STS-51 & STS-58 LEVEL III
FRR READINESS STATEMENT

ET PROJECT

EXTERNAL TANKS ET-59 & ET-57 IDENTIFIED IN THE STS-51 & STS-58 FLIGHT READINESS REVIEW, DATED JUNE 16, 1993, ARE CONSIDERED READY TO SUPPORT THEIR RESPECTIVE FLIGHTS UPON ACCEPTABLE DISPOSITION OF OPEN WORK AND OPEN ACTIONS.

H. GARRETT, EB21

J. MITCHELL, EL01

M. PESSIN, EE31

R. JACKSON, CP11

for C. KEY, EH01

R. BLEDSOE, CQ21

for H. SMYLY, EP01

L. FOSTER, ED33

P. V. COUNTS, SA31
CHAIRMAN

June 16, 1993

Space Shuttle
External Tank

Delta ET Project

STS-51/ET-59 & STS-58/ET-57 Flight Readiness Review

MARTIN MARIETTA
MANNED SPACE SYSTEMS

Agenda

• Overview	D. Deel
• Prior Mission Performance Summaries	
• STS-51 and STS-58 Highlights	
• ET-59 and ET-57 Highlights	
• Changes	D. Deel/E. Flauss
• SMRBs: No new items	
• SRM&QA Assessment	S. Parikh
• KSC Processing	A. Sarkees
• Verification/Certification - Status	D. Deel
• Mission Unique Assessment	
• Readiness Statement	

- Appendices
  - A: Minor Changes
  - B: SRM&QA
  - C: KSC Processing
  - D: Previously addressed material and miscellaneous supporting documentation

Overview

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

- This Delta review for STS-51/ET-59 and STS-58/ET-57 includes:
  - Missions STS-56/ET-54 and STS-55/ET-56 Performance Summaries
  - Items not previously addressed at prior Block 9 FRRs
  - Items specific to missions STS-51 and STS-58
  - Details of previously addressed items are available in appendix

FRR Series	**STS-51/ET-59**	**STS-58/ET-57**
- Block 9 (ETs 51-60)		
• MMC Corporate	10/21/91	10/21/91
• ET Project/SRM&QA PFA (Baseline)	10/22/91	10/22/91
- Mission Specific Reviews		
• ET/SRB Mate	5/28/93	7/9/93
• Delta Corporate	6/8/93	6/8/93
• Delta ET Project (Baseline)	6/16/93	6/16/93
• Associate Administrator FRR	7/1/93 (U/R)	8/27/93 (U/R)
• Mission Management Team (L-2 Day)	7/13/93 (U/R)	9/8/93 (U/R)

Mission STS-56/ET-54 Performance Summary

System	Launch Abort, 4/6/93 (T-11 seconds)	Launch, 4/8/93
OMRSD/LCC	No ET violations	No ET violations
Instrumentation	Nominal	Nominal
MPS	Nominal * • Faster than expected initiation of drain • Evaluated by MPS community - Recommended changes to the OMRSD loading procedures	Nominal
Hazardous Gas	Nominal	Nominal

* Discussed with OMRSD Changes

Mission STS-56/ET-54 Performance Summary

System	Launch Abort, 4/6/93 (T-11 seconds)	Launch, 4/8/93
TPS	Nominal	Post separation photos revealed divots on the -Z side of the ET Intertank (In-Flight Anomaly) *
ET Disposal	N/A	• Intact impact point within predicted footprint - 42.41 deg S - 154.35 deg W • Approximately 74 NM uprange from preflight prediction
Orbiter Tile Damage	N/A	Average

* Details on subsequent charts

STS-56/ET-54 In-Flight Anomaly

Issue:

- Post separation crew photographs show 10 possible divots in -Z Intertank acreage SOFI
- Unique pattern - 2 lines of 3-4 divots in a line

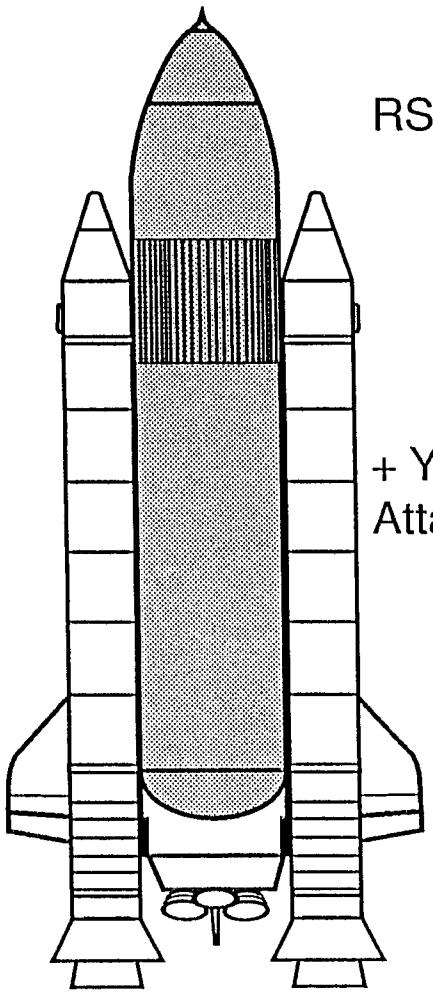
Background:

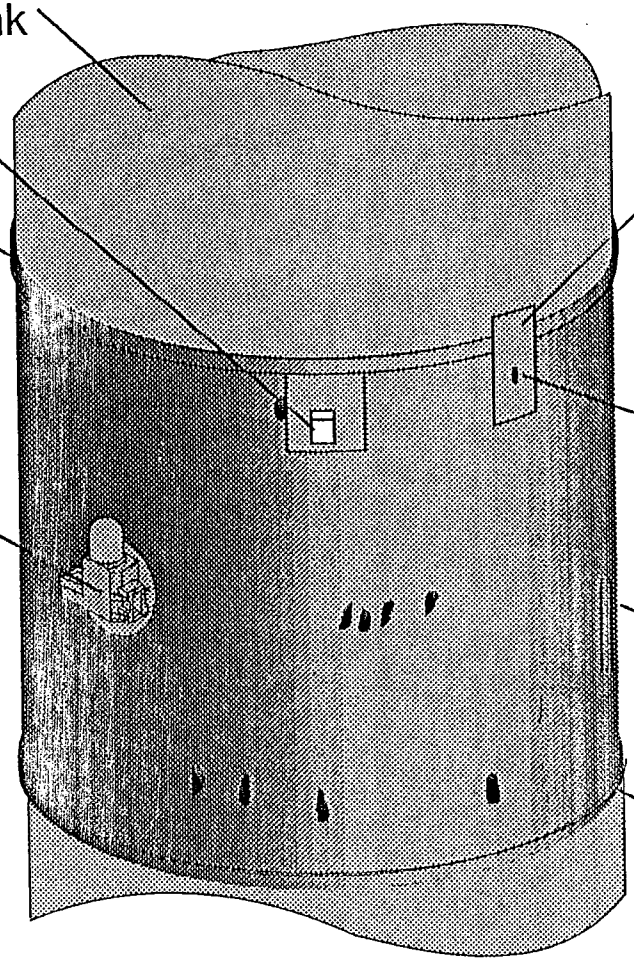
- Intertank TPS divots are within flight experience base
- Flights of same Intertank spray process have exhibited TPS divots

STS-44/ET-53	No photos
STS-42/ET-52	2 divots, +Z side
STS-52/ET-55	No divots
STS-54/ET-51	2 divots, +Z side
STS-56/ET-54	10 divots, -Z side
STS-55/ET-56	3 divots, +Z side

- STS-42 IFA resulted in detailed review of spray process qualification, build and non-conformance paper for ETs 51, 52, and 53
  - No definitive cause identified
- STS-54 divot resulted in MMC special investigation - In progress
  - Focus on +Z TPS processing

STS-56 In-Flight Anomaly





LO2 Tank

RSS Antenna

I/T-LO2 Flange C/O

+ Y ET/SRB Attach Fitting

LO2 Cryoflex Test Panel C/O

- Z Aero Vent

I/T Access Door

I/T-LH2 Flange C/O

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STS-56/ET-54 In-Flight Anomaly

Actions In Process:

- Tiger team formed to reevaluate issue and develop plan of action
  - No cause identified to date
  - No constraints to flight identified
  - ECD 6/28/93

Flight Rationale:

- Divots are within experience base
- Evaluation of divots indicates shallow surface foam loss
  - Photos do not indicate bond line concerns
  - No heating concern for Intertank
- MRB and build paper review for ETs 57 and 59 has been performed
  - Confirmed all acceptance requirements have been met
  - No significant processing anomalies identified
- Orbiter tile damage for STS-56 and other two-gun spray ETs within family
- Recommend no constraint for flight

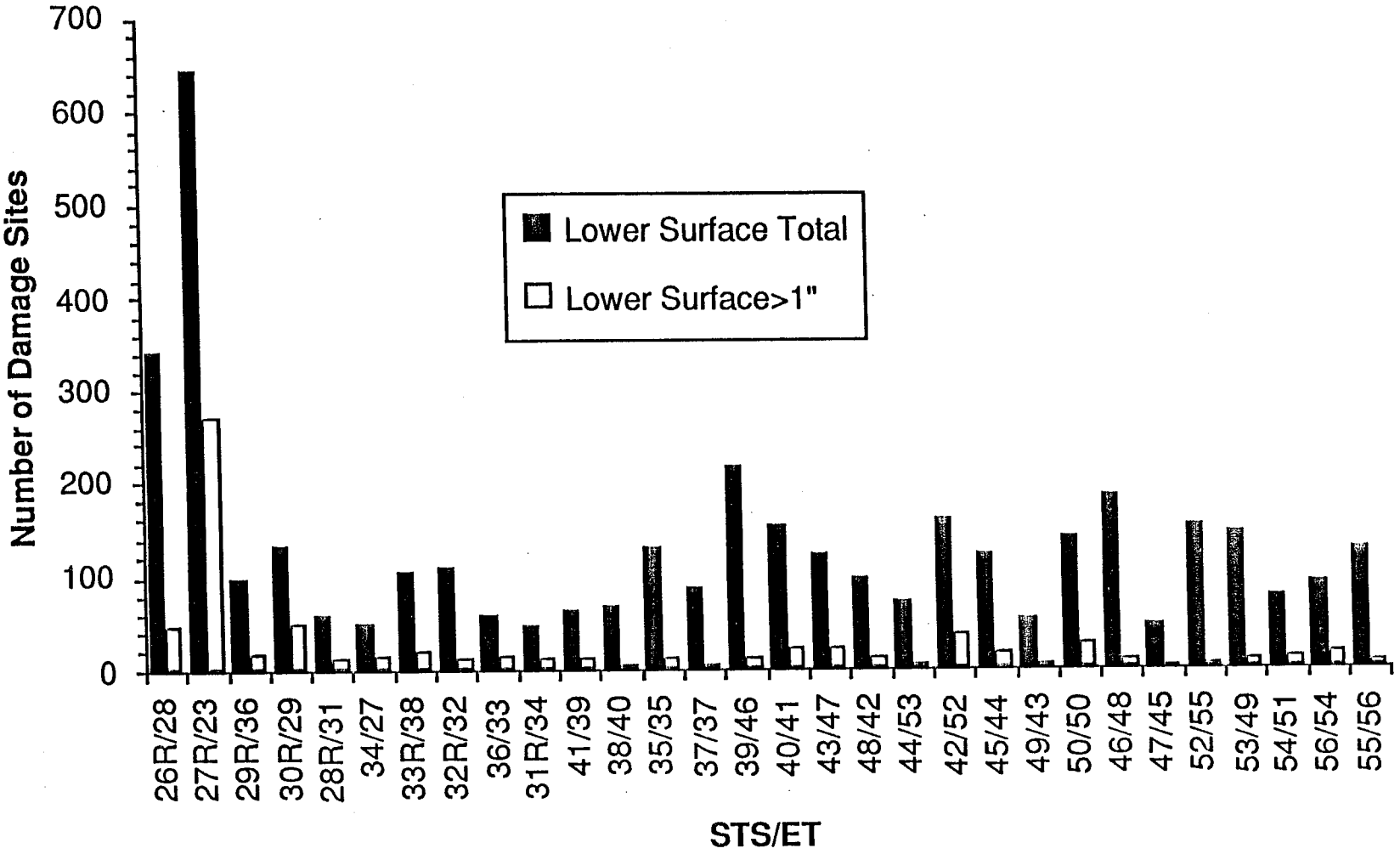
Mission STS-55/ET-56 Performance Summary

