Closeouts (B01787/J30884)

Background/ Reason:

- Productivity - Implement RIM (Reaction Injection Molding) process for LO2/Intertank ice/frost ramp SOFI closeouts

Description:

- Added automatic SOFI (PDL) pour process in Cells G and H
  - Replaced hand weigh/hand mix/hand pour process with automatic injection delivery system
  - Implement new pour mold units

- Documentation
  - RIM process included in Return to Flight Baseline CIL

Basis for Certification:

- System validation with pathfinder test articles
- Validation of STP 1525
  - Applications to mock-ups with production molds and procedures
  - Dissection examination for voids
  - Mechanical property and adhesion tests
- Formal ORI (Operational Readiness Inspection)
- Test verification of all software programs
- Development test program at MSFC
  - Mechanical properties and adhesion
  - Wind tunnel ablation tests
- Final product acceptance
  - Density
  - Hardness/softness
  - Finish surface criteria
  - Drawing configuration

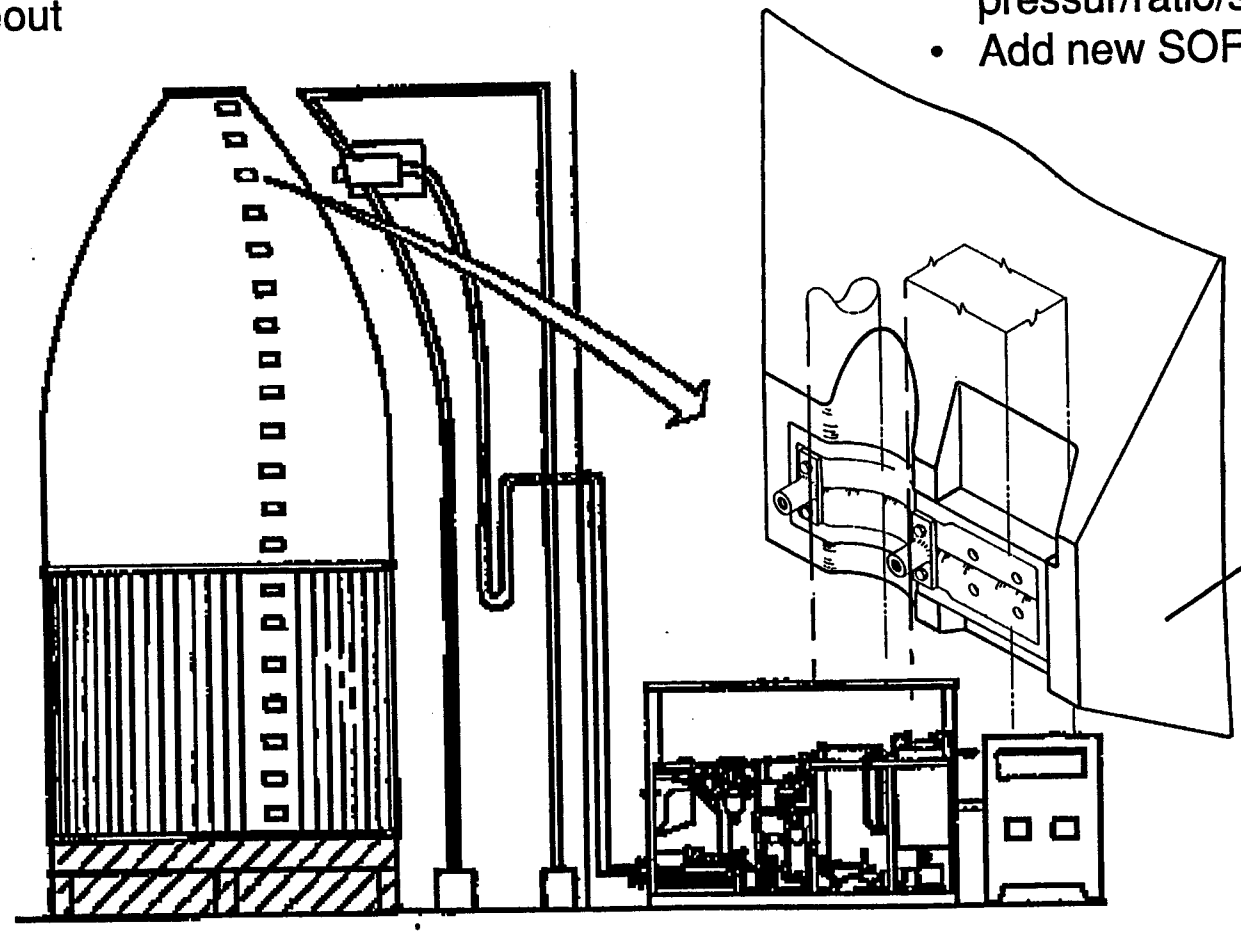
RIM Pour Process on Ice/Frost Ramps (B01787/J30884)

Prior Configuration

- Manual hand mix/hand pour application for PDL SOFI closeout

ET-62 and subs

- Add automatic SOFI injection delivery system (temperature/ pressur/ratio/shot size)
- Add new SOFI pour molds



Ice/Frost Ramp

Intertank to LH2 Tank Flange Foam Closeout

Background/ Reason:

- Post flight photo review of STS-35/ET-35 revealed TPS (BX-250 foam) divot on the Intertank to LH2 tank flange closeout
  - Closeout is difficult manual two-step operation with foam sprayed into narrow/deep cavity and around the LH2 tank/Intertank attach bolts
  - Investigation revealed voids can form at cavity and attach bolt locations
  - Voids could cryopump or fill with liquid nitrogen from Intertank crotch during loading
  - During ascent flange area warms and cryo liquid gassifies
    - Pressure increase causes divots

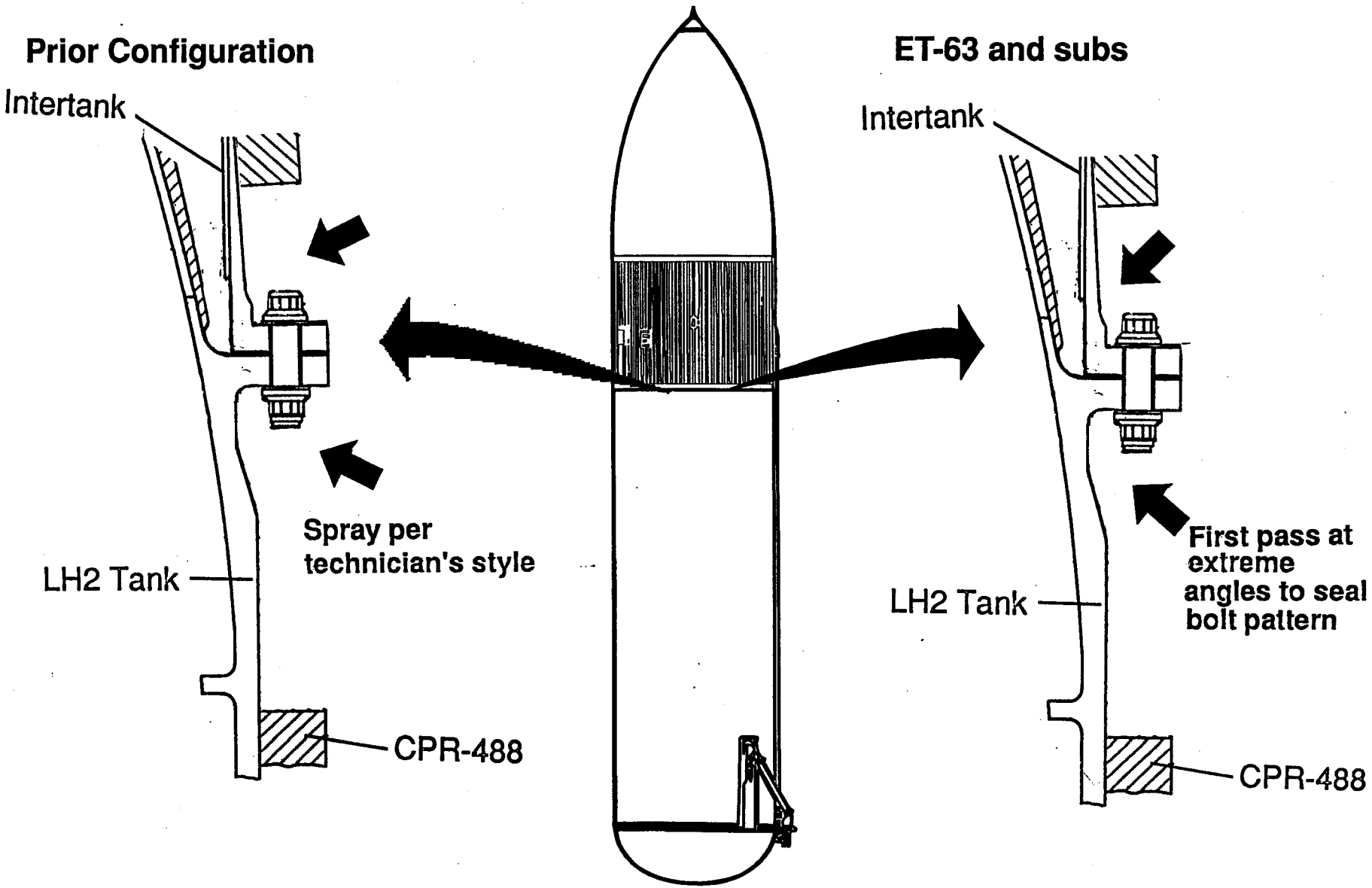
Description:

- Revise Intertank to LH2 tank flange foam application
  - Was
    - Technicians applied foam mainly to the face of the attach surface assuming foam would expand and fill these locations
  - Now
    - Foam applied at steep initial angle to ensure proper foam wetting and penetration behind the attach hardware to seal bolt pattern
    - Emphasis made to seal the hardware prior to thickness build-up

Basis for Certification:

- Certification for specific closeout required
- Ability demonstrated on Intertank to LH2 tank flange mock-up

Intertank to LH2 Tank Flange Foam Closeout



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Agenda - Block 10 (ETs 61-65) Items

• Overview	D. Deel
• Changes	
- Documentation	Al Listemaa
- Requirements	Al Listemaa
- Configuration	Al Listemaa/Eugene Sweet/ Leed Colon
- Process	Tom Conrad/Mike Javery
• ***Senior Management Review MARS***	***Diane Lowe/Al Listemaa***

Senior Management Review MARS - List

Description (MARS No.)	Effectivity
• Weld defects	
- 0.055" lack of fusion in GO2 pressure line BSTRA (T107194)	ET-61
- 0.075" and 0.050" lack of fusion in GO2 pressure line BSTRA (T117502)	ET-62
- 0.065" lack of fusion in LO2 feedline BSTRA (T114793)	ET-65
- 0.300" cluster cracks in LH2 internal feedline (T118120)	ET-65
• LO2/LH2 panels not etched (T123652)	ET-61 thru 74
• Out of family LH2 feedline usage (T119128)	ET-61
• GH2 pressure line bellows ply separation (T124401)	ET-65

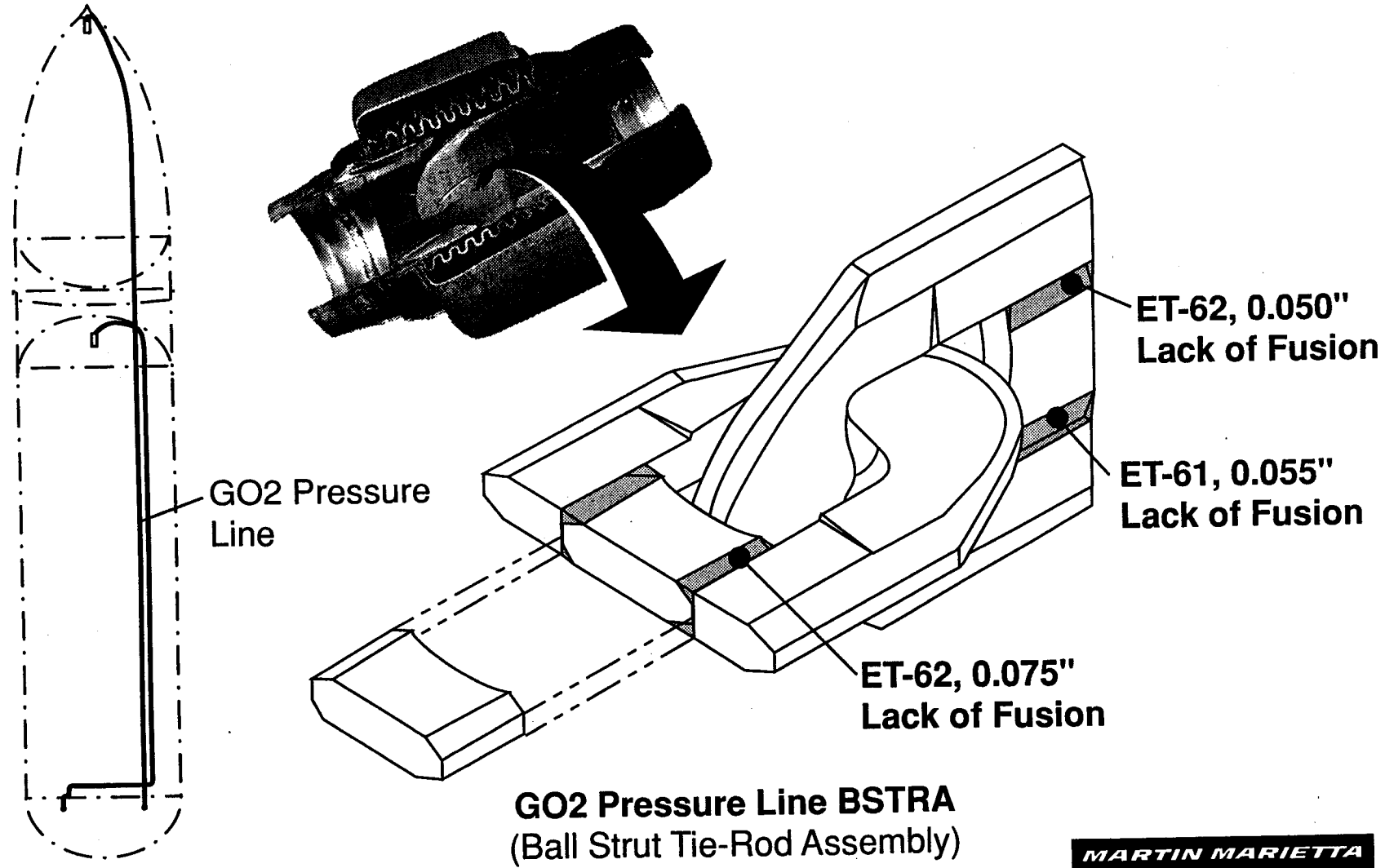
SMR - GO2 Pressure Line BSTRA Weld Defects