System	Launch Abort, 3/22/93 (T-3 seconds)	Launch, 4/26/93
OMRSD/LCC	No ET violations	No ET violations
Instrumentation	Nominal	Nominal
MPS	Nominal	Nominal
Hazardous Gas	Nominal	Nominal
TPS	Nominal	Post separation photos revealed missing jack pad closeout *
ET Disposal	N/A	• Intact impact point within predicted footprint - 12.75 deg N - 163.68 deg W • Approximately 83 NM uprange from preflight prediction
Orbiter Tile Damage	N/A	Average

* Discussed with Configuration Changes

Mission Performance Summary

Orbiter Tile Damage



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MANNED SPACE SYSTEMS

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Mission Highlights

	STS-51/ET-59	STS-58/ET-57
• **Launch**	7/15/93 (U/R)	9/10/93 (U/R)
- Window	9:19 - 10:34 EDT	11:54 - 14:24 EDT
- Pad	B	B
- Orbiter	Discovery (OV-103)	Columbia (OV-102)
- Orbital inclination	28.45 deg - Direct insertion at 160 NM	39 deg - Direct insertion at 153 NM
- ET photo coverage	Crew photos from cockpit window	Crew photos from cockpit window Umbilical well cameras
• **Mission payload**	Spacehab ACTS * (Advanced Communications Technology Satelitte) TOS * (Trans Orbit Stage)	SLS-2 (Space Life Sciences)
• **Landing**	7/25/93 (U/R)	9/24/93 (U/R)
- Time	07:18 EDT	12:17 EDT
- Location	KSC	KSC

* Martin Marietta Corporation Payloads

ET Highlights

	STS-51/ET-59	STS-58/ET-57
• **DD250 acceptance**	3/27/91	7/26/90
- Shipped to launch site	1/29/92	3/19/93
- Age at launch	27 months	32
• Certification: 72 months		
• **Nose cone**	No AADS	AADS

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Changes - List

New Items since Block 9 FRR, 10/91

Description	STS-51/ET-59	STS-58/ET-57	Presentation
• **Documentation/Configuration**			
- ET/SRB aft fairing splice plate fasteners (B01777D)	X		Appendix A
- Jack pad and third hardpoint closeout enhancements (B01945A)	X	X	Presented
• **OMRSD (Pending approval)**			
- ET nose cone heated purge (KS11646)	X	X	Appendix A
- LO2 loading changes (MS11648A)	X	X	Presented
- Prevent premature drain (MS11684)	X	X	Presented

Enhance Jack Pad & 3rd Hardpoint Closeouts (B01945A)

Background:

- ET separation photos revealed missing jack pad closeouts on 5 ETs
- TPS working group initiated effort to develop/validate enhanced PDL foam closeouts for the jack pad and third hardpoint load pad locations

Reason:

- Reliability enhancment - Provide more reliable/repeatable application process

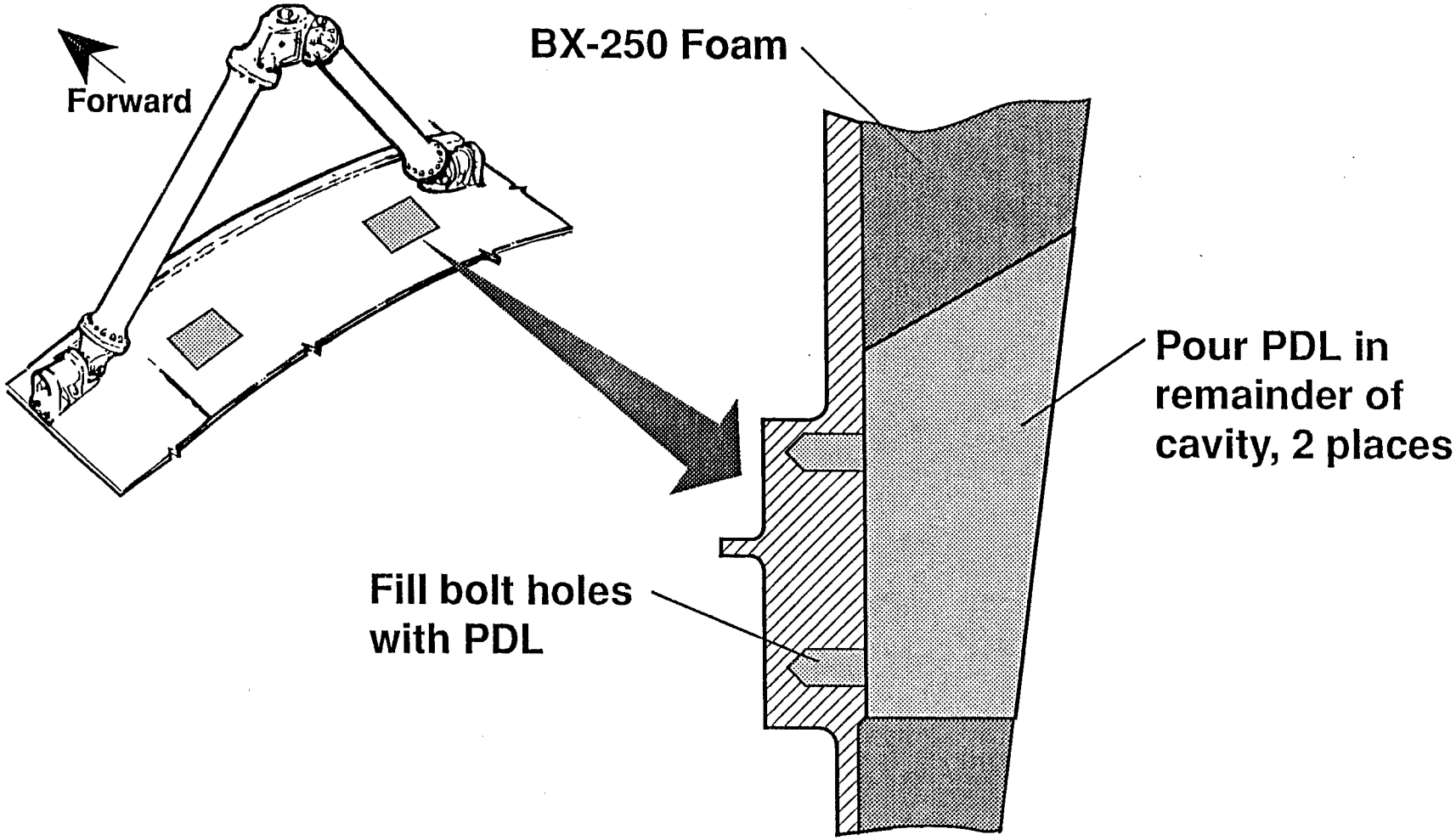
Description:

- Replace one-step PDL applicaton with two-step application for jack pad and third hardpoint closeouts
  - Fill bolt and alignment guide holes with PDL
  - Final PDL application over remainder of cavity

Basis for Certification:

- Development/validation tests
  - Cryogenic/vacuum exposure/bond strength/dissection
- KSC technician proficiency demonstration/certification

Enhance Jack Pad Closeout (B01945A)



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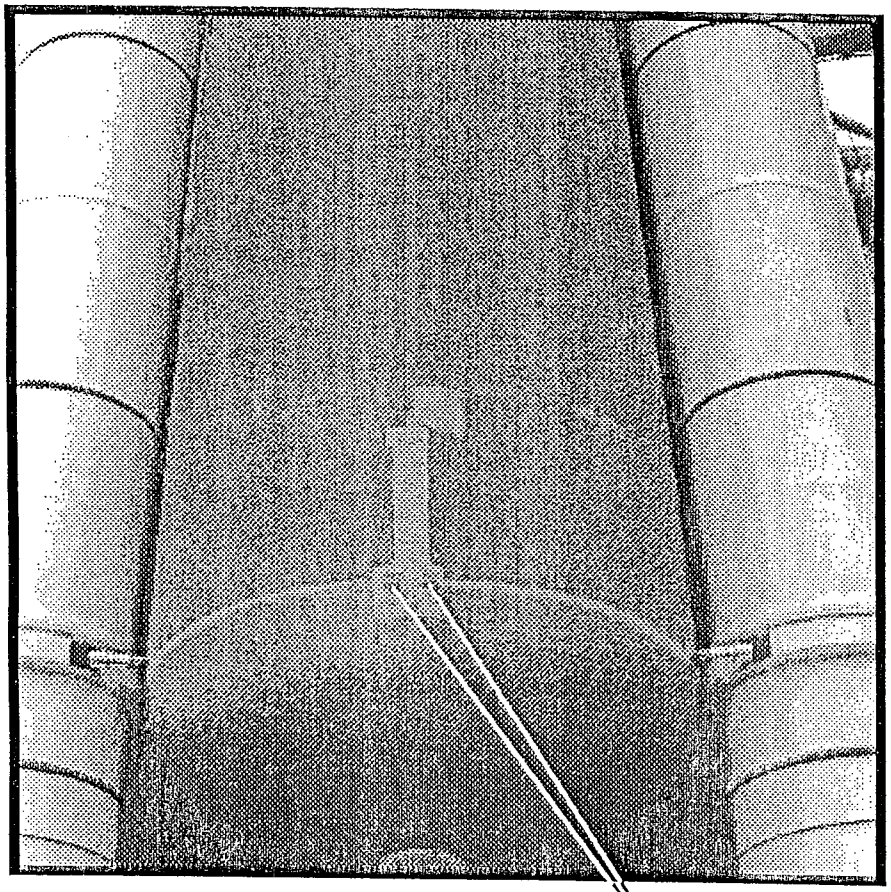
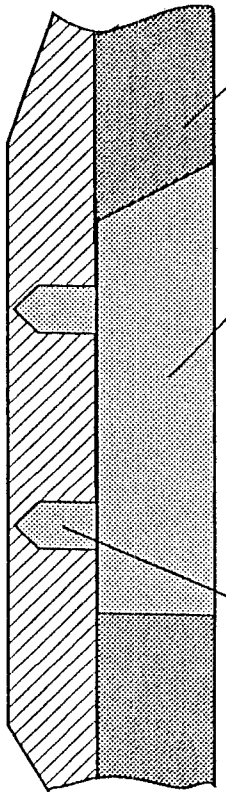
Enhance 3rd Hardpoint Closeout (B01945A)



Third hardpoint load pads



BX-250 Foam

Pour PDL in remainder of cavity, 2 places

Fill bolt holes and alignment guide holes with PDL

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Prevent Premature Drain (RCN MS11684)

Background:

- PSIG recommended change to MPS drain initiation procedures
  - Resulting from faster than expected drain initiation on STS-56 launch scrub

Reason:

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

Description:

- Relax helium inject reinitiation requirement following an abort/scrub

Was	**Now**
- If either LO2 17" manifold disconnect temperature measurement exceeds spec do not reinitiate helium 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*

ET Evaluation:

- No impact to ET hardware
- Other geyser-avoidance requirements insure the vehicle is in a safe configuration while manifold temps decrease to within safe limits for reinitiating helium inject