Dispositioned use as is

Description (MARS No.)	Material	Basis for Certification: Missions to Burst based on fracture mechanics analysis	Basis for Certification: FS
• ET-61, 0.055" lack of fusion in GO2 pressure line BSTRA (T107194)	21-6-9/Inconel 718	Infinite	5.7
• ET-62, Lack of fusion (2) in GO2 pressure line BSTRA (T117502)	21-6-9/Inconel 718		
- 0.075"		Infinite	5.7
- 0.050"		infinite	5.7

SMR, GO2 Pressure Line BSTRA Weld Defects

ET-61, T107194/ET-62, T117502



GO2 Pressure Line BSTRA
(Ball Strut Tie-Rod Assembly)

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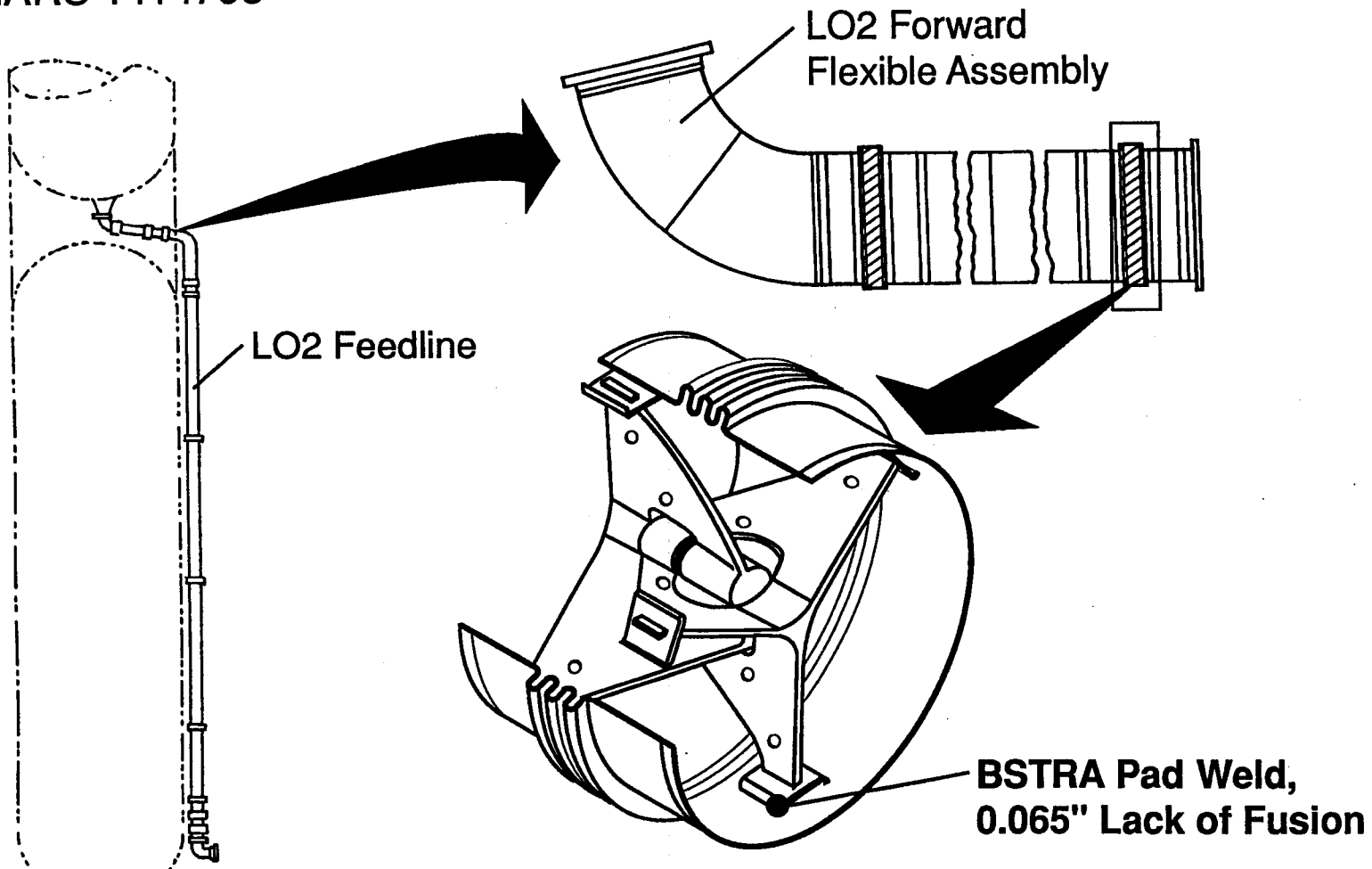
SMR - Feedline Weld Defects

Dispositioned use as is

Description (MARS No.)	Material	Basis for Certification: Missions to Burst based on fracture mechanics analysis	Basis for Certification: FS
• ET-65			
- 0.065" lack of fusion in LO2 feedline BSTRA (T114793)	21-6-9/Inconel 718	Infinite	12.7
- 0.300" cluster of cracks in LH2 internal feedline (T118120)	2219-T62	Infinite	27.1

ET-65 SMR, LO2 Feedline BSTRA Weld Defect

MARS T114793



LO2 Feedline BSTRA
(Ball Strut Tie-Rod Assembly)

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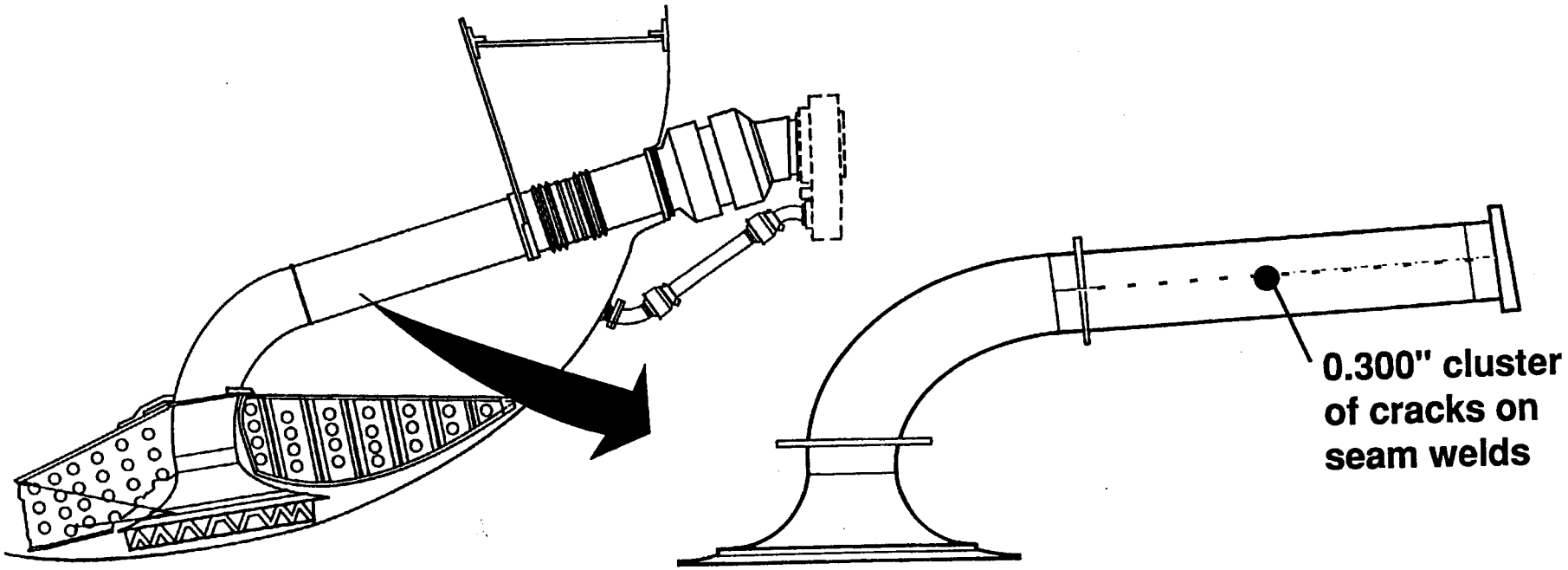
ET-65 SMR, LH2 Internal Feedline Weld Defect

T118120



LH2 Aft Dome

LH2 Internal Feedline

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ETs 61-74 SMR, LO2/LH2 Panels Not Etched

T123652

Issue:

- LO2 and LH2 ogive and dome gore panels were mechanically sanded and did not receive etch prior to penetrant inspection
  - 24 part numbers/449 serialized panels affected

Background:

- ETs 1-43 (1975 - 1985)
  - All 24 part numbers received etch and penetrant inspection
- ET-44 and subs (1985)
  - Deleted etch and penetrant inspection requirements on 15 of 24 adequately proof tested part numbers
  - Maintained both etch and penetrant inspection requirements on 9 part numbers
- ETs 44-60 (1985-1988)
  - Aerochem etched all 24 part numbers although only 9 were required
- ETs 61-74 (1988-1992)
  - Aerochem deleted etch on all 24 part numbers
  - AHF continued penetrant inspection on 9 part numbers without etch

Cause:

- Incorrect planning approved at Aerochem, AHF and Martin Marietta

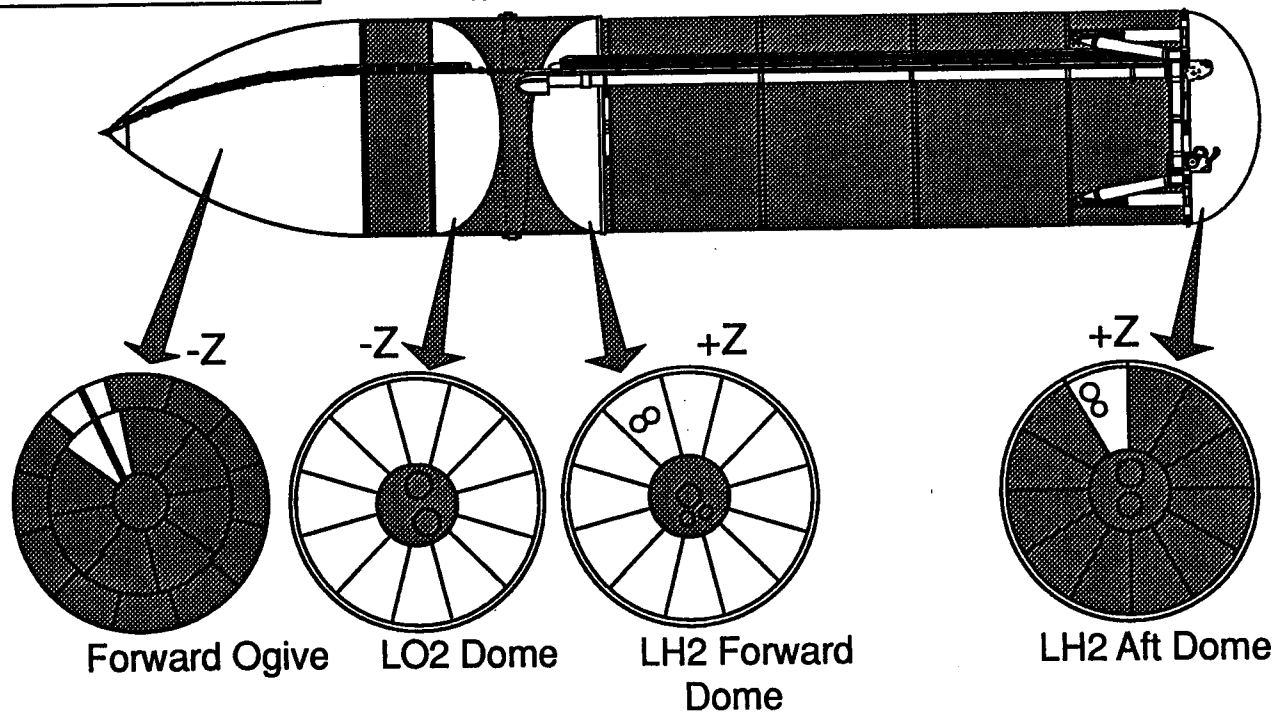
ETs 61-74 SMR, LO2/LH2 Panels Not Etched

T123652

AHF
- Ultrasonically inspect (at mill)
- Stretch form
- Age

Aerochem
- Chem Mill
- Sand/blend
- **Etch (deleted from planning in error)**

AHF
- Drill tooling holes
- Penetrant inspect



☐ Not etched prior to penetrant ▒ Not affected

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ETs 61-74 SMR, LO2/LH2 Panels Not Etched

T123652

Rationale for Flight:

- All parts were ultrasonically inspected before forming
- Large flaw would cause failure during forming
- Review of complete history showed no penetrant rejections for more than 2500 panels
- Penetrant inspection should detect large flaw without prior etch
- No proof test failures of panels
- Existing stress analysis shows:
  - 4 of 9 affected part numbers are adequately proof tested
  - All inadequately proof tested areas are leak-before-burst
- Critical flaw size in flight is > 1.4"

Disposition:

- Use as is

ET-61 SMR, Out of Family LH2 Feedline Usage

T119128

Issue:

- Unique occurrence of line being removed from ET-37 during hydrogen umbilical leak investigation
  - Subjected to multiple cryogenic tests

Background:

- MAF
  - Flange lapped
  - LH2 feedline installed on ET-37
- KSC
  - 3 tanking tests performed (max pressure = 33.5 psi)
  - Removed with disconnect intact and sent to MSFC to support leak investigation test
- MSFC
  - Flange lapped
  - 19 test runs performed
    - 14 partial fill runs (max pressure = 68 psi) with one over pressure spike of 129 psi)
    - 1 chill - slow fill run (max pressure = 34 psi)
    - 2 cold shock runs (max pressure = 58 psi)
    - 1 cold shock runs followed by partial fill (max pressure = 30 psi)
    - 1 slow fill runs (max pressure = 61 psi)
  - Flange lapped
- MAF
  - TPS removed

ET-61 SMR, Out of Family LH2 Feedline Usage

T119128

Cause:

- Test pressure spike caused by LH2 flash to vapor in warm feedline
  - Revised procedure
- Flange thickness reduction caused by excessive lapping of flange
- Flange dimensional discrepancies caused by residual stress relief and incorrect attachment of drill fixture to part (CAPS P-068)
- Overlength condition consistent with bellows convolution overspacing caused by flexural cycling

ET-61 Flight Rationale:

- Configuration control maintained on part
- Successful retest at supplier
  - Deflection
  - Leakage
  - NDE

ET-61 SMR, Out of Family LH2 Feedline Usage

T119128

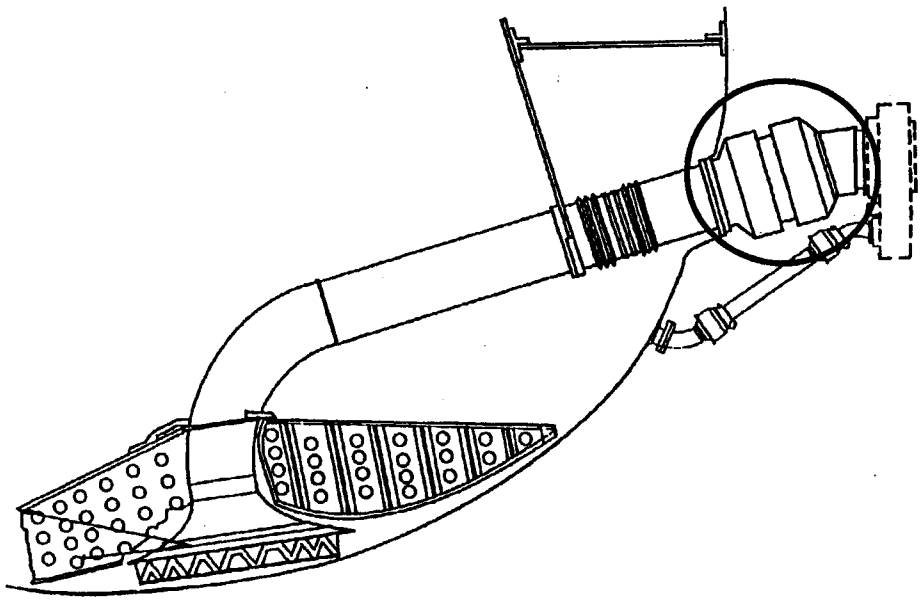
ET-61 Flight Rationale (continued):

- Analysis
  - Flange thickness
    - FS = 2.6, yield; 12.2, ultimate
    - Flange deflection at primary seal = 0.00023"
      - 0.002" allowed
  - Pressure vessel
    - 129 psi pressure spike
      - Bellows (sidewall bulging)
        - FS = 1.21, yield; 3.02, ultimate
      - Elbow
        - FS = 4.3, yield; 7.2, ultimate
    - 110 psi max qualification test pressure
    - 55 psi max flight pressure
  - Flight flow induced vibrations
    - Infinite life
    - Max flow induced stress is 6.4% of material endurance limit
- DAR 194 and ICD waiver approved misclocked flange and bolt hole pattern concentricity discrepancies
  - Structural margins unaffected
    - Hardware not affected by bolt circle clocking
    - 0.008" true position shift of bolt circle and 8 oversized attach holes do not affect mating operations or installed position of ET/Orbiter disconnect

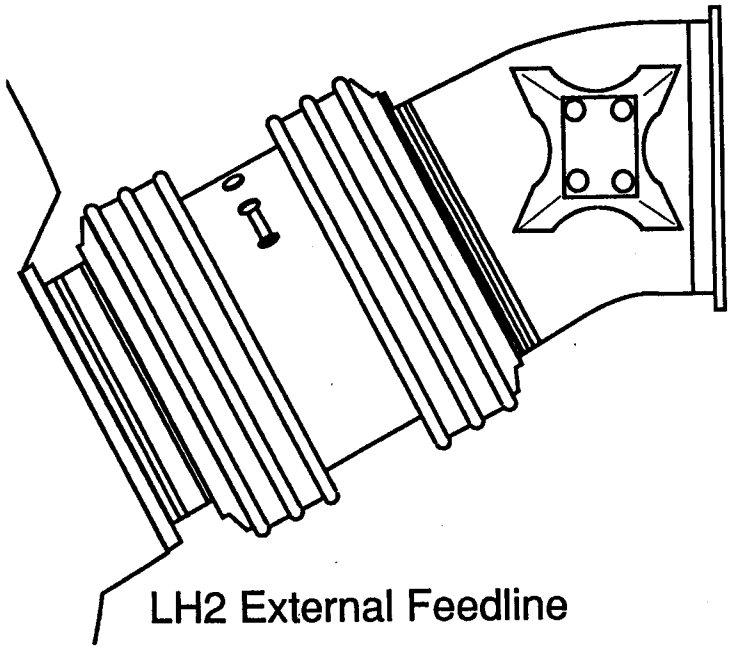
Disposition: Use as is

ET-61 SMR, Out of Family LH2 Feedline Usage

T119128



LH2 Aft Dome



LH2 External Feedline

ET-65 SMR, GH2 Pressure Line Bellows Ply Separation 67

T124401

Issue:

- GH2 pressure line bellows assembly has separation (0.050" max) between outer plies of the 3 ply bellows assembly

Background:

- Vendor visibly detected bellows ply separation in BSTRA detail components prior to Acceptance test
- Investigation determined ply separation occurred as a result of water intrusion/entrapment between plies during manufacture which vaporized causing inter-ply pressure during subsequent weld operations
  - Problem isolated to single specific build process (Type VI) used on recent build of GO2/GH2 pressure lines
    - Two defective bellows reviewed - Potential water intrusion / entrapment scenario established
    - Thermal/stress analysis support vaporization of entrapped water by weld heat conduction and resulting ply separation
- Initiated x-ray inspection for ply separation on all installed/non-installed pressure lines and post weld BSTRAs containing Type VI component
  - ET-65 GH2 pressure line bellows deformation identified

ET-65 SMR, GH2 Pressure Line Bellows Ply Separation

T124401

ET-65 Flight Rationale:

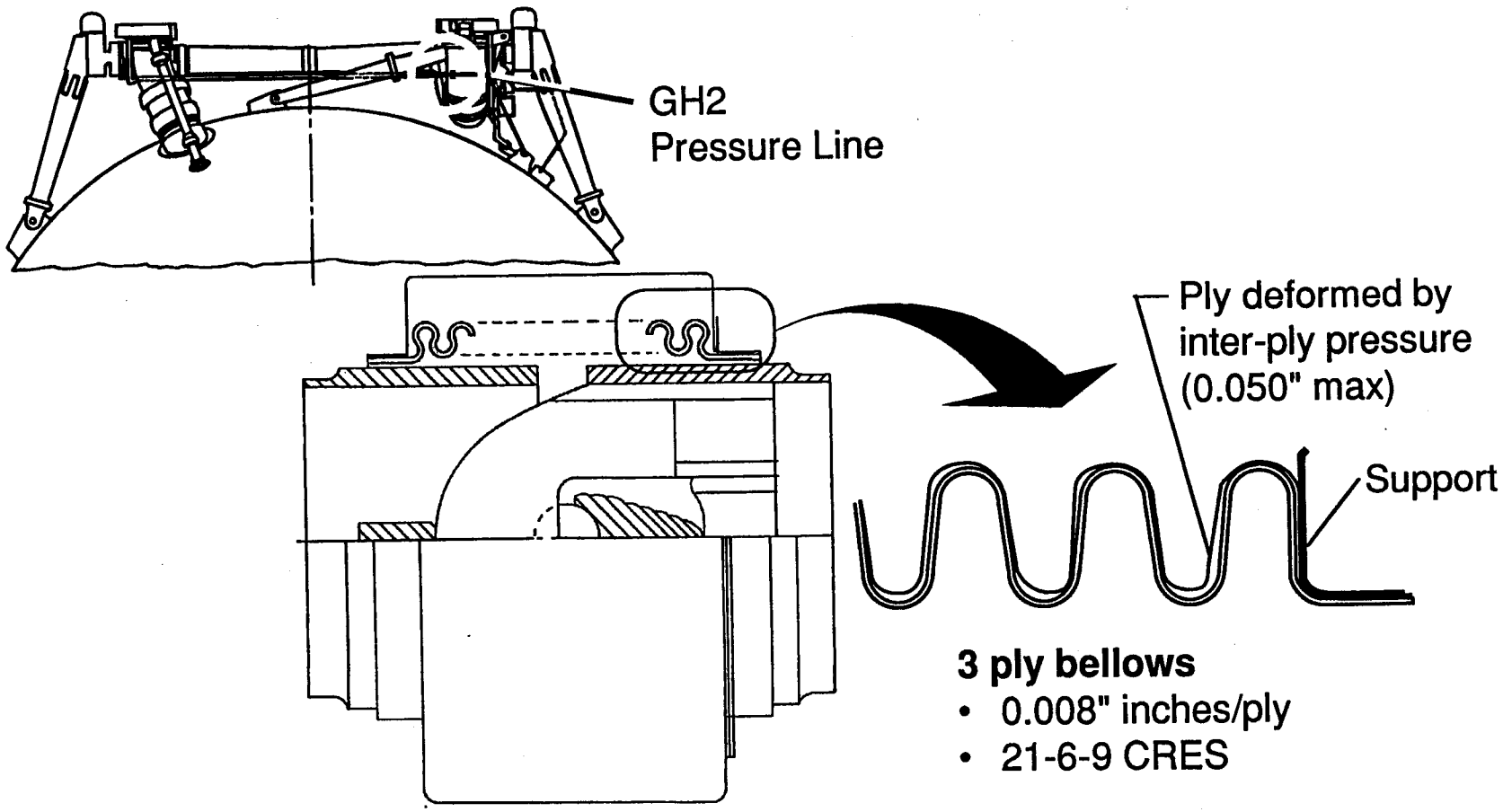
- No potential for continued degradation in flight
  - Max flight temperature (+129°F) is less than water boiling point
- Functional capability not impaired
  - Expected induced angulation (±4.5) considerably less than design capability (±14°)
  - Bellows in question exhibited spring rate values within ATP specification limits
- Corrosion not an issue
  - Laboratory analysis of entrapped water verified as deionized
  - Material is high toughness/high corrosion resistant CRES 21-6-9
- Line assembly successfully passed acceptance test with defect
- Stress analysis of bellows
  - FS = 4.05 with 3 plies - sidewall bulging
  - FS = 2.70 with 2 plies - sidewall bulging

Disposition:

- Use as is

ET-65 SMR, GH2 Pressure Line Bellows Ply Separation

T124401



GH2 Pressure Line Bellows (cross section)

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Agenda

• Introduction	Dennis Deel
• Mission Performance Summaries	
• Block 10 (ETs 61-65) Items	See Block 10 Agenda
• ***Mission STS-60 Items***	***See Mission STS-60 Agenda***
• Appendices - A: Minor Changes - B: KSC Processing - C: Previously addressed material	

Agenda

• ***Mission STS-60 Highlights***	***Dennis Deel***
• SRM&QA Assessment	Frank Ramsey
• KSC Processing	Ameen Sarkees
• Verification/Certification Status	Larry Hartley
• Mission Unique Assessment	
• Readiness Statement	Dennis Deel

Mission STS-60 Highlights

• **Launch**	1/27/94
- Window	0714 - 0944 EST
- Pad	A
- Orbiter	Discovery (OV-103)
- Orbital inclination	57 deg - Direct insertion at 190 NM
- ET photo coverage	Crew photos from cockpit window
• **Mission payload**	Spacehab-2
• **Landing**	2/4/94
- Time	1244 EST
- Location	KSC

Agenda

• Mission STS-60 Highlights	Dennis Deel
• ***SRM&QA Assessment***	***Frank Ramsey***
• KSC Processing	Ameen Sarkees
• Verification/Certification Status	Larry Hartley
• Mission Unique Assessment	
• Readiness Statement	Dennis Deel

SRM&QA Assessment

Item	Status
• **Alerts**	None
• **MRB Assessment** - MRB MARS Items - PR/MRBs	Complete - No issues/no impact to hazard controls 784 6
• **Hazard Assessment**	Complete - All hazard reports were re-assessed and hazard controls verified
• **Corrective Action Problems Summary (CAPS)**	
- T-066PF, Missing foam from Intertank and jack pad on ET-57 (STS-58)	• Previously presented with Mission STS-58/ET-57 Performance Summary
- E-152, Tavis transducer acceptance test failures	• Previously presented with Tavis LO2 Ullage pressure transducers (B01773A)
- S-076C, LH2 tank web thickness	• See subsequent chart

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CAPS S-076C, LH2 Tank Web Thickness

Crit	Title/Description	Vehicle Clearance	Status/ECD
3	LH2 tank webs at Station 1973 do not meet thickness requirements	• ETs 60 thru 68, 70, 71, 72, 73 & 75 cleared by tests and analysis • ETs 69 & 74 cleared by DC&R • ET-76 & Subs cleared by inspection	Corrective action in progress, ECD 1/3/94

Agenda

• Mission STS-60 Highlights	Dennis Deel
• SRM&QA Assessment	Frank Ramsey
• ***KSC Processing***	***Ameen Sarkees***
• Verification/Certification Status	Larry Hartley
• Mission Unique Assessment	
• Readiness Statement	Dennis Deel

KSC Processing - Status

as of 12/13/93

- **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

* Included in Appendix B

KSC Processing - Status

as of 12/13/93

- Changes *
  - ET modifications
    - Mod Kit — 0
    - DC&R (Discrepancy Check and Report) — 1
    - Bldg 45 — 0
    - FEC (Field Engineering Change) — 0
  - Launch Complex 39 A and B upgrades
    - Delete ET aft LO2 feedline heater GSE
    - Upgrade Hazardous Gas Detection System
  - Software
    - Prevent Premature Drain
      - SIM Launch — 1/11/94
      - SIM Load — 12/15/93

* Included in Appendix B

Agenda

• Mission STS-60 Highlights	Dennis Deel
• SRM&QA Assessment	Frank Ramsey
• KSC Processing	Ameen Sarkees
• ***Verification/Certification Status***	***Larry Hartley***
• ***Mission Unique Assessment***	
• Readiness Statement	Dennis Deel

Verification/Certification

Item	Status
• **NSTS 07700, Volume X Baseline** - Revision L, Change 197	**No constraints**
• **Certification documentation** - Hardware Certification Sheets (HCS) - Certificates of Qualification (COQ)	**Complete - No issues**
• **Waivers/Deviations** - LH2 feedline flange dimensions, DAR 194 *	**Complete - No issues**

* Previously presented with SMR, Out of Family LH2 Feedline Usage

Mission Unique Assessment

as of 12/13/93

Category/Item	STS-60/ET-61
• Vehicle loads	ECD 1/7/94
• Thermal assessment - Ascent - Intact abort and reentry	Complete - No issues
• Review of MRB actions using updated loads and environmental data	ECD 1/7/94
• MPS Preflight Prediction Package	ECD 1/17/94