SMRBs - List

Previously presented at Block 9 FRR - Included in Appendix D

Description

- **STS-51/ET-59: None**

- **STS-58/ET-57**
  - LH2 Feedline
    - 0.100" porosity in internal circumferential weld (T93850)
    - 0.035" porosity in bellows circumferential weld (T98829)
    - 0.035" - 0.175"(5) lack of fusion in elbow support bracket (T98829)
  - GH2 pressure line, 0.100" void in link on flexible elbow BSTRA (T98832)

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SRM&QA Assessment

Item	Status
• **Alerts**	None
• **MRB Assessment**	Complete - No issues/no impact to hazard controls
- MRB MARS Items	STS-51/ET-59: 374 — STS-58/ET-57: 420
- PR/MRBs	STS-51/ET-59: 8 — STS-58/ET-57: 6
• **Hazard Assessment**	Complete - All hazards reports were re-assessed and hazard controls verified
• **Corrective Action Problem Summary (CAPS)**	No constraints (Discussed on subsequent charts)

CAPS - Summary/Status

CAPSNo.	Crit	Title/Description	Vehicle Clearance	Status/ECD
E-151	1	Connector failed a dielectric withstand voltage test (DWV)	All ETs cleared • All delivered ETs passed acceptance tests	Under investigation, ECD 7/23/93
T-065PF *	1	Missing foam on ET-54 Intertank	All ETs cleared • Divots are within experienced data base • Evaluation of divots indicate shallow surface foam loss	Under investigation, Deferred until 10/23/93

* Previously discussed as STS-56/ET-54 In-Flight Anomaly

CAPS - Summary/Status

CAPS No.	Crit	Title/Description	Vehicle Clearance	Status/ECD
S-076A	N/A	Frame segment have thickness violation in web details	• ETs thru ET-59 cleared - Parts received from different supplier • ETs 60 thru 68, 70, 71, 72, 73, and 75 cleared by test and analysis • ETs 69 and 74 cleared by DC&R inspection • ET-76 and subs cleared by inspection of MAF stock	Corrective action in progress, ECD 6/18/93
S-077	N/A	Web details are suspect having low material properties	• ETs thru ET-59 cleared - Parts received from different supplier • ETs 60 and subs cleared by test and analysis	Under investigation, ECD 6/18/93

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KSC Processing - Status

as of 6/9/93

- **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 Waiver ***
  - ET-59, LO2/LH2 tank pressures not recorded for 5 consecutive days after tank move

* Included in Appendix C

KSC Processing - Status

as of 6/9/93

• **Changes ***	STS-51/ET-59	STS-58/ET-57
- ET modifications		
• Mod Kit (1*)	3	2
• DC&R (Discrepancy Check and Report)	2	2
• Bldg 45	1	1
• FEC (Field Engineering Change)	0	0
- Software	0	0
• SIM Load	7/2/93	8/27/93
• SIM Launch	6/18/93	8/17/93

* Included in Appendix C

(1*) First time modification - Previously presented with Configuration Changes

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Verification/Certification - Status

Item	Status
• **NSTS 07700 Volume X Baseline** - Revision K, Change 191	**No constraints**
• **Certification documentation** - Hardware Certification Sheets (HCS) - Certificates of Qualification (COQ)	**Complete - No issues**
• **Waivers/Deviations**	**No new items**

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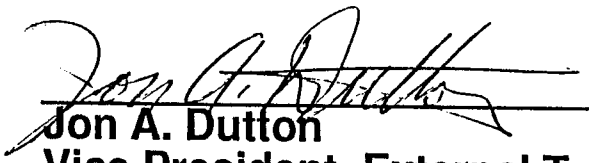
Mission Unique Assessment

Category/Item	STS-51/ET-59	STS-58/ET-57
• Vehicle loads	Complete - No issues	ECD 8/13/93
• Thermal assessment - Ascent - Intact abort and reentry	Complete - No issues	ECD 8/13/93
• Review of MRB actions using updated loads and environmental data	Complete - No issues	ECD 8/13/93
• MPS Preflight Prediction Package	ECD 7/6/93	ECD 9/1/93

ET-59 Readiness Statement

The External Tank, ET-59, is hereby certified and ready for STS-51 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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ET-57 Readiness Statement

The External Tank, ET-57, is hereby certified and ready for STS-58 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

- B: SRM&QA
  - MRB Assessment Criteria
  - Details of CAPS

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

- D: Miscellaneous supporting documentation and previously reviewed material
  - SMRBs
  - Waivers/Deviations

ET/SRB Aft Fairing Splice Plate Fastener (B01777D) A1

Description:

Revised Pack & Ship drawing and KSC Planned Work drawing reference callouts to reflect proper fastener and washers as called out on build/assembly drawings

- **Was:** 26L3-3-9 fastener and one washer
- **Now:** 26L3-3-8 fastener and two washers

Reason:

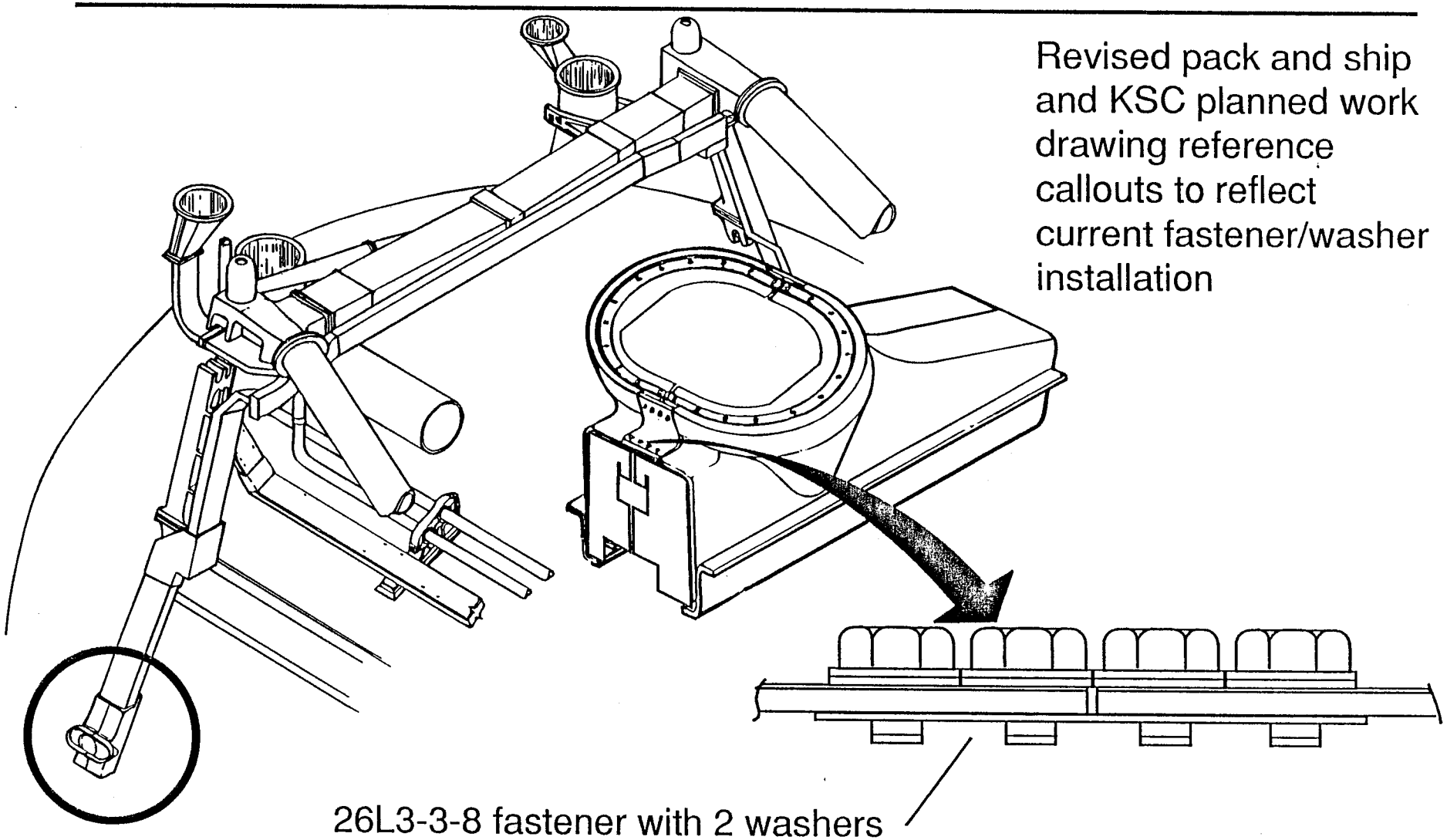
- Build/assembly drawings previously revised as result of bolt shanking/grip length investigation
  - Pack & Ship drawing and KSC Planned Work drawing reference callout inadvertently omitted

Basis for Certification:

Documentation only - Correct fastener and washer installed

ET/SRB Aft Fairing Splice Plate Fastener (B01777D)

A2



Revised pack and ship and KSC planned work drawing reference callouts to reflect current fastener/washer installation

26L3-3-8 fastener with 2 washers

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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 - List

Change No.	Description
Electrical	
H50001-699	Allow use of tape an as alternate to split tubing for wire abrasion protection material on the LO2 aft level sensor mast
Logistics	
H34809-662	Add 8 year life to nose cone requirement and include spike assembly and fairing assembly to SCID
Propulsion	
H34809-530	Clarify bond strap drawing part built per correct intent - Documentation change
H34809-644	Lift freeze order on rework of LSCs for use on LO2 tank (B01948A)
H50001-707	Clarify 7" QD bellows drawing to reflect proof pressure and leak test media presently used - Documentation only

Class II or JS/DCN Changes - List

Structures

Change No.	Description
H34809 -557	Clarified counterbore depth on LH2 tank Station 1973 frame machined fitting
-645	Corrected slot dimension on LH2 forward sensor mast bracket which was omitted in error
-649	Relaxed true position tolerances on LO2/Intertank and LH2/Intertank mating flange hole patterns to accommodate drill templates
-650	Reinstated dimensions on LH2 anti-vortex baffle bracket that were omitted in error
-656	Clarified dimensional verification requirements of nose cone fairing assembly for restrained and unrestrained conditions

Class II or JS/DCN Changes - List

Structures

Change No.		Description
H34809	-661	Corrected line and fillet representations on field of drawing for GH2 vent line bracket detail
	-665	Clarified notes to specify shim locations for LO2/Intertank mating flange
	-676	Revised method of dimensioning stiffener locations on LO2 slosh baffles ring frame webs to accommodate vendor request
	-671	Added dimension extension line to LO2 manhole fitting machining drawing which was inadvertently omitted
H50001	-626	Corrected quantities of hi-lok collars on parts list for LH2 frame installation at manufacturing request
	-670	Revised part marking location for LH2 forward dome to facilitate inspection

Class II or JS/DCN Changes - List

Change No.	Description
TPS	
H34809-625	Acceptance criteria for defects adjacent to nose cone
H34809-643	Replace DA-15 adhesive with conathane

STM/STP Changes - List

Material Science

Change No.	STM/STP	Description
H34809-651	K170	Added manufacturer's code numbers to specification and deleted color requirements for Zinc Chromate primer solvent
H34809-658	32L8 32L10	Revised tolerance on flex hose hard tubing portion lengths from +/- 0.010 to +/- 0.030"
H34809-666 -667	1510 (MAF and KSC)	Updated material designations in reference list and provided single max open time requirement independent of humidity for DC-1200 primer for handpack SLA
H50001-716	3006	Lowered Chromium content of proof test water from 65 to 10 ppm for environmental/toxicity reduction
H50001-718	F144	Lowered temperature requirement for recovering heat shrinkable tubing prior to LO2 impact testing

MRB Assessment Criteria

- 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

Connector Failed DWV Test (CAPS E-151)

Problem: NB series connector failed a dielectric withstand voltage test (DWV)