MARTIN MARIETTA
MANNED SPACE SYSTEMS

Agenda

• Mission STS-60 Highlights	Dennis Deel
• SRM&QA Assessment	Frank Ramsey
• KSC Processing	Ameen Sarkees
• Verification/Certification Status	Larry Hartley
• Mission Unique Assessment	
• ***Readiness Statement***	***Dennis Deel***

ET-61 Readiness Statement

The External Tank, ET-61, is hereby certified and ready for STS-60 flight pending completion/closure of open and planned work

Jon A. Dutton
Vice President, External Tank Project
Martin Marietta Manned Space Systems

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Appendices

- A: Minor Changes
  - Class I
  - Class II and JS/DCNs
  - Substitutions

- B: KSC Processing
  - Processing/Planned Work Schedules
  - PR/MRB Summaries
  - Limited Life Components
  - KSC Component Replacement List
  - Modification Summary/Status
  - Software Change
  - Software Verification/Validation Process

- D: Previously reviewed items
  - MRB Assessment Criteria
  - Waivers/Deviations Baseline

Minor Changes, Documentation - Summary

A1

Description	Reason	Basis for Certification
Revised PDs to reflect MMMSS responsibiltiy/ ownership of GUCP vent system 7" QD drawings and released into MMMSS drawing system	Assembly vendor of GUCP QD no longer in business	Documentation only
Revised ICD and GH2 pressure line PD to be consistent with vendor drawings (B01936)	Review of PD requirements, ICD and supplier documentation revealed inconsistencies between MMMSS PDs, ICD and vendor drawing	Documenation only • Hardware built to approved vendor documentation

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Implement Pyrotechnics Spec Revision (B01984) A2

Background/ Reason:

- Level II issued revision to NSTS 08060 (Rev G), Pyrotechnic Specification for new design
  - Existing Shuttle hardware grandfathered

Description:

- No configuration change

- Documentation
  - Deleted single lot control for non-explosive items
  - Deleted annual PVT (Pyro Verification Test) on GUCP bolt
  - Revised qualification test requirements
    - Autoignition requirement
      - Was: No auto ignition above +275°F
      - Now: No auto ignition within +50°F above maximum flight prediction (LSC max temp = +350°F)
        - LSC tests demonstrated no autoignition below +430°F
    - Increased severance capability of LSC from 100% to 115%
      - No severance margin tests performed on LSC
  - Modified acceptance requirements
    - Extension of life past 10 years with annual test similar to 4 and 7 year extended life test
    - Useful life from date of DLAT (Destructive Lot Acceptance Test) instead of date of manufacturing
  - Revised CIL to delete reference to annual PVT on GUCP bolt

Basis for Certification:

- Documentation only
- Existing Shuttle pyrotechnics hardware is grandfathered and does not require requalification

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Forward LH2 PAL Ramp Installation (B01867)

Background:

- Previous change (J31036) for ET-51 and subs relocated several TPS applications from Bldg 420 to Final Assembly
  - Forward 18" of LH2 PAL ramp included
- For ETs 51-60, the forward 18" of LH2 PAL ramp continued to be installed in Bldg 420 as deferred work

Reason:

- Productivity - Helium leak check performed in Bldg 420 prevented LH2 cable tray fairing and forward PAL ramp installation in Final Assembly

Description:

- Hardware
  - Engineering revised to relocate forward LH2 PAL ramp installation to Bldg 420
- Documentation
  - CIL, HCS and EIS revised to reflect part number change

Basis for Certification:

- No configuration change

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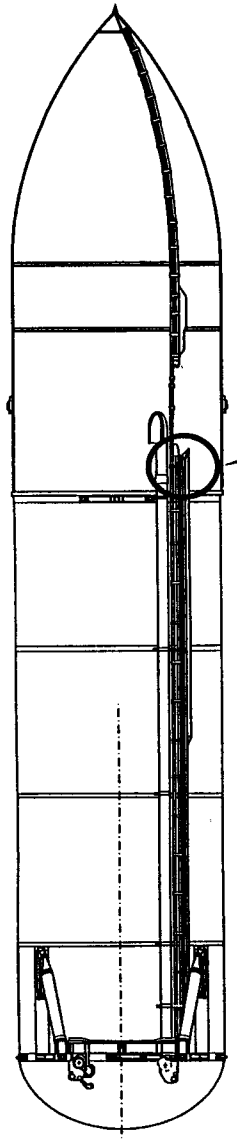
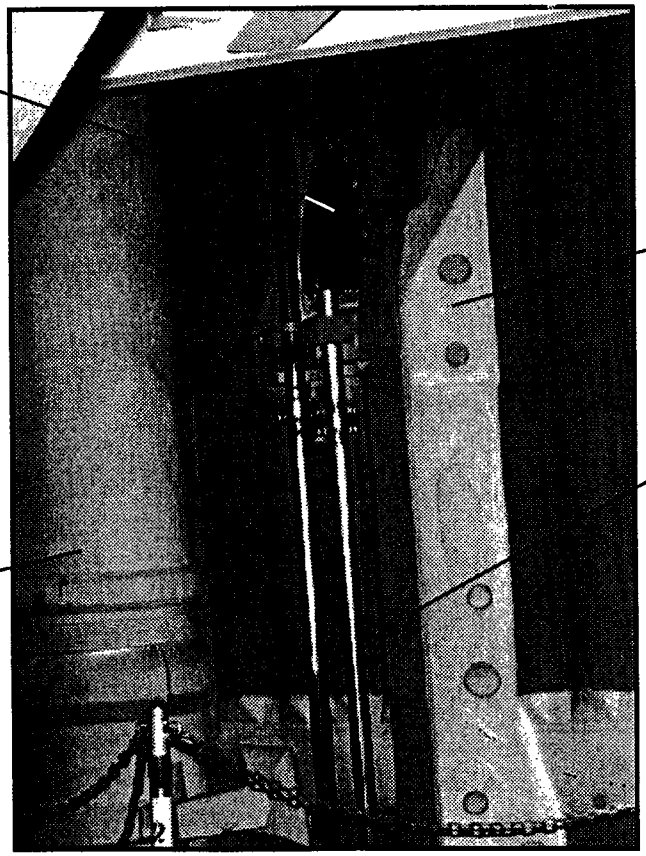
Forward LH2 PAL Ramp Installation (B01867)



GH2 Pressure Line Fairing

LO2 Feedline



Forward LH2 PAL Ramp

LH2 Cable Tray

Minor Changes, Documentation - Summary

Description	Reason	Basis for Certification
Revised procurement of pyro connectors (B01570A/B) • **Was:** Contractor Furnished Equipment (CFE) • **ETs 61-63:** Government Furnished Equipment (GFE) • **ET-64 and subs:** Contractor Furnished Equipment (CFE)	Customer direction	Documentation only
Implement Shuttle Connector Analysis Network (SCAN) on ET Project (B01941) • SCAN is computerized data set consisting of engineering wiring diagrams reformatted for KSC usage • Data delivered electronically to KSC at vehicle shipment	Enhance launch site trouble shooting and capability of defining retest requirements during vehicle processing	Documentation only

Minor Changes, Requirements - Summary

A5A

Description	Reason	Basis for Certification
Deleted test requirements to checkout LO2 aft heater operations at MAF (B01937A)	• LO2 aft heaters not activated since STS-45/ ET-44 • Heaters will be deleted for ET-71 and subs (B01937)	• Ice/frost formation in this area within acceptable limits
Deleted 50 VDC isolation resistance test of Tavis LO2 solid state ullage pressure transducers at MAF (B01971)	Active electronics are susceptible to damage when exposed to more than 5 VDC (operating voltage)	• Components tested by supplier for > 50 megohms at 50 VDC with connector pins commoned • All systems test provides funtional/operational verification of transducers and wiring

Minor Changes, Configuration - Summary

Description	Reason	Basis for Certification
Incorporate in-line bolt grip revisions on 27 drawings/ applications (B01777) • Revised bolt grip lengths and/or washer quantities • Implemented bolt gauging on blind fastener applications where tolerance stack-ups do not permit single bolt/ washer callout	Ensure adequate engagement of lock feature and prevent shanking	Engineering analysis - Tolerance studies assured correct fastener selection within design criteria

Date/Inspect ET Pyrotechnic Hardware (B01923) A7

Background/ Reason:

- MSFC imposed additional requirements on the GUCP separator assembly pressure cartridge and Linear Shape Charge (LSC)
  - Based on USBI RSS test anomalies

Description:

- Hardware
  - Added date of manufacture to separator assembly pressure cartridge name plate
- Documentation
  - Revised LSC PD acceptance critieria for tubes:
    - Inspect and record measurements at three locations along the tube length in addition to the existing trimmed end measurements
    - Verify apex angle and surface flatness on 100% of tube length
    - Add acceptance criteria for irregularities along the LSC which could impact performance
  - Revised CIL to add dimensional requirements to retention rationale

Basis for Certification:

- Inspection
- Similarity to previously flown hardware

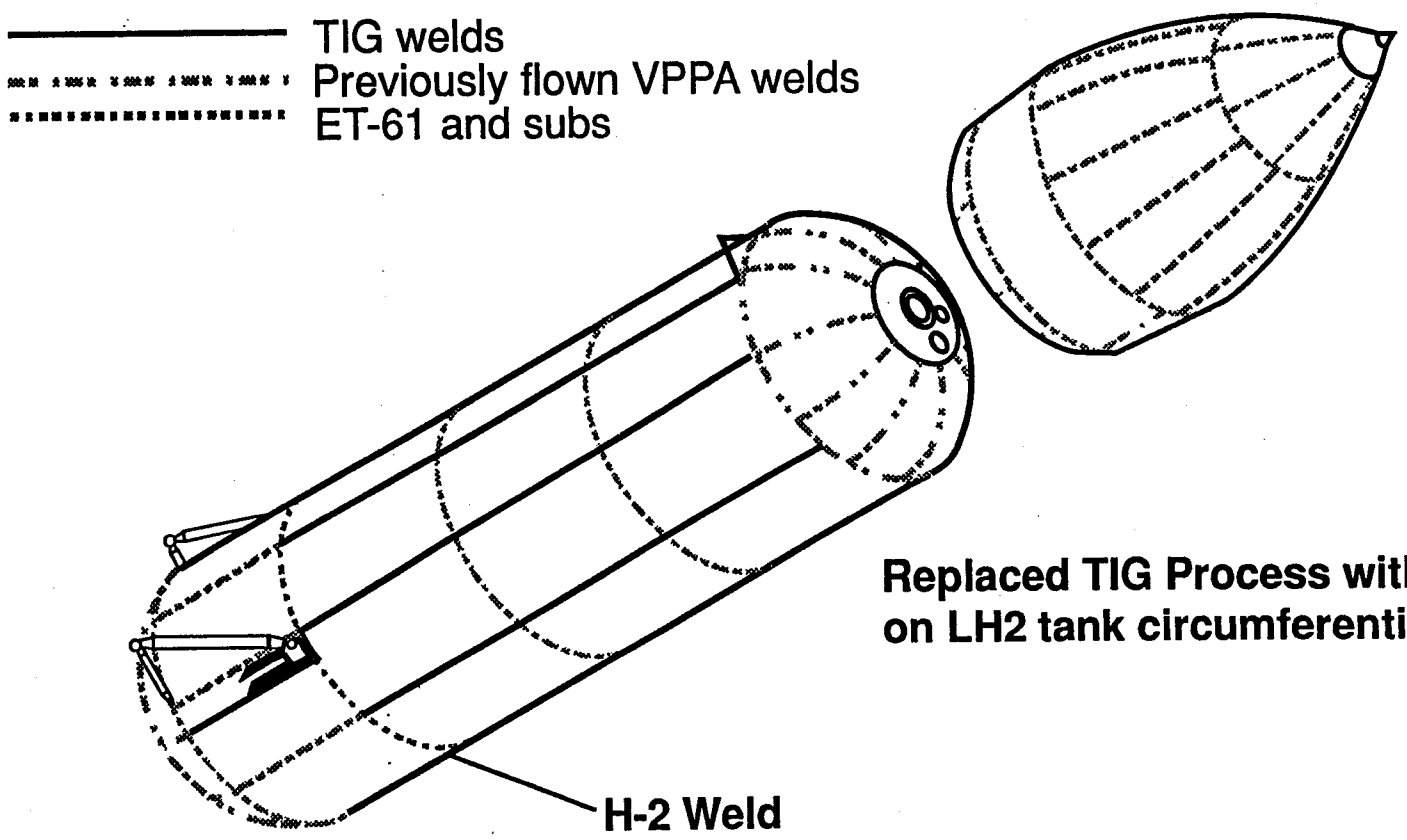
Minor Changes, Configuration - Summary

Description	Reason	Basis for Certification
Replace Teflon split sleeving on LO2 internal harness with PTFE tape (J31097) • Sleeving used to protect harness under clamps and from sharp edges	Productivity enhancement • Teflon sleeving often failed batch LO2 compatibility test	LO2 compatibility test
Use larger diameter teflon clamp insert for LO2 internal harness (B01927) • Was: 0.468" ID • Now: 0.624" ID	Increase in thickness of fiberglass sleeving required larger diameter clamp insert	Previously flown on ETs 8-29

Minor Changes, Process - Summary

Description	Reason	Basis for Certification
Replace TIG weld process with VPPA process on LH2 tank H-2 weld (B01650U)	Productivity • Reduce weld preparation and rework activitiy • Reduce cost and schedule time	Tests • Certification/confidence panels • Proof test Inspection • X-ray • Penetrant • Leak • Visual

LH2 Tank VPPA Welding (B01650U)



Replaced TIG Process with VPPA on LH2 tank circumferential weld

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Class I/II or JS/DCN Changes

- Class I/II JS DCN changes that have been reviewed by MSFC S&E Resident Manager's 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 II or JS/DCN Changes, Electrical - List

Change No.	Description	Effectivity
H33809-865	Improve P-clamp support and reduce chaffing potential	ET-63 and up
H34809-477	Revised drawing to show correct STP callout for cable bonding to ET surfaces under TPS and to clarify pictorial of bonded wires	ET-64 and up
H34809-499	Revise AWS drawing note to agree with ferrule location pictorial	ET-65 and up
H34809-542	Revise wire cut length to agree with finish length of cable	ET-64 and up
H34809-598	Delete callout for anti-tamper seal on lockwired transducer reference port	ET-64 and up
H34809-755	Delete gap check requirement for 45L5 type clamps	ET-61 and up
H50001-287	Add ICD note to leak check fitting on LH2 ullage pressure transducer assembly	ET-61 and up
H50001-451	Revise cable view to clarify routing	ET-61 and up
H50001-704	Delete planarity requirements for LO2 ullage pressure transducer flex hoses	ET-64 and up

Class II or JS/DCN Changes, Propulsion - List

Change No.	Description	Effectivity
H33809-277	Revise tumble valve pressure cartridge post fire leak test success requirement, to bulkhead leakage allowed through cartridge if performance meets pressure/time requirements	ET-61 and subs
H33809-420	Change material for LH2 and LO2 tank pressurization diffuser screen to 316L Stainless Steel to accommodate availability	ET-61 and subs
H33809-438	Change pressurization line callout for material length and STP type, used on GH2 and GO2 pressurization line guide rail material	ET-61 and subs
H33809-453	Update documentation to reflect the "as built" condition for LH2 and LO2 tank pressurization diffuser screen assembly	ET-61 and subs
H33809-594	Add torque values on guide rail bolts for helium inject line at Intertank	ET-61 and subs
H33809-681	Change P/L material code for helium inject support material	ET-61 and subs
H33809-783	Change P/L material code for LH2 feedline support frame material	ET-61 and subs
H33809-785	Revise flange surface between the primary and secondary seal grooves on LO2 feedline PD (Raco/Creavey seal flange) to enhance leak test margin	ET-61 and subs

Class II or JS/DCN Changes, Propulsion - List

Change No.	Description	Effectivity
H33809-793	Revise flange surface between the primary and secondary seal grooves on LO2 feedline aft elbow (Raco/Creavey seal flange) to enhance leak test margin	ET-61 and subs
H33809-807	Revise flange surface between the primary and secondary seal grooves on GH2 vent valve to enhance leak test margin	ET-61 and subs
H33809-808	Revise flange surface between the primary and secondary seal grooves on GO2 vent valve to enhance leak test margin	ET-61 and subs
H33809-814	Revise flange surface between the primary and secondary seal grooves on GH2 vent disconnect (Raco/Creavey seal flange) to enhance leak test margin	ET-61 and subs
H33809-816	Revise flange surface between the primary and secondary seal grooves on tumble valve to enhance leak test margin	ET-61 and subs
H34809-254	Clarify radiograph acceptance/reject criteria for pressure cartridge used on tumble valve	ET-61 and subs
H34809-286	Issue Freeze Order to stop design and procurement of LO2 feedline BSTRA proof test fixture	ET-61 and subs

Class II or JS/DCN Changes, Propulsion - List

Change No.	Description	Effectivity
H34809-361	Change bolt length to ensure minimum two thread protrusion on LO2 feedline installation	ET-62 and subs
H34809-380	Issued Freeze Order to stop production acceptance test of GH2 pressurization line	ET-61 and subs
H34809-413	Remove a note requiring penetrant inspection on LO2 feedline welds prior to radiographic because of environmental restrictions at supplier. Penetrant inspection will be performed after radiographic	ET-61 and subs
H34809-419	Revise separator assembly to specify verification of installation of seal in separator bolt by visual inspection instead of X-Ray	ET-61 and subs
H34809-459	Rework GH2 vent valve body inlet flange sealing surface (3)	ETs 64,65 and 66
H34809-474	Change bolt length and added washers to eliminate interference on the GH2 pressurization line Installation drawing	ET-62 and subs
H34809-481	Clarify features controlled by ICD on GO2 pressurization line	ET-61 and subs
H34809-508	Add ICD feature control to attach hardware for ET/Orbiter LO2 and LH2 umbilical disconnect	ET-61 and subs

Class II or JS/DCN Changes, Propulsion - List

Change No.	Description	Effectivity
H34809-515	Change shrink tubing diameter used on helium inject line/installation	ET-62 and subs
H34809-525	Change strut length used to support GH2 pressurization line to prevent interference	ET-62 and subs
H34809-625	Revise tolerance for outer average diameter for seal groove LO2 feedline	ET-62 and subs
H50001-292	Add direction arrows to indicate flow direction on pneumatic tube installation	ET-61 and subs
H50001-405	Add lockwire and drilled head bolts to insure locking feature at installation of LO2 and LH2 feedline hardware at ET/Orbiter umbilical disconnect	ET-61 and subs
H50001-433	Delete tab washer and add lockwire to leak check port plug on propellant feed installation drawing	ET-61 and subs
H50001-444	Change bolt length to insure minimum thread protrusion on "P" clamp attaching LO2 vent valve actuation line	ET-61 and subs
H50001-446	Clarify inspection requirements for using a functional gage to verify hole location for mounting holes on LO2 and LH2 propellant screens	ET-61 and subs

Class II or JS/DCN Changes, Propulsion - List

Change No.	Description	Effectivity
H50001-507	Delete flag note that does not apply to jumper on GH2 vent installation	ET-61 and subs
H50001-531	Change bolt length to ensure minimum two thread protrusion on propellant feed installation	ET-61 and subs
H50001-650	Revise seal groove diameter and lockwire hole tolerance, correct dash no. omission on LO2 feedline assembly	ET-61 and subs

Class II or JS/DCN Changes, Structures - List

Change No.	Description	Effectivity
B80571A-800	Added part marking call-out to intertank frame details	ET-61 & subs
B80571A-801	Added part marking call-out to intertank frame details	ET-61 & subs
B80571A-802	Added part marking call-out to intertank frame details	ET-61 & subs
B80571A-803	Added part marking call-out to intertank frame details	ET-61 & subs
B80571A-804	Added part marking call-out to intertank frame details	ET-61 & subs
B80571A-805	Added part marking call-out to intertank frame details	ET-61 & subs
B80571A-806	Added part marking call-out to intertank frame details	ET-61 & subs
H33809-246	Deleted chem milled pocket in aft crossbeam channel at interface with LO2 feedline support bracket to obviate shimming	ET-61 & subs
H33809-293	Revised nut call-out to be compatible with bolt threads on LO2 anti-vortex baffle vanes	ET-61 & subs
H33809-402	Clarified tooling hole locations on Intertank main frame web	ET-61 & subs
H33809-410	Corrected base thickness dimension on vertical strut fitting casting	ET-61 & subs
H33809-428	Deleted redundant dimension to slotted hole on LO2 cable tray fairing	ET-61 & subs
H33809-432	Relaxed tolerances on intertank intermediate and main frame beaded webs to facilitate manufacture	ET-61 & subs

Class II or JS/DCN Changes, Structures - List

Change No.	Description	Effectivity
H33809-479	Clarified primer touch-up requirements in attachment holes on intertank door	ET-61 & subs
H33809-501	Revised location of stiffener on nose cone cable tray fairing to prevent distortion of fairing skin during installation	ET-61 & subs
H33809-540	Revised dimensions for location of angle stiffener and cable support bracket on intertank intermediate frames	ET-61 & subs
H33809-574	Relaxed tolerances on intertank intermediate and main frame beaded webs to facilitate manufactur	ET-61 & subs
H33809-581	Added missing locating dimensions for splice plates on aft cross beam cable tray structure	ET-61 & subs
H33809-595	Revised hi-loc fastener grip length on intertank intermediate frame	ET-61 & subs
H33809-629	Revised rivet code callout to indicate rivet finish requirement and revised dimension locating angle on intertank intermediate frame 1034.2	ET-61 & subs
H33809-630	Revised rivet code callout to indicate rivet finish requirement on intertank intermediate frame 941.4	ET-61 & subs
H33809-631	Revised rivet code callout to indicate rivet finish requirement on intertank intermediate frame 897.1	ET-61 & subs
H33809-632	Previously presented with B01777 during STS-26R/ET28 FRR	ET-61 & subs

Class II or JS/DCN Changes, Structures - List

Change No.	Description	Effectivity
H33809-633	Revised rivet code callout to indicate rivet finish requirement on aft crossbeam mechanical assembly	ET-61 & subs
H33809-638	Added missing rivet callout to intertank half section parts list	ET-61 & subs
H33809-653	Previously presented with B01777 during STS-26R/ET28 FRR	ET-61 & subs
H33809-667	Previously presented with B01777 during STS-26R/ET28 FRR	ET-61 & subs
H33809-685	Previously presented with B01777 during STS-26R/ET28 FRR	ET-63 & subs
H33809-691	Previously presented with B01777 during STS-26R/ET28 FRR	ET-61 & subs
H33809-700	Revised rivet code callout to indicate rivet finish requirement on intertank main frame 985.675	ET-61 & subs
H33809-747	Added dimension to clarify stringer fastener pitch on intertank panel 6	ET-61 & subs
H33809-754	Relocated clip to prevent interference with stiffener inside stringer on intertank panel 3	ET-61 & subs
H33809-779	Corrected usage of LH2 tank aft dome gore detail	ET-61 & subs
H33809-784	Deleted redundant dimension on intertank stringer panels 1, 2, 6, 7 & 8	ET-61 & subs

Class II or JS/DCN Changes, Structures - List

Change No.	Description	Effectivity
H33809-857	1 Replaced bolt with hi-lok fasteners at two locations on +Y/-Y Intertank thrust panel installations. Bolts were being changed for protrusion requirements and it was decided to replace them with hi-loks to match the remainder of the pattern on the frame segment installation 2 Deleted STP2014 reference from note calling for 'adjustment of washers beneath bolt head per STP2014' since STP does not discuss adjustment of washers under head. Washers are used under head to adjust maximum bolt protrusion from the surface of the panel and preclude interference with RSS Cross strap fairing installation at KSC 3 Added the flag note calling for Loctite to the low-profile non-locking nuts used in Item 2. The flag was inadvertently left off of the LWT-16 and up drawing. MPPs were reviewed to insure that Loctite was used on all vehicles from which the flag was missing 4 A washer callout was obviously incorrect on the field of the drawing. The callout was corrected and the parts list was verified to be correct	ET-61 & subs
H33809-882	Deleted erroneous support assembly call-out on aft crossbeam mechanical assembly	ET-61 & subs
H33809-889	Added dimension for stiffener fastener location and added pictorial views to clarify clip location on intertank main frame	ET-61 & subs
H33809-941	Corrected fastener edge distance dimension at one location for web to inner chord attachment on intertank main frame	ET-61 & subs

Class II or JS/DCN Changes, Structures - List

Change No.	Description	Effectivity
H33809-950	Revised application of epoxy coating from assembly to details on upper aft ET/SRB fitting fairing	ET-61 & subs
H33809-951	Revised application of epoxy coating from assembly to details on LH2 umbilical cable tray/aft crossbeam fairing	ET-61 & subs
H33809-954	Revised application of epoxy coating from assembly to details on LH2 cable tray covers	ET-61 & subs
H33809-956	Revised application of epoxy coating from assembly to details on vertical strut to cable tray fairing	ET-61 & subs
H33809-957	Revised application of epoxy coating from assembly to details on aft cross beam cable tray structure	ET-61 & subs
H33809-980	Revised application of epoxy coating from assembly to details on LO2 feedline support fitting	ET-61 & subs
H33809-984	Revised application of epoxy coating from assembly to details on bipod fitting cover	ET-61 & subs
H33809-989	Revised application of epoxy coating from assembly to details on nosecone	ET-61 & subs
H33809-990	Revised application of epoxy coating from assembly to details on harness plate for aft structure cable tray	ET-61 & subs

Class II or JS/DCN Changes, Structures - List

Change No.	Description	Effectivity
H33809-991	Revised application of epoxy coating from assembly to details on vertical strut to aft crossbeam cable tray fairing cover	ET-61 & subs
H33809-996	Revised application of epoxy coating from assembly to details and added missing dimensions on LO2 and LH2 umbilical cable tray fairings	ET-61 & subs
H33809-998	Revised application of epoxy coating from assembly to details on RH vertical strut to LH2 tank cable tray cover	ET-61 & subs
H34809-004	Added dimension for minimum weld land width verification on LH2 aft dome quarter panel	ET-61 & subs
H34809-008	Added fastener location dimension for stiffener and corrected a view orientation on intertank intermediate frame 1082.0	ET-61 & subs
H34809-017	Added note to waive gap check requirement under head of nosecone installation bolts	ET-61 & subs
H34809-019	Added missing vent holes in skin where RSS antenna ground plane is installed on intertank string panels 2 & 7	ET-61 & subs
H34809-022	Corrected rivet code callout, web callout and fastener quantity callout on intertank intermediate frame 1082.0	ET-61 & subs
H34809-045	Revised dimension for spacer location, corrected fastener quantity callout and revised clip detail on intertank intermediate frame 1034.2	ET-61 & subs

Class II or JS/DCN Changes, Structures - List

Change No.	Description	Effectivity
H34809-048	Corrected rivet code callout and fastener quantity callout on intertank intermediate frame 897.1	ET-61 & subs
H34809-094	Moved hole call-out from detail to assembly on LH2 anti-vortex baffle clevis	ET-61 & subs
H34809-106	Increased bend radii on disconnect panel details in intertank to facilitate forming	ET-61 & subs
H34809-140	Revised fillet weld size from .12 to .09 to be compatible with base thickness of T-clips on LH2 aft dome gore	ET-61 & subs
H34809-144	Added note to clarify minimum thickness after spotfacing on LO2 feedline support fitting	ET-61 & subs
H34809-162	Revised application of epoxy coating from assembly to details on LH2 umbilical cable tray	ET-61 & subs
H34809-171	Revised application of epoxy coating from assembly to details on RH vertical strut cable tray fairings	ET-61 & subs
H34809-174	Revised application of epoxy coating from assembly to details on LO2 umbilical cable tray	ET-61 & subs
H34809-179	Revised application of epoxy coating from assembly to details on GH2 pressure line fairing mounted under aft crossbeam	ET-61 & subs

Class II or JS/DCN Changes, Structures - List

Change No.	Description	Effectivity
H34809-186	Clarified touch-up of epoxy coating on aft crossbeam mechanical assembly	ET-61 & subs
H34809-191	Revised application of epoxy coating from assembly to details on LO2 cable trays	ET-61 & subs
H34809-197	Revised application of epoxy coating from assembly to details on LH2 fwd dome manhole cover	ET-62 & subs
H34809-210	Revised web to web gap requirement and tolerances on location of 'P' clamp holes in inner chord on intertank intermediate frames and main frame	ET-61 & subs
H34809-237	Clarified location of machining run-out to as forged surface on vertical struts	ET-61 & subs
H34809-262	Added alignment marks for clocking of forward ogive fitting to forward ogive weld assembly	ET-62 & subs
H34809-265	Deleted two rivet callouts on intertank main frame at location where roll tie fasteners are installed at a later control point	ET-61 & subs
H34809-269	Revised intertank main frame splice plate to prevent interference with previously installed fasteners	ET-61 & subs
H34809-272	Revised intertank intermediate frame splice angles to prevent interference with previously installed fasteners	ET-61 & subs