Background:
- Failure occurred at MAF during acceptance test in Final Assembly area, ET-68
- Harness had a resistance less than the minimum acceptable value of three (3) megohms at 1500 volts
- Troubleshooting of the harness isolated failure to the connector insert
- Defective connector was assembled by Time Electronics from components manufactured by ITT Cannon
- Manufacturer had a identical failure reported by another customer
- Both failed connectors had inserts from the same production run
- Manufacturer will identify all connectors associated with the insert production run used in the failed connectors
- Failure analysis found particle inclusion in phenolic insulation between pins

Cause: Inclusion in phenolic insulation

Vehicle Clearance: All ETs cleared - all delivered ETs have passed the acceptance test and service voltage in Crit 1 circuit does not exceed 32 VDC and 100 AC on Crit 3 circuits

Alert:
- MMMSS internal alert has been issued
- GIDEP alert in approval loop

Corrective Action: Pending results of supplier investigation

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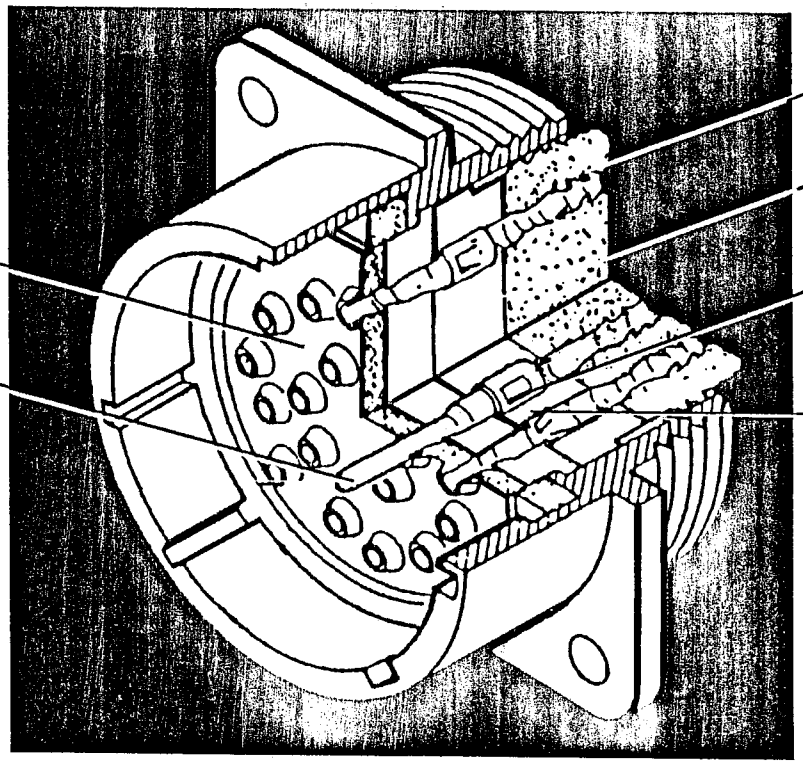
Connector Failed DWV Test (CAPS-151)



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Missing Intertank Acreage Foam (T-065 PF)

Problem: Missing Intertank acreage foam on the -Z axis for STS-56/ET-54

Background:
- Missing foam observed on review of photographs taken during ET separation on STS-56
- Intertank Foam Configuration
  - ETs 51 and Sub - Two gun spray system (CPR only)
  - ET-1 thru 50 - Two tone foam (CPR over BX)
- A team has been formed to evaluate the anomaly and analyze the process

Cause: Under investigation

Vehicle Clearance: All ETs cleared
- Based on previous flights of the same Intertank (two gun spray) configuration the following applies:
  - Divots are within experience base
  - Evaluation of divots indicates shallow surface foam loss

Corrective Action: Pending investigation

ET Station 1973 LH2 Tank Frame Webs (S-076A)

Problem: LH2 Station 1973 frame segment have thickness violations in the web details

Background:

- Discovered during assembly at MAF
- MCI supplier for ET-60 and subsequent
- Inspected 241 LH2 Frame Segment Assemblies
  - Seventeen (17) parts found undersize
- Test/analysis performed on parts resulted in Engineering Use-As-Is
- All critical and selected non-critical parts supplied by MCI were sample inspected at MAF
  - A total of 1,667 parts inspected
  - Three (non-critcal) parts were identified as having minor under thickness discrepancy

Cause: Probable Cause(s):

- Subcontractor build process revealed lack of adequate controls on etching process and no thickness verification after etching
- Material was sanded using an automated grinding machine to remove scratches from raw stock during the first ship set

ET Station 1973 LH2 Tank Frame Webs (S-076A)

Vehicle Clearance:

- ETs through ET-59 have been cleared since they were received from previous supplier (Teledyne Aero-Cal)
  - Supplier documentation verifies that thickness measurements were taken of web details prior to etching and chem filming
  - Webs were then sent to a subcontractor for a controlled etching process Upon return of the parts to Teledyne, thickness measurements were taken again and accepted by MMMSS QAR
- ETs 60 through 68, 70, 71, 72, 73 and 75 have been cleared by multi effectivity MARS based on test and analysis
- ETs 69 and 74 have been inspected per DC&R with no discrepancies found
- ET-76 and subs have been cleared by inspection of MAF stock

Corrective Action: Coordination of corrective action is in process with the Supplier

ET Station 1973 LH2 Tank Frame Webs (S-077)

Problem: Web details are suspect of having low material properties

Background:
- Anomaly discovered during investigation of web thickness issue (Ref. CAPS S-076A)
- Worst case thickness web panel tested to determine actual tensile strength values
- Panel failed min yield (48.6 KSI) and ultimate (60.6 KSI)
  - Required = yield 50 KSI min and ultimate 64 KSI min
- One additional low thickness panel tested and found to be within drawing requirements
- Two panel submitted by MCI (etched and unetched) tested at MAF and found to be within drawing requirements
- Engineering performed an analysis for worst case yield and ultimate
  - Webs acceptable for flight
  - Worst case - FTy = 47.0 KSI and FTu = 59.0 KSI

Cause: Probable Cause(s):
- Slack quench - time from furnace to quench water >15 seconds, or steam pockets formed decreasing cooling rate
- Over aged - approximately 14 hours could give similar properties (double normal age time)

Vehicle Clearance:
- ETs through ET-59 have been cleared since they were received from a previous supplier (Teledyne Aero-Cal)
- ET-60 and up cleared by Engineering rationale based on worst case analysis

Corrective Action: Pending completion of investigation

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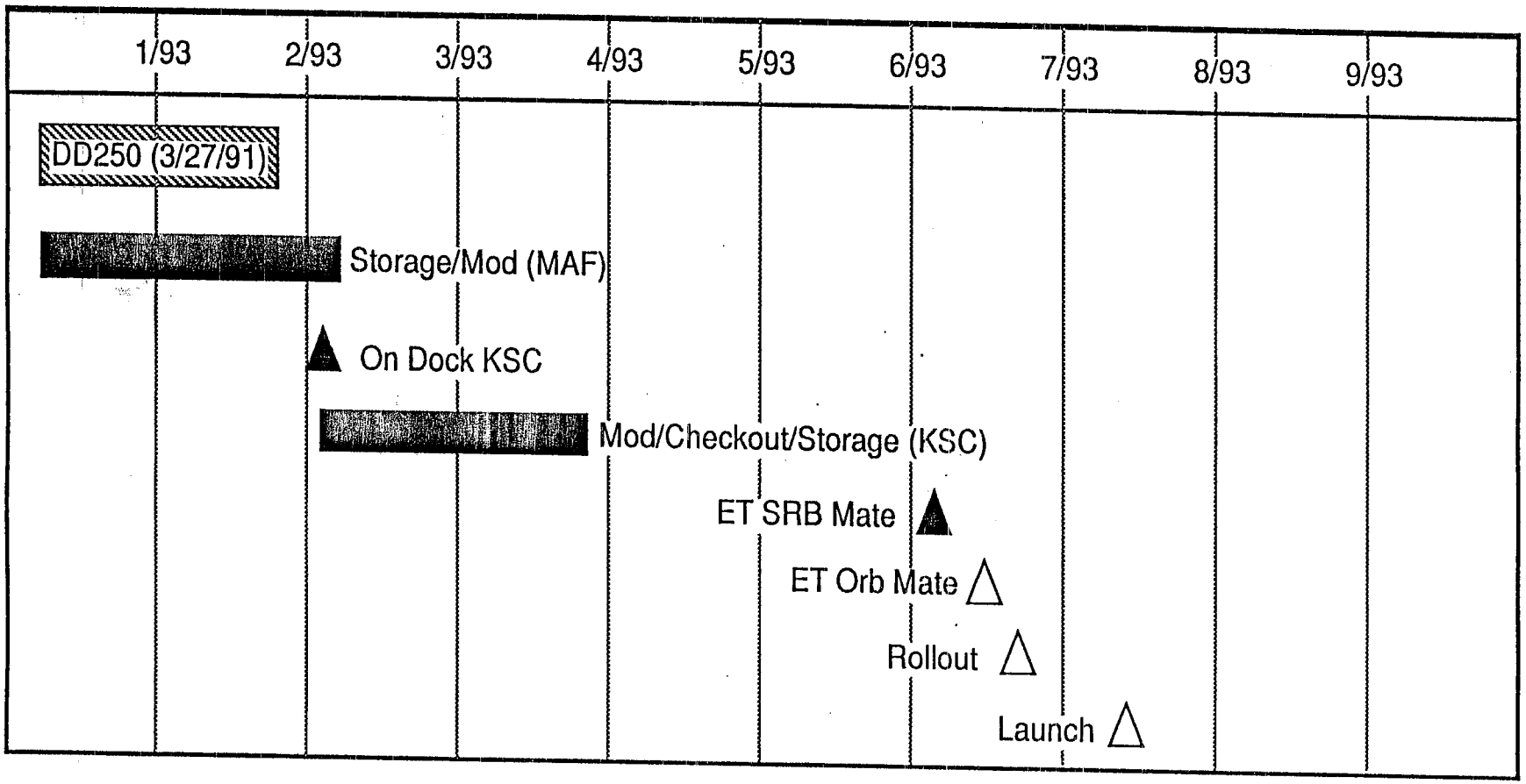
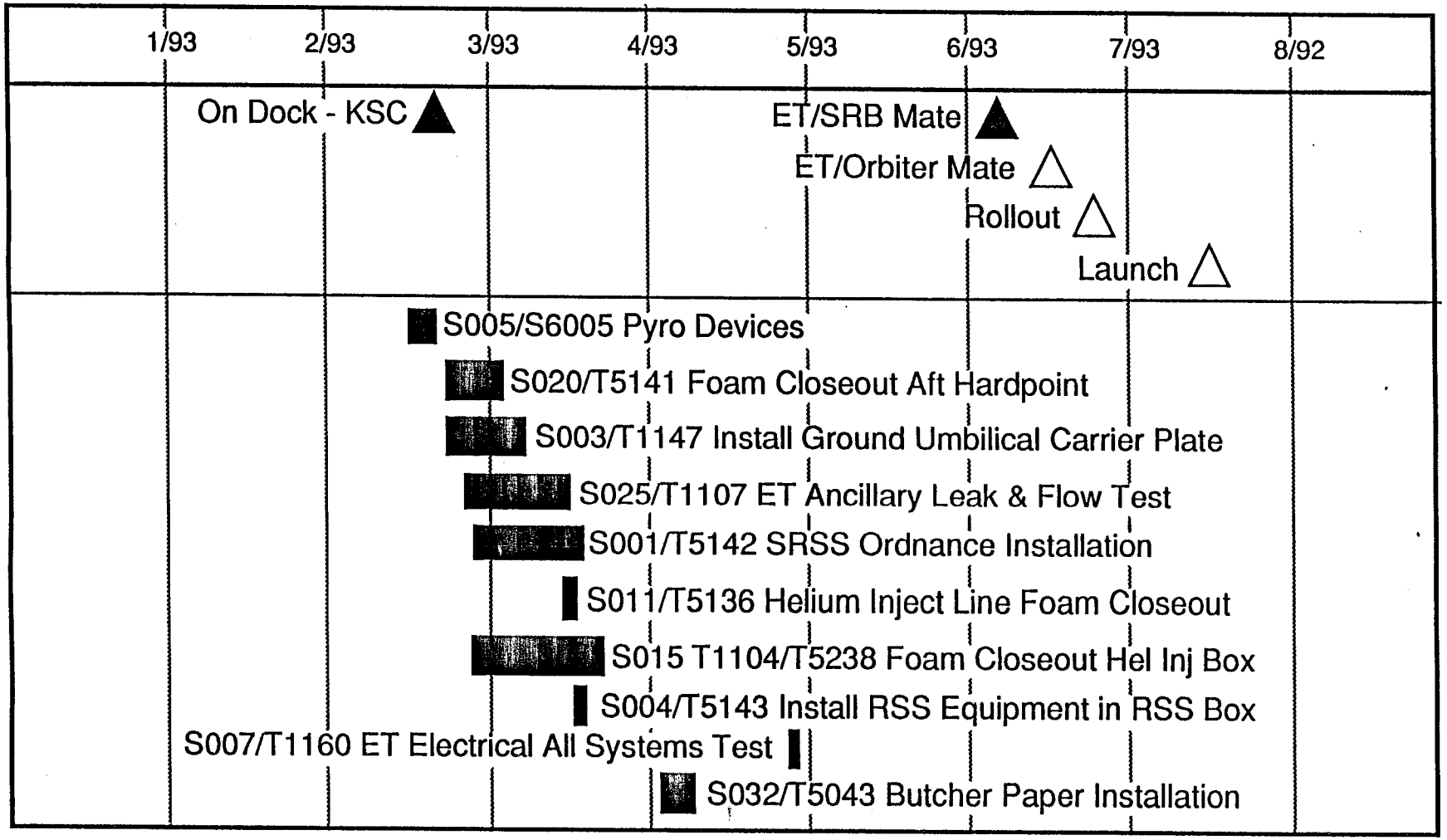
MANNED SPACE SYSTEMS