Class II or JS/DCN Changes, Structures - List

Change No.	Description	Effectivity
H34809-283	Clarified size of fillet weld for internal lugs on forward ogive assembly	ET-61 & subs
H34809-318	Added dimension for minimum weld land width verification on LH2 forward dome cap to dome body weld assembly	ET-61 & subs
H34809-323	Added pictorial view of stiffener profile and added reference dimension to clarify orientation of stiffener on intertank main frame	ET-61 & subs
H34809-337	Revised rivet hole locations in frame +/-Y splice plates to prevent interference with tooling holes in webs on intertank intermediate frames	ET-61 & subs
H34809-338	Added two hi-lok fasteners omitted in error on intertank thrust panel installations	ET-61 & subs
H34809-358	Deleted pilot holes at ends and added tooling holes at centers to facilitate manufacture of ring frames for nose cone assembly	ET-61 & subs
H34809-366	Added notes to clarify clocking of nut plates and frame locations on nose cone assembly	ET-61 & subs
H34809-379	Revised note to clarify definition of "unrestrained" on LH2 tank longeron	ET-64 & subs
H34809-418	Clarify shim call-out and use of zinc chromate paste on aft crossbeam mechanical assembly	ET-61 & subs

Class II or JS/DCN Changes, Structures - List

Change No.	Description	Effectivity
H34809-425	Relaxed thickness tolerance for corners of channels and hole positional tolerance on LO2 feedline support fitting to facilitate manufacture of aft crossbeam details	ET-61 & subs
H34809-438	Clarified dimension line location to ensure correct interpretation by manufacturer of LO2 anti-vortex baffle vanes	ET-61 & subs
H34809-457	Added note to allow trimming of shims on installation to prevent interference with closure plates on LO2 tank/intertank to LH2 tank splice	ET-62 & subs
H34809-473	Revised dimension from 1.5 to 1.4 for minimum weld land width verification to facilitate manufacture on LH2 forward and aft dome cap to dome body weld assembly	ET-61 & subs
H34809-484	Added minimum thickness requirement for flange after spot facing holes on vertical strut	ET-61 & subs
H34809-523	Added alternate washer call-out on LO2 cable tray segment installation	ET-62 & subs
H34809-524	Added note to allow trimming of ablator on cable tray/pressurization line support bracket at STA 371.0 to provide a clearence with nose cone fairing bulkhead brackets	ET-63 & subs
H34809-532	Added shim to close gap between cable tray and aft crossbeam attach fitting for LO2 umbilical cable tray installation	ET-61 & subs

Class II or JS/DCN Changes, Structures - List

Change No.	Description	Effectivity
H34809-550	Clarified use of light washers required for GH2 pressure line guide rail in intertank	ET-64 & subs
H34809-695	Revised specification of zinc chromate primer from MIL-P-6808 to MIL-P-85582 in order to meet EPA regulations levied on manufacturer of intertank intermediate and mainframe webs	ET-61 & subs
H34809-713	Clarified flatness requirements across periphery of manhole and siphon penetrations in LH2 aft dome cap	ET-61 & subs
H34809-738	Relaxed tolerances to facilitate manufacture and prevent rework of tooling for upper aft ET/SRB fitting fairing	ET-61 & subs
H34809-742	Added note to center buttstrap within .03 over gap between intertank stringer panel to thrust panel splices	ET-61 & subs
H34809-744	Added note to center buttstrap within .03 over gap between intertank stringer panel splices	ET-61 & subs
H34809-747	Corrected drafting pictorial errors and fastener quantities on RSS box assembly	ET-61 & subs
H34809-750	Clarified location of machined corner radius run-outs on helium inject line thrust fitting	ET-61 & subs
H34809-764	Added note to clarify minimum thinning allowed after forming of skin on upper aft ET/SRB fitting fairing	ET-61 & subs

Class II or JS/DCN Changes, Structures - List

Change No.	Description	Effectivity
H34809-765	Deleted call-out for specific solvent to clean aluminum surfaces prior to tape application on RSS box panels	ET-61 & subs
H50001-171	Added part marking call-out to intertank frame details	ET-61 & subs
H50001-172	Added note to clarify touch-up of holes on intertank door mounting structure	ET-61 & subs
H50001-173	Revised location of angle on harness plate assembly in aft cable tray to prevent interference of helium inject line with lower plate detail	ET-61 & subs
H50001-218	Revised note to allow epoxy primer in pilot holes on LO2 umbilical cable tray support fittings	ET-61 & subs
H50001-232	Transferred the installation of eight hi-lok fasteners from panel 6 assembly to umbilical support installation on intertank.	ET-61 & subs
H50001-241	Added radius block to prevent interference of fastener head with fillet radius of extruded stringer on intertank panel 6	ET-61 & subs
H50001-254	Transferred the installation of four hi-lok fasteners from all intermediate frame +/-Z splices to half section assemblies to provide clearance for installation of blind fasteners during panel installations on intertank	ET-61 & subs
H50001-256	Revised raw material stock thickness to eliminate machining of material to finished thickness prior to manufacture of webs for LH2 tank frame STA 1871	ET-61 & subs

Class II or JS/DCN Changes, Structures - List

Change No.	Description	Effectivity
H50001-259	Increased bend radius to facilitate manufacture of LO2 slosh baffle inboard angle splice detail	ET-61 & subs
H50001-268	Added pilot holes to facilitate manufacture in LO2 slosh baffle inboard angle splice detail	ET-61 & subs
H50001-278	Added notes to clarify tolerance of insert hole location in longeron attach fittings	ET-61 & subs
H50001-301	Transferred the installation of sixteen rivets from intertank main frame half section assembly to main frame segment assembly to allow for installation of fasteners by automatic riveter	ET-61 & subs
H50001-308	Revised locating dimension of fasteners to edge of stringers in lieu of centerlines on intertank panels 3 and 6 to provide consistency with dimensioning on intertank panels 1,2,7 and 8	ET-61 & subs
H50001-310	Revised panel close-out trim from -Z to +Y to facilitate manufacture of LO2 tank barrel weld assembly	ET-61 & subs
H50001-315	Added missing radius dimension to spot face call-out at intersection of fastener and chord tang step on LH2 frame 1129.9 installation	ET-61 & subs
H50001-319	Added tooling holes in LH2 barrel panel trim off areas to facilitate manufacture in alignment and clocking of barrel weld assemblies	ET-61 & subs
H50001-329	Added epoxy primer call-out to edges of solid shims to facilitate manufacture during vertical strut installation	ET-61 & subs

Class II or JS/DCN Changes, Structures - List

Change No.	Description	Effectivity
H50001-344	Clarified area of flatness requirement on LO2 dome cap electrical feed-through penetration	ET-61 & subs
H50001-348	Added connector indent marking, clarified part marking and corrected insert call-out on electrical feed-through connector fairing assembly at LH2 longeron	ET-61 & subs
H50001-350	Revised fastener hole edge distance for CDF P-clamp location on intertank intermediate frame to provide optimum cable run	ET-61 & subs
H50001-366	Transferred location of part marking from inner to outer face of rib on machined back-up fittings at frame 2058.0	ET-61 & subs
H50001-367	Revised web gap dimensions at splice joints to facilitate manufacture on intertank mainframe	ET-61 & subs
H50001-369	Relaxed tolerance for location of electrical feed-through connector harness attach clip on LH2 forward dome	ET-61 & subs
H50001-376	Revised location of part and serial number marking on LH2 frame 1871.0 webs to facilitate identification after installation	ET-61 & subs
H50001-391	Corrected fastener call-outs and dimensional errors on intertank intermediate frame 1082.0	ET-61 & subs
H50001-392	Corrected quantity of fasteners in parts lists for intertank intermediate frame 941.4	ET-61 & subs

Class II or JS/DCN Changes, Structures - List

Change No.	Description	Effectivity
H50001-393	Combined two intertank RSS ground plane structure sub-assembly/installations into one installation permitted by deletion of TPS under ground plane which caused assembly sequencing	ET-61 & subs
H50001-394	Corrected quantity of fasteners in parts lists for intertank intermediate frame 897.1	ET-61 & subs
ET-61 & subs	Clarified use of temporary spaces in LO2 tank slosh baffle sub-assemblies	
H50001-397	Corrected quantity of fasteners in parts lists for intertank main frame 985.675	ET-61 & subs
H50001-401	Revised notes to clarify epoxy primer application and touch-up requirements on LO2 and LH2 cable trays	ET-61 & subs
H50001-408	Revised method of dimensioning location of SRB beam close-out panels to ensure clearence for subsequen t installation of angle through beam for intertank main frame tie-in	ET-61 & subs
H50001-411	Clarified/corrected LH2 forward and aft dome gore to gore weld grade requirements to prevent mis-interpretation	ET-61 & subs
H50001-412	Deleted strippable coating from LO2 and LH2 manhole cover assemblies which is not required for corrosion protection due application of chem film and primer at detail level introduced by previous changes	ET-61 & subs

Class II or JS/DCN Changes, Structures - List

Change No.	Description	Effectivity
H50001-429	Corrected weld bead shaving tolerance on LH2 tank T-ring welds	ET-61 & subs
H50001-432	Relaxed nut plate clocking angular tolerance and relocated part marking to facilitate manufacturing of GH2 pressline fairing	ET-61 & subs
H50001-435	Relaxed tool index hole tolerance and skin thickness tolerance to facilitate manufacturing of LH2 tank longeron	ET-61 & subs
H50001-437	Relaxed channel thickness tolerance in chem-milled corners and clarified part marking location to facilitate manufacturing on aft crossbeam	ET-61 & subs
H50001-453	Deleted unnecessary serialization and traceability from LH2 tank frame stabilizers and installation	ET-61 & subs
H50001-463	Clarified application of zinc chromate paste and corrected erroneous part number callouts on LH2 cable tray installation	ET-61 & subs
H50001-465	Corrected fastener quantities for aft crossbeam mechanical assembly	ET-61 & subs
H50001-469	Revised part marking note to include marking serial number of nose cone and spike assembly	ET-61 & subs
H50001-482	Revised part marking location to facilitate manufacture of LH2 aft dome barrel weld assembly	ET-64 & subs

Class II or JS/DCN Changes, Structures - List

Change No.	Description	Effectivity
H50001-487	Revised fastener hole location and added notes to clarify splice plate trim requirements to facilitate manufacture of upper aft ET/SRB fairing	ET-64 & subs
H50001-506	Relocated and revised fastener hole locations in center splice angles to facilitate tooling on LO2 anti-vortex baffle installation	ET-61 & subs
H50001-508	Deleted unnecessary requirement to verify that no debond of SLA on nose cone assembly has occured within 24 hours of installation	ET-61 & subs
H50001-515	Added flatness requirement to facilitate tooling for TPS application on LO2 cable tray covers	ET-61 & subs
H50001-526	Corrected fastener quantity errors for forward coverplate installation	ET-61 & subs
H50001-533	Added flagnote to indicate gaps to be sealed on aft cable tray cover installation	ET-61 & subs
H50001-536	Revised unbonded length between jumper tangent point and jumper lug and also clarified note regarding insertion of krytox in thrust strut pin to facilitate manufacture of ET/ORB aft mounting structure installation	ET-61 & subs
H50001-537	Relaxed waviness height requirements to facilitate manufacture in areas outside of critical seal surface on LO2 and LH2 manhole covers and fittings	ET-61 & subs

Class II or JS/DCN Changes, Structures - List

Change No.	Description	Effectivity
H50001-543	Relaxed tolerance for bead depth to facilitate manufacture of intertank main frame webs	ET-61 & subs
H50001-617	Revised width dimension of rubber dam to facilitate installation in LH2 cable tray fairing mounting structure	ET-65 & subs
H50001-625	Removed unnecessary scribe lines called out for orientation of radiographic inspection on LO2 and LH2 dome cap/manhole weld assemblies	ET-61 & subs

Class II or JS/DCN Changes, Systems - List

Change No.	Description	Effectivity
H34809-335	Deleted requirement to inspect drain hole on the SRB. (Requirement is in USBI engineering.)	ET 61-UP
H34809-526	Incorporated changes to CIL inspection requirements driven by Class II changes	ET 61-UP
H34809-567	Corrected effectivity information for rubber/ablator dam installation inspections	ET 8-UP
H34809-577	Revised method of securing connector covers to the P78-3123-3 Electrical Cable Support, and permit use of alternate breather system	ET 23-UP
H34809-588	Added inspection of GO2 vent louvers to permit removal of OMRS required inspection	ET 8-UP
H34809-664	Revised electrical cable CIL part number callouts. (314W12 was 314J12)	ET 61-UP
H34809-736	Revised statement of ET circumference from three decimal places to two decimals places	ET 40-UP
H34809-749	Deleted erroneous CIL inspection requirements and corrected part number callout	ET 61-UP

Class II or JS/DCN Changes, Systems - List

Change No.	Description	Effectivity
H50001-535	Added ± Y designators to clarify Intertank temperature sensor location	ET 8-UP
H50001-696	Revised CIL inspection Find Number	ET 61-UP
H50001-717	Revised electrical cable CIL part number callouts. (314W12 was 314J12)	ET 61-UP

Class II or JS/DCN Changes, TPS - List

Change No.	Description	Effectivity
H34809-041	Add serialization and traceability to list of material and note	ET-61 and up
H34809-251	Add note to ensure seating of nut plate during TPS application	ET-61 and up
H34809-259	Add note to ensure seating of nut plate during TPS application	ET-61 and up
H34809-276	Add note to ensure seating of nut plate during TPS application	ET-61 and up
H34809-298	Add note to ensure seating of nut plate during TPS application	ET-61 and up
H34809-332	Add Passivation requirement to cable tray gap closure detail	ET-61 and up
H34809-455	Revise note to waive foam rind hardness test on bipod closeout	ET-61 and up
H34809-496	Revise drawing to incorporate new validated mold for helium inject box closeout and delete SLA application to helium inject box cover	ET-61 and up
H34809-504	Revise SLA coverage over crossbeam heater and wires	ET-61 and up
H34809-522	Add note to specify minimum requirement for PAL Ramp gap tool	ET-64 and up
H34809-555	Add flushness requirement to foam closeout to prevent foam intrusion within the GH2 pressure line guide rail	ET-65 and up
H50001-273	Revise the dimensional location for the vertical strut SLA trim	ET-61 and up

Class II or JS/DCN Changes, TPS - List

Change No.	Description	Effectivity
H50001-320	Revise foam trim on GH2 vent line to provide mechanical hardware access	ET-61 and up
H50001-323	Clarify LH2 and LO2 umbilical cable trays views to enhance TPS build requirements	ET-61 and up
H50001-445	Add missing nut plate and note allowing hole in TPS due to screw protrusion	ET-62 and up
H50001-473	Add optional hand pack closeout to locations where spray SLA may not conform	ET-61 and up
H50001-492	Revise build tolerance from 0.03" to 0.06"	ET-61 and up
H50001-496	Add near side "ns" and far side "fs" to build dimension and add leader line to flag note	ET-61 and up
H50001-498	Revise drawing to clarify no topcoat areas, no SLA and future closeout areas, and add dimension for radii trim	ET-61 and up
H50001-499	Relocate part and serial number ink stamp location	ET-61 and up
H50001-501	Revise note to remove "primer" (could be misinterpreted as epoxy primer)	ET-61 and up
H50001-502	Add acceptance criteria for voids at sta. 2058 base fittings	ET-61 and up

Class II or JS/DCN Changes, TPS - List

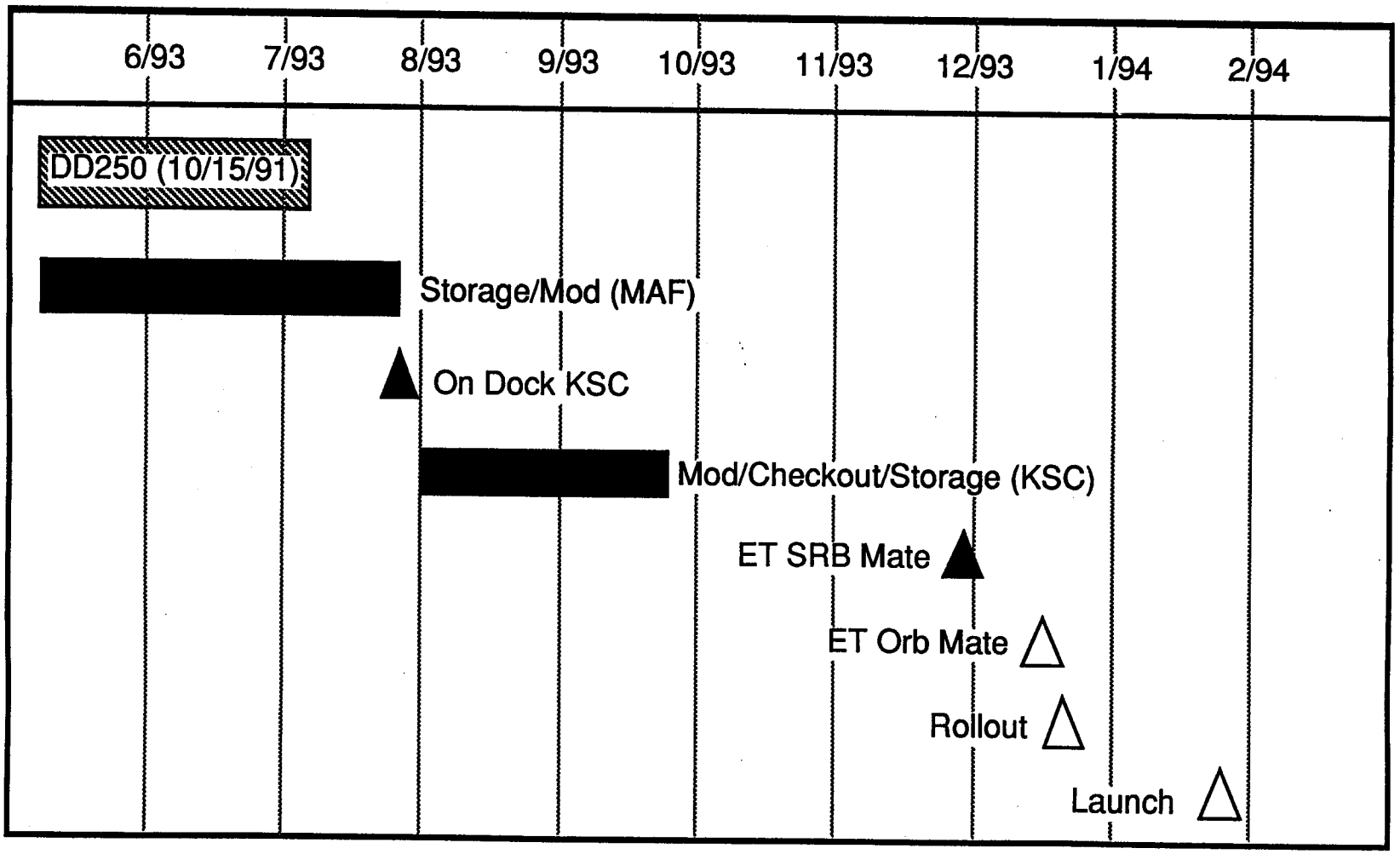
Change No.	Description	Effectivity
H50001-503	Expand top coat coverage on three feedline supports	ET-61 and up
H50001-504	Relocate part and serial number ink stamp location	ET-61 and up
H50001-523	Revise LO2 feedline drawings to add clarity, consistency, and reduce non-conformance activities	ET-63 and up
H50001-540	Clarify, relax, and add build dimensions; identify TPS trims that are "future closeout"	ET-64 and up
H50001-553	Provide 0.5 inch "no top coat" limits at future closeout areas	ET-61 and up
H50001-561	Add top coat requirement to SLA detail and closeout drawing, delete note referencing "no top coat this area"	ET-63, 65 and up
H50001-567	Reduce SLA thickness over structural doublers and splice plates	ET-61 and up
H50001-655	Relocate section view cut to reflect actual drain hole location	ET-61 and up
H50001-639	Clarify tape wraps and existing trims on GO2 vent duct foam segments at installation	ET-63 and up
H50001-701	Eliminate the bonding of molded detailed foam panels and replace with sprayed on/machined foam, relax trim tolerance	ET-61 and up
H50001-709	Revise and clarify PAL ramp/cable tray gap closure trim dimensions	ET-61 and up

Class II and JS/DCN Changes, Materials

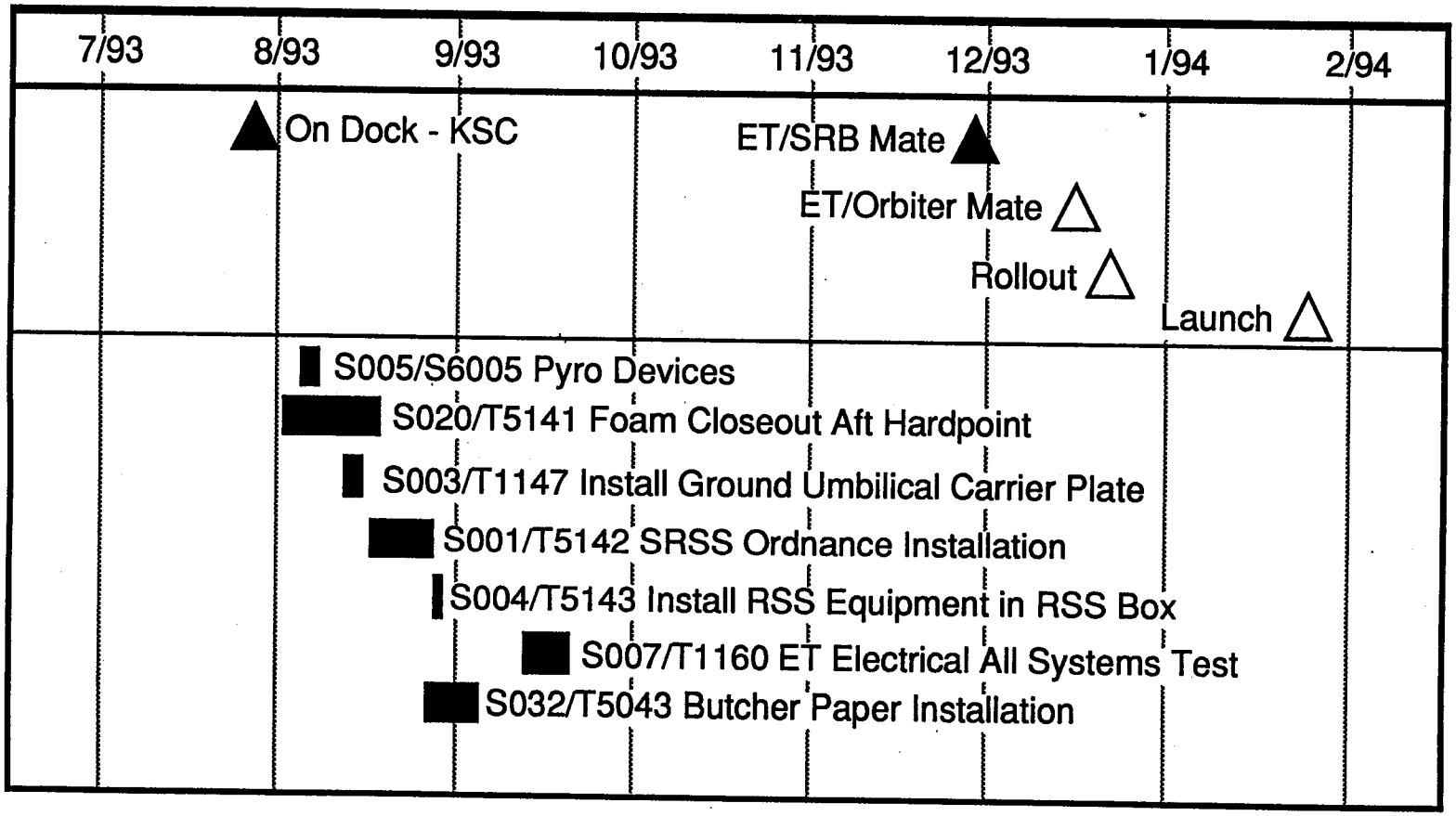
Change No.	STM/STP	Description
H34809-634	K1A2 & K557	Created Code Control Sheets to allow procurement of TT-P-1757 Rev. A zinc chromate primer and MIL-T-81772 thinner per MMSK381
H34809-673	K381	Allow usage of conversion coated 2219-T87 aluminum panels for zinc chromate primer receiving inspection tests to be more representative or ET usage
H34809-708	STP-6501	Add frictional force separation test for connector socket contacts after assembly and implement MSFC Workmanship Manual
H34809-709	F144,F203, F250,F417	Added cleaning requirements for test specimens prior to submittal for LO2 impact testing
H34809-751	STM-Y964	Added three approved suppliers and deleted five suppliers from Approved Vendors List for Conductive Polyethylene Bagging Material

ET-61 Processing Schedule

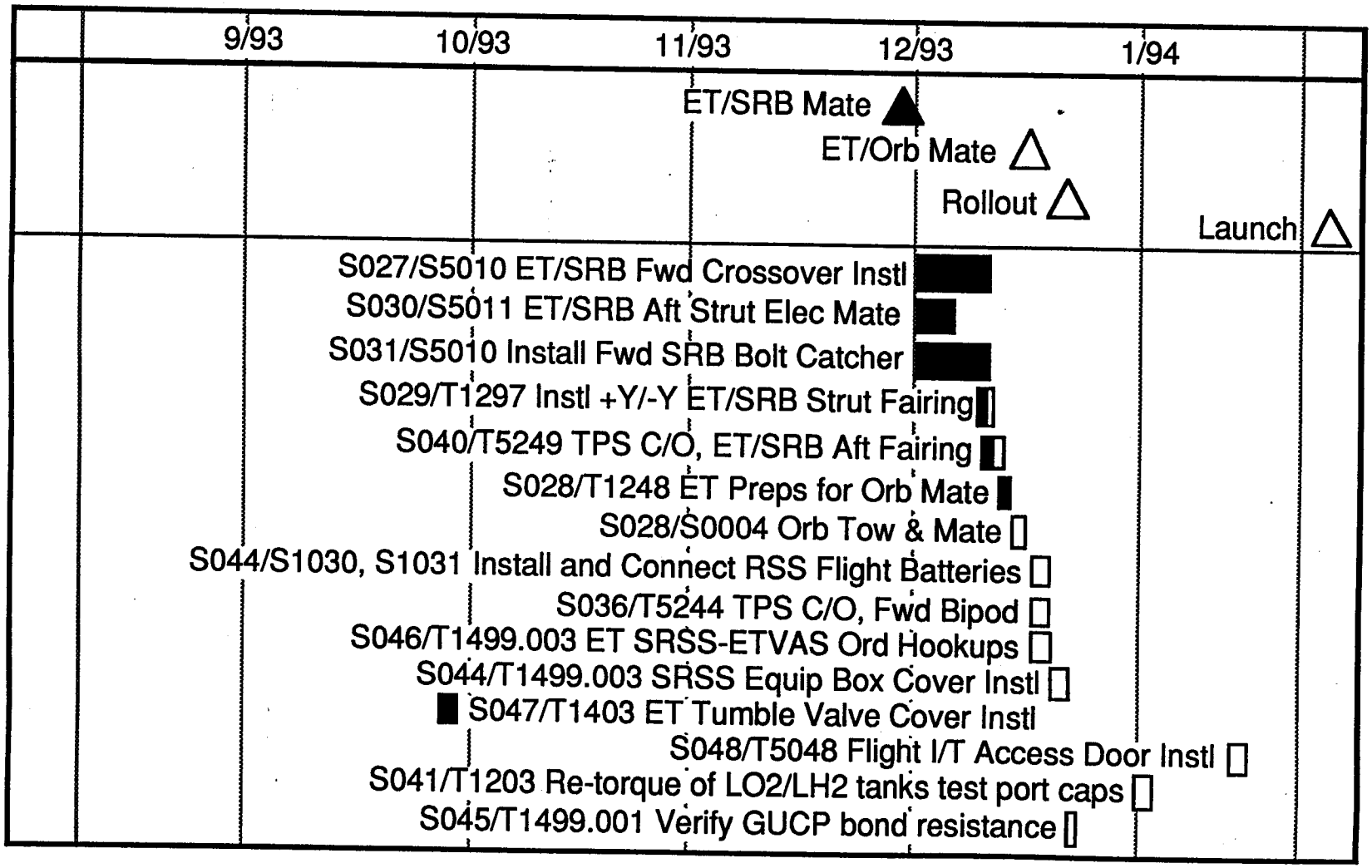
B1



ET-61 Planned Work



ET-61 Planned Work



ET-61 DR/PR/OMRSD Waivers/Exceptions - Summary B4

as of 12/13/93

	Discrepancy	Problem				
			MRB Items		Waivers/Exceptions	
System	Total	Total	Total	Open	Total	Open
• Electrical	1	2	**0**	**0**	0	0
• Propulsion/ Pneumatics	1	8	**2**	**0**	0	0
• Range Safety	0	0	**0**	**0**	0	0
• Structures	0	4	**1**	**0**	0	0
• Thermal (TPS)	4	9	**3**	**1**	0	0
Total	**6**	**23**	**6**	**1**	**0**	**0**