ET-59 Processing Schedule

C1



ET-59 Planned Work



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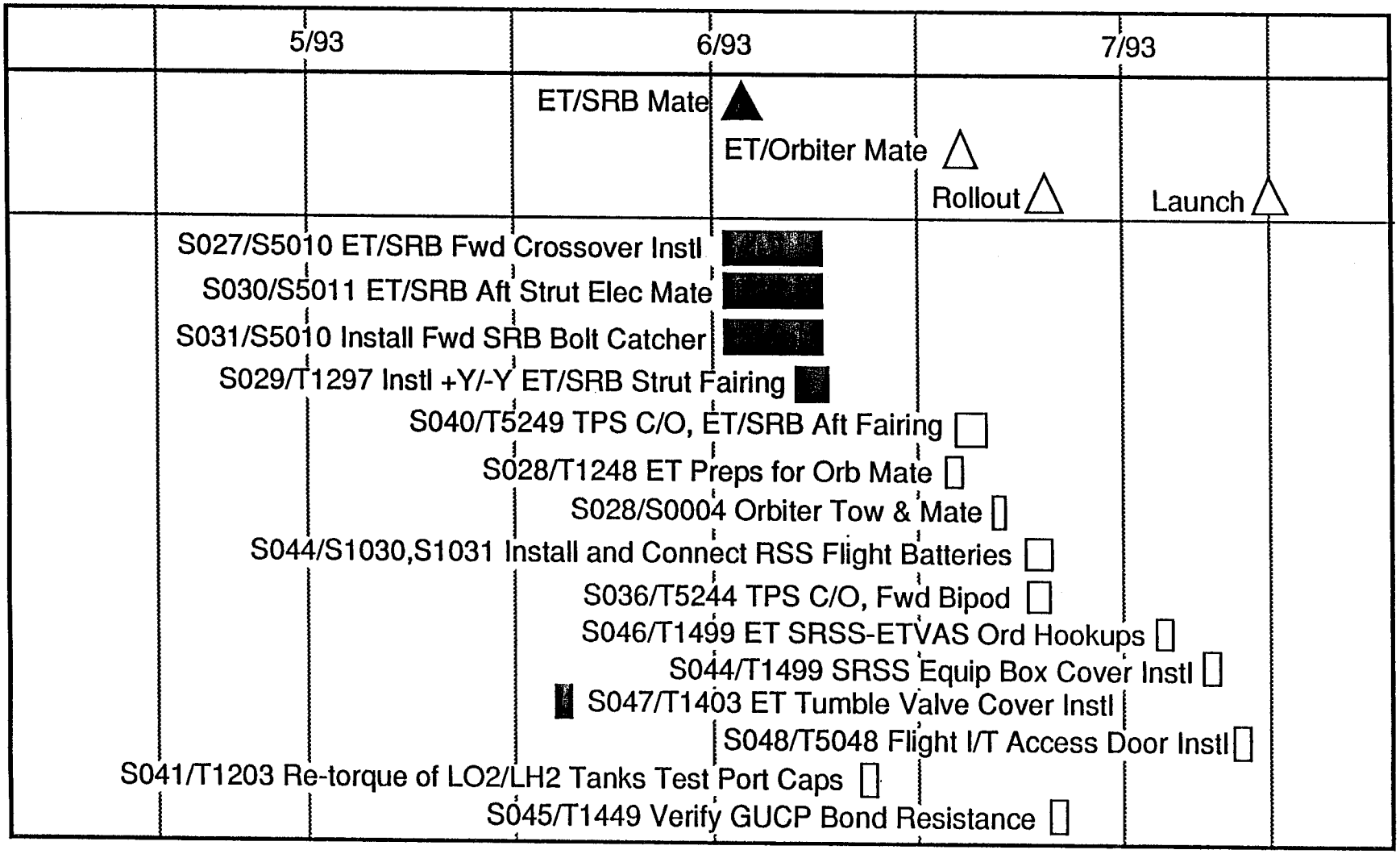
MANNED SPACE SYSTEMS

ET-59 Planned Work

C3



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MANNED SPACE SYSTEMS

ET-59 DR/PR/OMRSD Waivers/Exceptions - Summary C4

as of 6/9/93

Discipline	Discrepancy Total	Problem Total	MRB Items Total	MRB Items (Open)	Waivers/ Exceptions Total	Waivers/ Exceptions (Open)
• Electrical	1	1	**0**	**(0)**	0	(0)
• Propulsion/Pneumatics	1	14	**1**	**(0)**	1	(0)
• Range Safety	0	2	**1**	**(0)**	0	(0)
• Structures	1	9	**3**	**(1)**	0	(0)
• Thermal (TPS)	0	12	**3**	**(0)**	0	(0)
Total	3	38	**8**	**(1)**	1	(0)

ET-59 PR/MRBs - Summary

Propulsion

PR No./Status	Title/Description	Disposition
PET-59-FP-0006 Closed	LH2 2 in. disconnect support frame (RIC GFE) - 1.0 in. (L) X 0.032 in. (D) tooling mark on surface of frame	• Use as is • Documents tooling mark

ET-59 PR/MRBs - Summary

Range Safety

PR No./Status	Title/Description	Disposition
PET-59-RSS-0001 Closed	Missing threads on one of five 33L9 nutplates used to support the LSC in the LO2 cable tray has missing threads	• Tap threads • Install fasteners with locktite • Use as repaired

ET-59 PR/MRBs - Summary

Structures

PR No./Status	Title/Description	Disposition
PET-59-ST-0001 Closed	Raised metal on the EB-1 bearing surface • Raised metal was removed • Dye penetrant inspection performed • No finish re-applied to bare metal	• Bare metal areas are outside of critical bearing surface • Use as repaired
PET-59-ST-0002 Closed	Raised metal on the EB-2 bearing surface • Raised metal was removed • Dye penetrant inspection performed • No finish re-applied to bare metal	• Bare metal areas are outside of critical bearing surface • Use as repaired
PET-59-ST-0009 Open	Nick on bipod yoke fitting damaged during handling - Measures 0.008" deep • No dye penetrant performed • Raised metal removed • Primer applied	• Nick on non-critical, high margin area • Interactive faces of yoke fitting not involved • Use as repaired

ET-59 PR/MRBs - Summary

Thermal

PR No./Status	Title/Description	Disposition
PET-59-TS-0002 Closed	Missing area of SLA on edge of ET/SRB aft fairing - Measures 0.5 in. (L) X 0.5 in. (W) X 0.125 in. (D)	• Use as is • PDL applied to area in conjunction with aft fairing TPS closeout • PDL will provide adaquate thermal protection
PET-59-TS-0003 Closed	Gouge in aft dome NCFI approximately 20 in. below Station 2058 on +Y side of aft hardpoint - Measures 0.75 in. (L) X 0.50 in (W) X 0.62 in. (D)	• Repair with PDL • Remaining NCFI and PDL will provide sufficient thermal protection during cryo loading and ascent
PET-59-TS-0010 Closed	Void in LH2 recirculation line BX250 closeout - Measures 3.0 in. (L) X 0.37 in. (W) X 0.25 in. (D)	• Repair with PDL • Remaining BX and underlying ablator will provide sufficient thermal protection during cryo loading and ascent

ET-59 OMRSD, File IV - Waiver

Waiver No./Status	Description	Acceptance Rationale
WK02748R2	LO2/LH2 tank pressures not recorded for 5 consecutive work days after move	Tank pressures taken after the move when compared to pressures taken before the move showed that no degradation occurs

ET-59 Limited Life Components

Cycle Sensitive

Description	Part No.	Serial No.	Limit	Required	Remaining
LH2 Manhole Cover Assy	80914081488 -019	00000181	100	2	100
LO2 Mechanical Assy	80912002000 -019	00000052	100	1	100
LH2 Mechanical Assy	80914002000 -009	00000052	100	2	100
LO2 Manhole Cover Assy	80911001205 -010	00000146	100	1	100
LO2 Fwd Ogive Cover Plate	80911001207 -020	00000180	100	1	100
LH2 Manhole Cover Assy (Aft Dome)	80911001444 -010	00000314 00000315	100 100	2 2	100 100

ET-59 Limited Life Components

Age Sensitive

Description	Part No.	Serial No.	Limit	Initiation	Expiration
External Tank	80901000000 -229	00000052	6 Years	3/91	3/97
RSS Battery A	10406-0133 -801	---	2 Years 90 Days	--- ---	--- ---
RSS Battery B	10406-0133 -801	---	2 Years 90 Days	--- ---	--- ---
Tumble Valve Nozzle Flight Cover	PD4700193 -004	0000711	5 Years 180 days	5/90 5/93	5/95 11/93

ET-59 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	10315-0002				
	-825	AAB	291	1/93	3/96**
	-826	AAB	248	1/93	3/96**
	-827	AAB	204	1/93	3/96**
	-828	AAB	160	1/93	3/96**
	-829	AAB	337	1/93	3/96**
	-830	AAB	377	1/93	3/96**
	-831	AAB	433	1/93	3/96**
Confined Detonating Fuse Manifold	10312-0002-803	AAT	2002119	4/92	7-Yr, 3/95*
		AAT	2002123	4/92	7-Yr, 3/95*
Safe & Arm Device	10311-0001-803	AAH	2000410	9/92	1/95***
NSD	SEB26100094	JEJ	0000278	10/90	4-Yr, 10/94
	-201	JEJ	0000292	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-59 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	PD5000020-059	AAD	0001112	12/92	4-Yr, 2/96
Cartridge Assy	PD5000020 -030	AAD	11195	12/92	4-Yr, 2/96
		AAD	11196	12/92	4-Yr, 2/96
Linear Shaped Charge	PD500016 -050	AAJ	0001560	2/91	4-Yr, 4/94

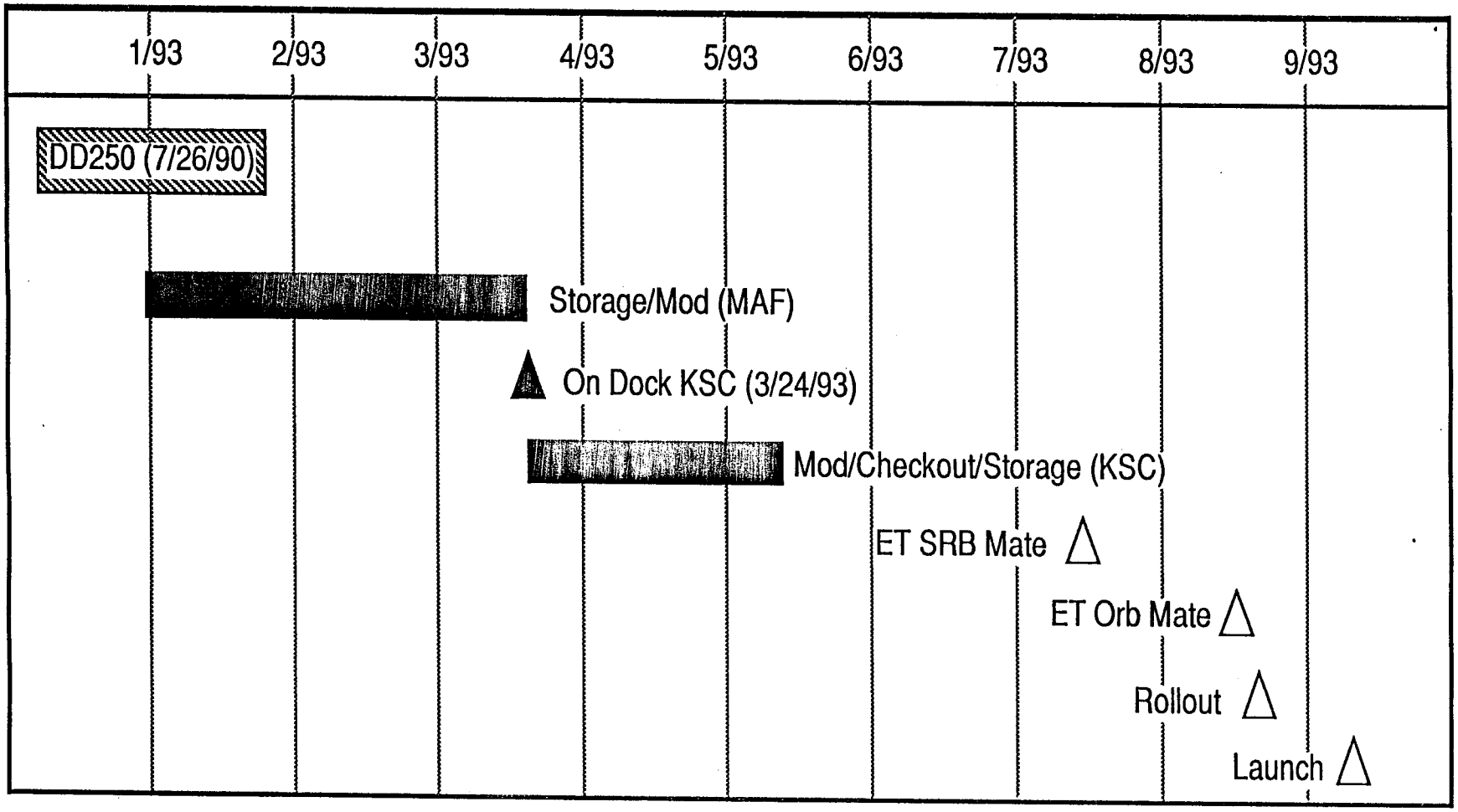
ET-59 KSC Component Replacement List

Part Name	Part Number	Serial Number Removed	Serial Number Installed	Authority
CDF Manifold	10312-0002-803	0000632 0000633	2002123 2002119	ET-59-RSS-001/ H0595B
Bipod Yoke Shear Pin	80911009181 -007	0000499	0000458	ET-59-ST-001

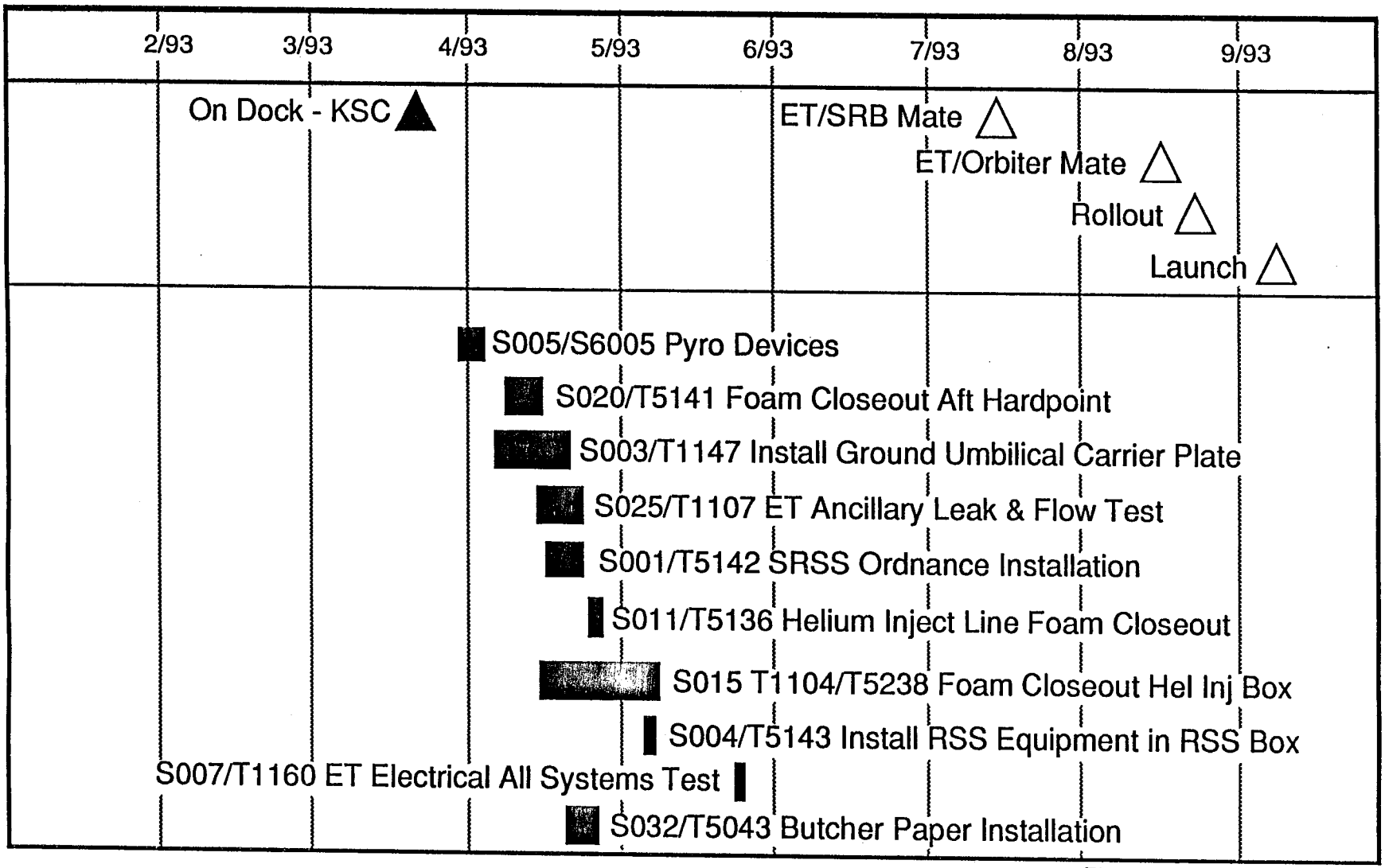
ET-59 Changes, Modification Summary

No.	Description	Status
Mod Kits		
E117/B01857A	Helium inject box line closeout with MMSH135A fiberglass tape	**Closed**
E119/B01777D	ET/SRB upper aft fairing fastener modification	In Work
E120/B01945A	Enhanced jack pack and third hardpoint closeout process at KSC	Open
DC&Rs		
T-91-006	Inspect LH2 umbilical cable tray fairing closeout	**Closed**
S-91-007	Inspect forward ET/SRB fitting inserts	**Closed**
Bldg. 45		
H0595B	Remove and replace (2) CDF manifolds	**Closed**

ET-57 Processing Schedule



ET-57 Planned Work



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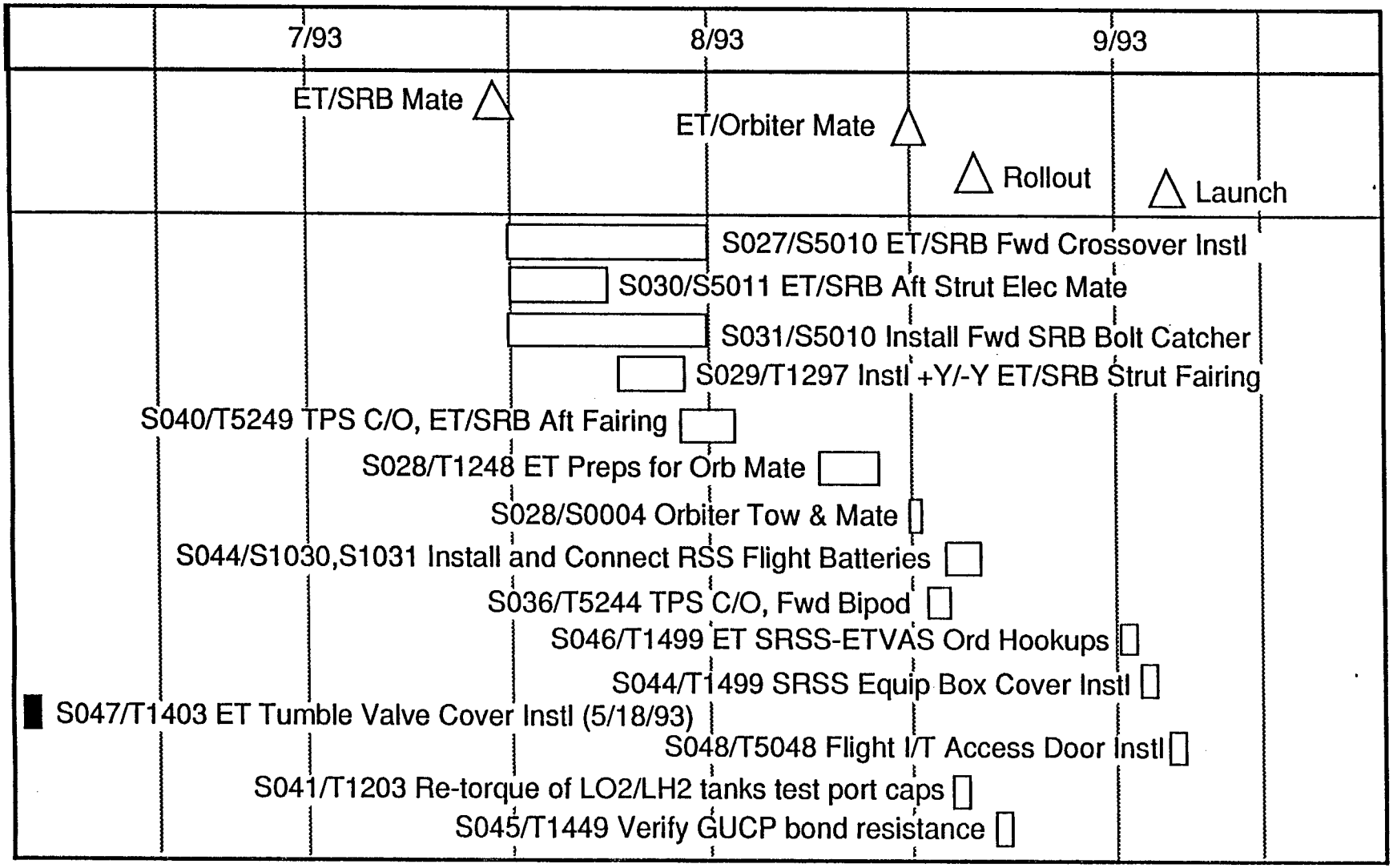
ET-57 Planned Work