ET-61 PR/MRBs - Summary

Propulsion/ Pneumatics

PR No./Status	Title/Description	Disposition
PET-61-FP-0003 Closed	LH2 4" disconnect to recirculation line flange • P/N 26L2P4H19 drilled head bolts installed • Should be 26L2P4-19 non-drilled head bolts	Use as repaired • Drilled head bolts made from same part number as non-drilled head bolts • Bolt strength not affected
PET-61-FP-0008 Closed	LH2 disconnect teflon purge barrier • Ribbed areas of the teflon purge barrier damaged when wrong configuration plate installed	Use as is • RIC stress analysis assessed remaining teflon for adaquate contact area between purge barrier and orbiter purge curtain attach plate

ET-61 PR/MRBs - Summary

Thermal (TPS)

PR No./Status	Title/Description	Disposition
PET-61-TS-0001 Closed	LH2 umbilical cable tray cover purge hole diameter out of tolerance • Actual: 1.05 inches • Should be: 0.85 inches (max.)	Use as is • Area not subject to aero heating • Adequate thermal protection - Will not compromise acceptable ice/frost formation per NSTS08303 • Venting not affected, vent orifice or SLA diameter not increased beyond engineering requirements
PET-61-TS-0006 Closed	LH2 recirc line: SLA on umbilical end below drawing (80971028411-39) thickness in four places	Use as is • Four areas violate minimum dwg thickness by 0.03 inches or less • Average SLA thickness is above minimum dwg requirements resulting in no loss of thermal protection capabilities

ET-61 PR/MRBs - Summary

Thermal (TPS)

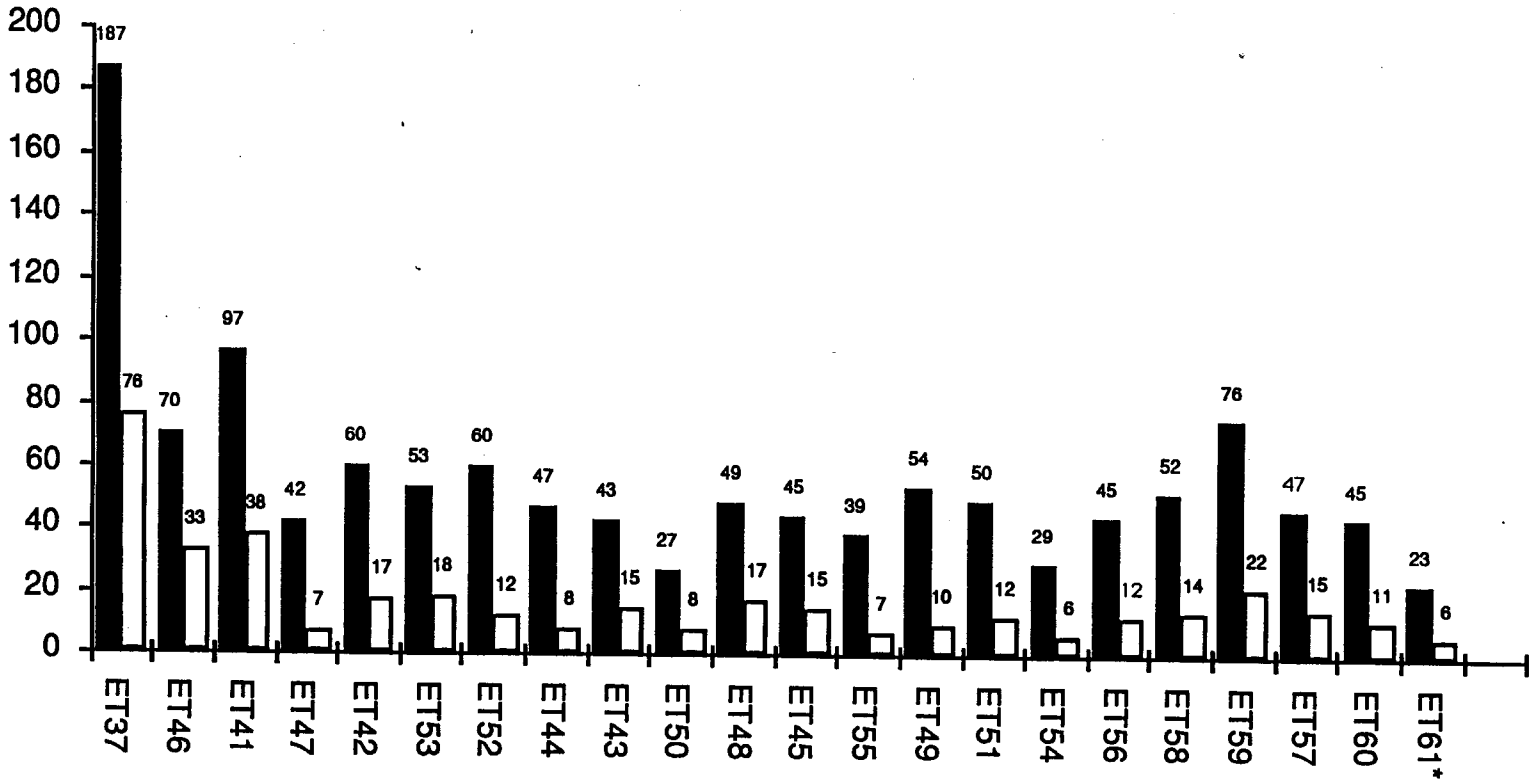
PR No./Status	Title/Description	Disposition
PET-61-TS-0008	Damaged foam around -Y bipod strut • Damaged beyond 0.010" allowable envelope • Dimensions of damaged areas - 0.20" outside envelope, 0.40" long - 0.30" outside envelope, 0.60" long - 0.20" outside envelope, 0.70" long	• Use as is • All loose material removed • MAF Material Science data base indicates cracks of this type do not extend more than 0.1" below visible depth • Shallow cracks not a debris or ice/frost concern

ET-61 PR/MRBs - Summary

Structures

PR No./Status	Title/Description	Disposition
PET-61-ST-0004 Closed	Bipod yoke assembly • Ding (0.0173 inches deep) located on outboard edge of flange mating surface • Scratch (5.0 inches long x 0.0012 inches deep) located on flange mating surface	Use as is • 9X inspection revealed no crack like indications • Defect less than 5% of flange thickness • Raised metal removed

PR/MRB History (1991 - Present)



* Incomplete data

Total PRs
Total MRBs

ET-61 Limited Life Components

Cycle Sensitive

Description	Part No.	Serial No.	Limit	Required	Remaining
LH2 Manhole Cover Assy	80914081488 -019	00000184	100	2	100
LO2 Mechanical Assy	80912002000 -019	00000054	100	1	100
LH2 Mechanical Assy	80914002000 -009	00000054	100	2	100
LO2 Manhole Cover Assy	80911001205 -010	00000150	100	1	100
LO2 Fwd Ogive Cover Plate	80911001207 -020	00000183	100	1	100
LH2 Manhole Cover Assy (Aft Dome)	80911001444 -010	00000320 00000321	100 100	2 2	100 100

ET-61 Limited Life Components

Age Sensitive

Description	Part No.	Serial No.	Limit	Initiation	Expiration
External Tank	80901000000 -230	00000054	6 Yrs	10/91	10/97
RSS Battery A	10406-0133 -801	---	2 Yrs 90 Days	--- ---	--- ---
RSS Battery B	10406-0133 -801	---	2 Yrs 90 Days	--- ---	--- ---
Tumble Valve Nozzle Flight Cover	PD4700193 -004	0000803	5 Yrs 180 Days	5/90 9/93	5/95 3/94

ET-61 Limited Life Components

Age Sensitive Pyrotechnics - 10 Years Life/Requires Lot Verification Tests After 4 and 7 Years

Description	Part No.	Lot No.	Serial No.	Latest Retest	Expiration
Confined Detonating Fuse	10315-002				
	-825	AAB	294	1/93	3/96**
	-826	AAB	250	1/93	3/96**
	-827	AAB	206	1/93	3/96**
	-828	AAB	162	1/93	3/96**
	-829	AAB	340	1/93	3/96**
	-830	AAB	380	1/93	3/96**
	-831	AAB	435	1/93	3/96**
Confined Detonating Fuse Manifold	10312-0002-803	AAT	2002084	4/92	7-Yr, 3/95*
		AAT	2002085	4/92	7-Yr, 3/95*
Safe & Arm Device	10311-0001-803	AAH	2000414	9/92	1/95***
NSD	SEB26100094	JEJ	0000343	10/90	4-Yr, 10/94
	-201	JEJ	0000344	10/90	4-Yr, 10/94

* Oldest sub-assy mfg date of 3/89
** Oldest sub-assy mfg date of 3/86
*** Oldest sub-assy mfg date of 1/85

ET-61 Limited Life Components

Age Sensitive Pyrotechnics - 10 Years Life/Requires Lot Verification Tests After 4 and 7 Years

Description	Part No.	Lot No.	Serial No.	Latest Retest	Expiration
Separator Assy GUCP	PD500020 -059	AAF	0000801	5/92	4-Yr,5/96
Cartridge Assy	PD500020 -030	AAF AAF	69913 69914	5/92 5/92	4-Yr, 5/96 4-Yr, 5/96
Linear Shaped Charge	PD500016 -050	AAJ	0001563	2/91*	4-Yr, 4/94*

* Date of manfacture
** Oldest sub-assy mfg date, 4/90

ET-61 Modification Summary

No.	Description	Status
DC&Rs		
S-91-007	Inspect forward ER/SRB fitting inserts	Closed

Launch Complex 39A and B Upgrades

Description	Reason	Basis for Certification
Delete ET aft feedline heater GSE wiring and LPS capabilities to monitor heater power	• LO2 feedline bracket heaters not activated since STS-45/ET-44 • LO2 feedline bracket heaters will be deleted for ET-71 and subs (B01937)	• Ice/frost formation in this area within acceptable limits
Upgrade Hazardous Gas Detection System (NASA TD DE014) • Sensors upgraded • Mass flow controller used in place of rotometer flow adjustment	• Improved reliability • Improved gas flow control to gas analyzer	• System upgrade only • Validations complete
• Wiring routed through new HIMS	• Separate sensor wiring from LH2 HIMS to a Haz Gas HIM	

STS-60/ET-61 Software Change

Prevent Premature Drain - Implements requirements of RCN MS11684 (effective for STS-58/ET-57)

Description:

- Relax helium injection requirement following an abort/scrub

Was:	**Now:**
- If either LO2 17" manifold disconnect temperature measurement exceeds spec do not reinitiate inject, ***proceed directly to drain***	- If either LO2 17" manifold disconnect temperature measurement exceeds spec ***and remains above limits*** or if helium inject cannot be reinitiated, proceed with drain
- Initiate helium inject flow within 30 seconds ***after start of terminal count safing or engine shutdown***	- Reinitiate helium inject flow within 30 seconds ***after LO2 feed manifold disconnect temps are within limits***

Reason:

- Preclude loss of a recycle opportunity due to a forced premature drain

Rationale:

- Immediate drain is not required during LO2 terminal count drainback even if manifold temps exceed the limit for helium inject reinitiation
- Other requirements insure the vehicle is in a safe configuration while manifold temps decrease to within safe limits for renitiating helium inject

KSC Software Revision Verification/Validation Process B17

- Software changes identified and approved by Technical Review Panel (TRP)
- Code changed and de-bugged against propellant loading model
  - Desk top review performed by MMC Software/Project Engineer
- Software Verification Procedures (SVP) revised by System Engineers
- Software Verification Process
  - Desk top review performed by SPC Quality Engineer
  - Automated "was/is" program listing produced and verified
  - Revised software loaded into simulation firing room
  - Software Verification Procedures (SVPs) performed to test changed code against propellant loading model*

*LO2/LH2 Main Propulsion System Models
- High fidelity
- Reflects system dynamics
- Provides simulation for:
  - Application software
  - De-bug/verification
  - Engineering training
  - Propellant loading

KSC Software Revision Verification/Validation Process B18

- Revised software
  - Used for
    - S0044, Simulated launch
    - S0056, Simulated load (Shuttle Propellant Load Countdown Simulation)
      - LO2/LH2 software all executing concurrently
      - Nominal and contingency operations simulated
      - Provides end-to-end software verification
  - Loaded into operational firing room for hardware use

Note: Unless indicated, both SPC and MMC/LSS personnel are involved in all operations

MRB Assessment Criteria

C1

- First assessment of all MARS Items
  - Adequacy of technical dispositions
  - Completeness of required repair/retest
  - First time occurrences/SMR

- Second assessment of all MRB MARS Items
  - Adequacy of technical dispositions
  - Completeness of required repair/retest
  - Verification of margin of safety assessment/documented
  - Review of impact to hazards
  - Engineering review for impact to loads

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 packackage	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
Range safety system compliance with AFETRM 127-1 and SAMTECM 127-1	S94934 9/10/88	3.5.4.12	388	ETs 28 & 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
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				
*Design pyrotechnics for reliability - No redundant tumble valve	S003422E 6/24/88	3.1	60	ETs 23, 27-29, 31 & up *
Use 40M36298 connectors	S040732F 6/24/88	3.4.1	61	ETs 23,27-29, 31 & up
Epoxy to separate dissimilar metals on LSCs	S040732F 6/24/88	3.5.8	62	ETs 23, 27-29, 31 & up
Circuit resistance check not required after connector mate in tumble system	S040732F 6/24/88	7.3	63	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

* Tumble valve will be deleted at ET-65 - Waiver will be rescinded

MARTIN MARIETTA
MANNED SPACE SYSTEMS

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

Level II Waivers - Baseline

Document/ Requirement	Authority	Paragraph	Waiver No.	Effectivity
SL-E-0001 - Specification Electromagnetic Compatibility Requirement				
Wire marking is not applicable to the ET	S40732K 9/27/88	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 Deviations - Baseline

Document/Requirement	Paragraph	Deviation No.	Effectivity
ICD-2-12001 LH2 17" feedline flange dimension violates ICD requirement for 48 bolt hole pattern • Requirement = 0.469"+0.004"/-0.001" position tolerance within 0.010" to basic pattern diameter • Actual - Bolt hole circle is misclocked by 0.189° in a counterclockwise direction - 8 of the 48 bolt holes were reamed from 0.003" to 0.005" oversize with the as-built bolt hole pattern shifted in the -Y direction 0.008" beyond requirements • Structural margins are unaffected - Hardware not affected by bolt circle clocking - 0.008" true position shift of bolt circle and 8 oversized attach holes do not affect mating operations or installed position of ET/Orbiter disconnect	Rev. M Fig. 3.1-7 View AO-AO	194	61

ICD Waivers - Baseline

Document/Requirement ICD-2-12001	CCBDNo.	PRCBD No.	Effectivity
Waive LH2 17 inch feedline attachment flange misclock (DAR 194)	ET3-008602B	84301A	61