MARTIN MARIETTA
MANNED SPACE SYSTEMS

ET-57 DR/PR/OMRSD Waivers/Exceptions - Summary C19

as of 6/9/93

Discipline	Discrepancy	Problem	MRB Items		Waivers/ Exceptions	
	Total	Total	Total	(Open)	Total	(Open)
• Electrical	0	3	1	(1)	0	(0)
• Propulsion/Pneumatics	0	9	1	(0)	0	(0)
• Range Safety	0	1	0	(0)	0	(0)
• Structures	0	4	0	(0)	0	(0)
• Thermal (TPS)	1	5	4	(2)	0	(0)
Total	1	22	6	(3)	0	(0)

ET-57 PR/MRBs - Summary

PR No./Status	Title/Description	Disposition
Electrical		
PET-57-EL-0003 Open	Borescope inspection of LH2 electrical monoball cable revealed wire termination insulation sleeve protruding through outer cable shielding	• Insulation sleeve has no signs of broken integrity • No broken strands of wire shielding • Protruding wire is unused • Use as is
Propulsion		
PET-57-FP-0007 Closed	Raised metal on upper inboard edge of LH2 umbilical fork assembly	• Raised metal removed • Not on a sealing surface • Use as repaired

ET-57 PR/MRBs - Summary

Thermal

PR No./Status	Title/Description	Disposition
PET-57-TS-0003 Closed	Void in LO2 umbilical cable tray support bracket foam exceeds STP 1518 requirement of 0.75 square inch and deeper than 0.75 inch	• Repair using PDL • PDL pour is downward and least susceptible for void formation
PET-57-TS-0004 Closed	Trimmed dimensions of void in LO2 umbilical cable tray fairing exceeded STP 1518 requirements of 0.75 sq in.	• Repair using PDL • PDL pour is downward and least susceptible for void formation

ET-57 PR/MRBs - Summary

Thermal

PR No./Status	Title/Description	Disposition
PET-57-TS-0006 Open	Three areas of damaged foam on Inter-tank occurred during preps for tank move to transporter. SRP-T-TS-0003 not available for use due to update requirements	• Repair using PDL • Defects within scope of SRP-T-TS-0003 limitations
PET-57-TS-0007 Open	Damaged foam on LO2 tank acreage occurred during preps for tank move to transporter. A securing latch broke, propelling the latch at the foam acreage - Resulted in 12.69 sq in. defect	• Repair using PDL - Taper forward foam edge • 9X visual inspection revealed no substrate anomaly • MAF analysis and x-ray review complete

ET-57 Limited Life Components

Cycle Sensitive

Description	Part No.	Serial No.	Limit	Required	Remaining
LH2 Manhole Cover Assy	80914081488 -019	0000162	100	2	100
LO2 Mechanical Assy	80912002000 -019	0000050	100	1	100
LH2 Mechanical Assy	80914002000 -009	0000050	100	2	100
LO2 Manhole Cover Assy	80911001205 -010	0000140	100	1	100
LO2 Fwd Ogive Cover Plate	80911001207 -029	0000176	100	1	100
LH2 Manhole Cover Assy (Aft Dome)	80911001444 -010	0000305 0000308	100 100	2 2	100 100

ET-57 Limited Life Components

Age Sensitive

Description	Part No.	Serial No.	Limit	Initiation	Expiration
External Tank	80901000000 -229	0000050	6 Years	7/90	7/96
RSS Battery A	10406-0133 -801	---	2 Years 90 Days	--- ---	--- ---
RSS Battery B	10406-0133 -801	---	2 Years 90 Days	--- ---	--- ---
Tumble Valve Nozzle Flight Cover	PD4700193 -004	0000839	5 Years 180 days	7/90 5/93	7/95 11/93

ET-57 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	10315-0002				
	-825	AAB	288	1/93	3/96**
	-826	AAB	244	1/93	3/96**
	-827	AAB	201	1/93	3/96**
	-828	AAB	155	1/93	3/96**
	-829	AAB	334	1/93	3/96**
	-830	AAB	375	1/93	3/96**
	-831	AAB	424	1/93	3/96**
Confined Detonating Fuse Manifold	10312-0002-803	AAT	2002125	4/92	7-Yr, 3/95*
		AAT	2002128	4/92	7-Yr, 3/95*
Safe & Arm Device	10311-0001-803	AAH	2000412	9/92	1/95***
NSD	SEB26100094	JEJ	0000330	10/90	4-Yr, 10/94
	-201	JEJ	0000339	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-57 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	PD5000020 -059	AAF	0000798	5/92	4-Yr, 5/96
Cartridge Assy	PD5000020 -030	AAF	69905	5/92	4-Yr, 5/96
		AAF	69906	5/92	4-Yr, 5/96
Linear Shaped Charge	PD500016 -050	AAJ	0001561	2/91	4-Yr, 4/94

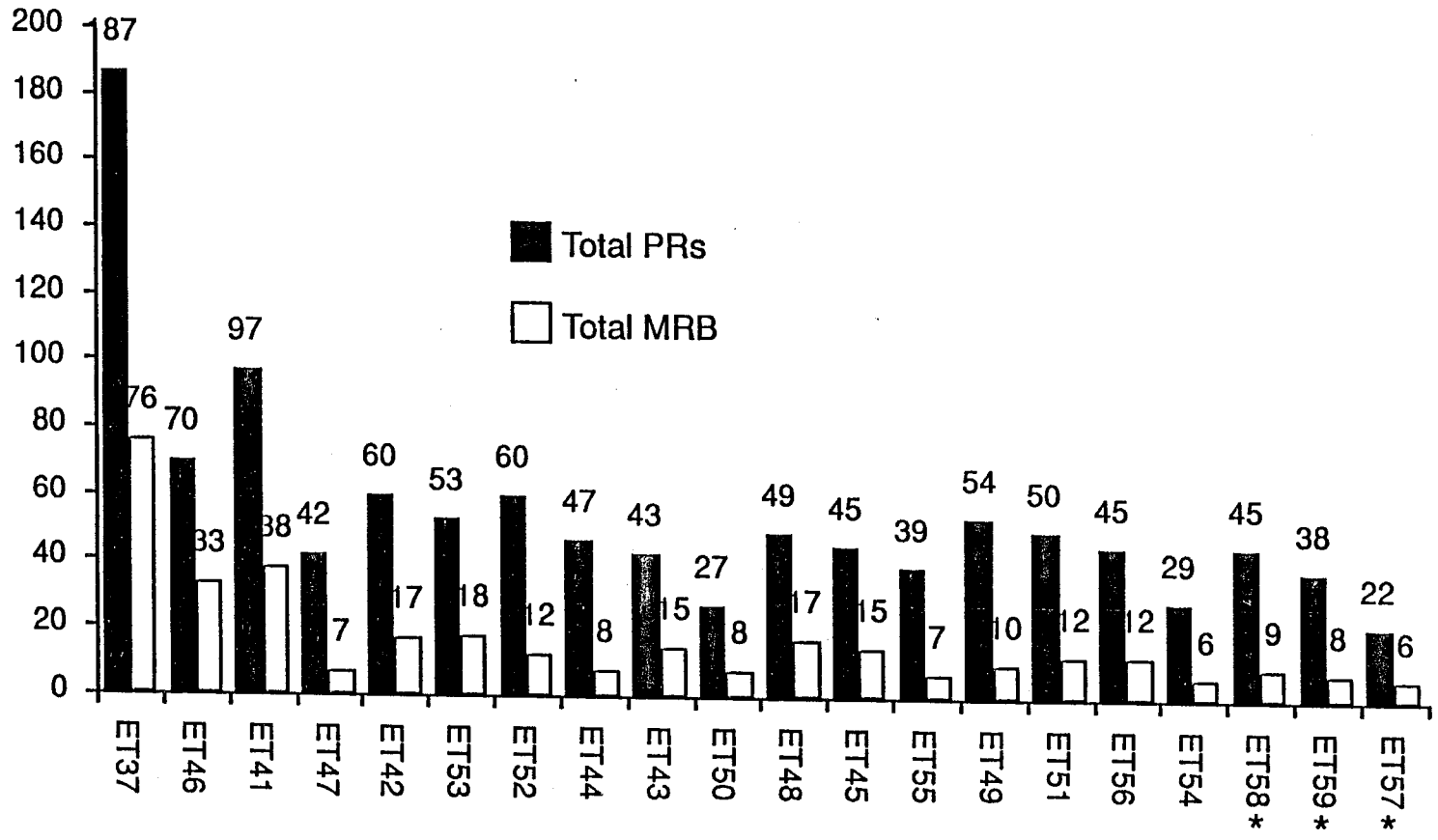
ET-57 KSC Component Replacement List

Part Name	Part Number	Serial Number Removed	Serial Number Installed	Authority
CDF Manifold	10312-0002-803	0000619 0000625	2002125 2002128	ET-57-RSS-001/ H0595B

ET-57 Changes, Modification Summary

No.	Description	Status
Mod Kits		
E118/B01857A	Closeout helium inject line with H135A fiberglass tape	**Closed**
B485/B01945A	Enhance jack pad and third hard point closeout process at KSC	Open
DC&Rs		
S-90-001	Inspect for adhesive staking of RF shorting caps on RSS antenna/GUCP	**Closed**
S-91-007	Inspect forward ET/SRB fitting inserts	**Closed**
Bldg. 45		
H0595B	Remove and replace (2) CDF manifolds	**Closed**

PR/MRB History (1991 - Present)



* Incomplete data

MARTIN MARIETTA
MANNED SPACE SYSTEMS

KSC Software Revision Verification/Validation Process C30

- 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 C31

- 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

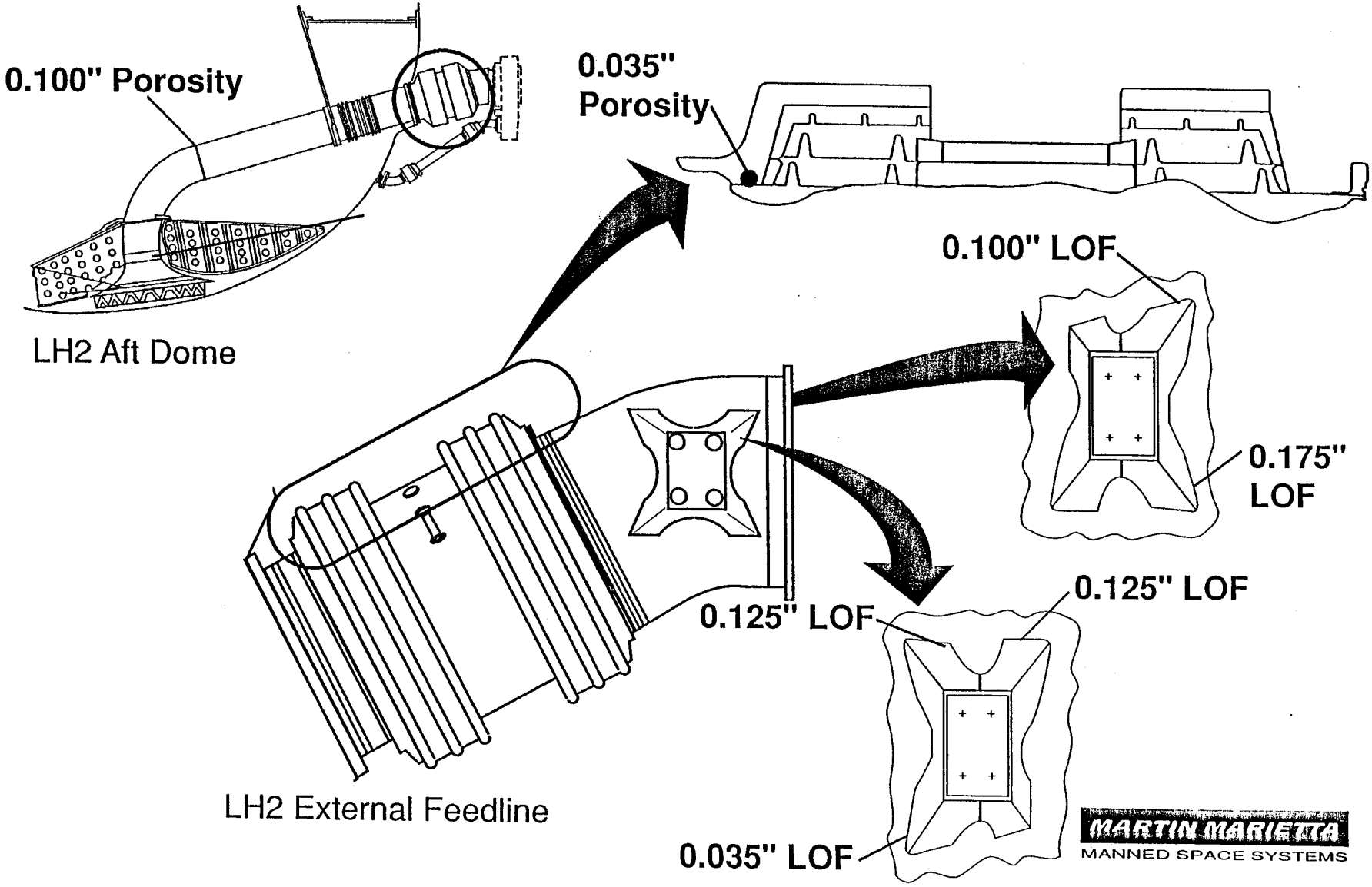
SMRBs - Summary

Description	Disposition/Vehicle Clearance
• LH2 feedline - 0.100" porosity in internal circumferential weld (T93850) • 2219-T62 Aluminum	• Use as is based on fracture mechanics analysis - Infinite missions to leak/burst
- 0.035" porosity in bellows circumferential weld (T98829) • 347 to Inconel 718	• Use as is based on fracture mechanics analysis - Infinite missions to leak/burst
- 0.035" - 0.175" (5) lack of fusion in elbow support bracket weld (T98829) • Inconel 718 to 21-6-9 stainless steel	• Use as is based on fracture mechanics analysis - 25 missions to burst (leak at this location not a concern)
• 0.100" void in link of GH2 pressure line flexible elbow BSTRA (T98832) - 21-6-9 stainless steel	• Use as is based on fracture mechanics analysis - 137 missions to burst (leak at this location not a concern)

ET-57 SMRB - LH2 Feedline Weld Defects

D2

T93850 /T98829



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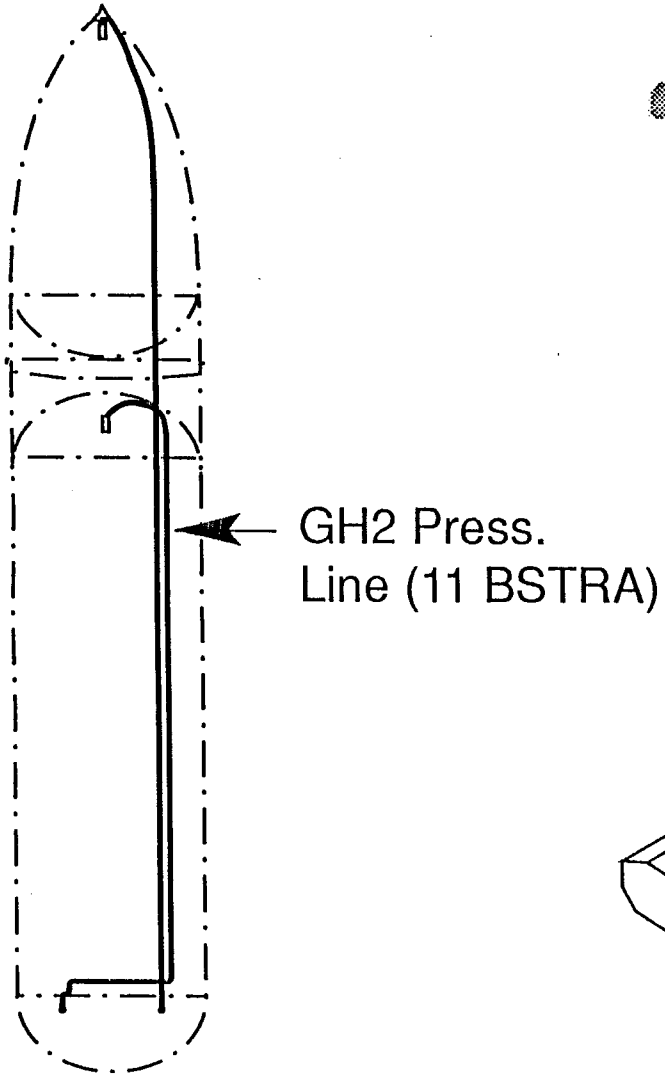
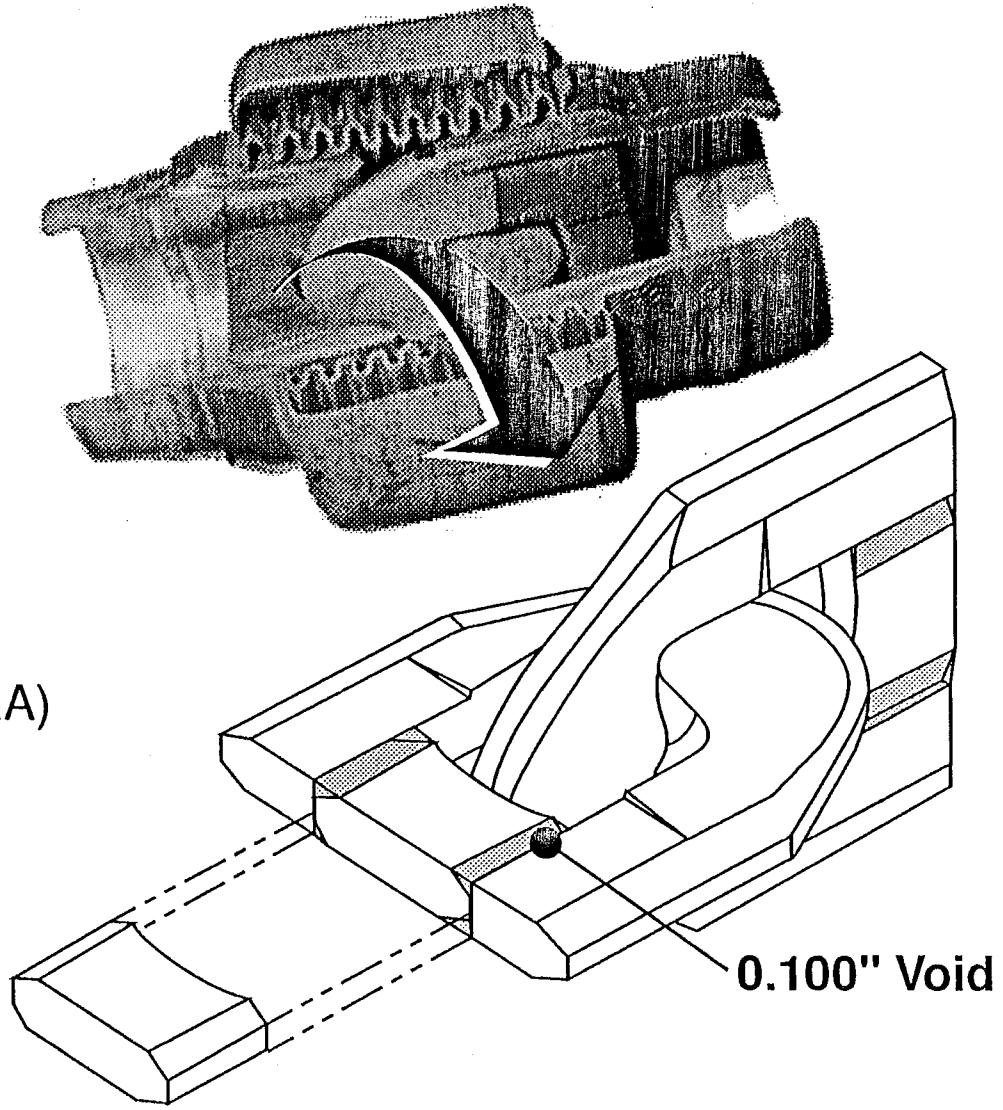
MANNED SPACE SYSTEMS

ET-57 SMRB - GH2 Pressure Line BSTRA Weld Defect D3

T98832





MARTIN MARIETTA
MANNED SPACE SYSTEMS

Level II Waivers, Baseline

Document/Requirement	Para	Waiver No.	Effectivity
Space Shuttle Flight and Ground System Specification (NSTS 07700 Vol. X)			
• Electrical Bonding (MIL-B-5087)	3.6.14	378	ETs 23, 27-29 & 31-999
• Soldering (NSTS 08800)	3.6.15.1.1	379	
• Circuit Boards	3.6.15.2.1	382, 383	
• Design Criteria & STDs (JSCM 8080--20C & 4B)	3.6.19	362	
• CIL Fail Safe & Redundancy Requirements	3.5.1.1.1 3.5.1.1.2 3.5.1.1.3	401	ETs 23, 27-29 & 31-999 (Variable, by item #)

Level II Waivers, Baseline

Document/Requirement	Para	Waiver No.	Effectivity
Space Shuttle Flight and Ground System Specification (NSTS 07700 Vol. X)			
• Lightning Protection and Shielding (NSTS 07636)	3.6.21	10, 11	ETs 23, 27-29, 31-999 (NSTS 07636, Rev F Changed Waivers to Exceptions)
• Lightning Protection & Verification (NSTS 07636)	3.6.21	S41383L	⊥
• Range Safety System	3.5.4.1.12	388	ETs 23, 27-29, 31 - 999

MARTIN MARIETTA
MANNED SPACE SYSTEMS

Level II Waivers, Baseline

Document/Requirement	Para	Waiver No.	Effectivity
Pyrotechnics (NSTS 08060)			
• Use connector 40M36298	3.4.1	061	ETs 23, 27-29 & 31-999
• Epoxy to separate metals on LSCs	3.5.8	062	
• Resistance check not required	7.3	063	
• Not required to meet voltage break down required	8.2.1	064	
• Route fire circuit wiring separately	8.2.3	065	
EMC (SL-E-0001) - Wire marking not applicable to ET	3.2.5	003	
EMC (SL-E-0002) - GUCA Leg Factor of Safety	3.2.2.2.2	021	
NSTS 07700 Vol V, NSTS Information Management Requirements - EEE Listing, Limited Life Status Pressure Vessel Historical Data	Tables C-5, C-6, C-13	005, 007, 009	

MARTIN MARIETTA
MANNED SPACE SYSTEMS

Level II Waivers, Baseline

Document/Requirement	Para	Waiver No.	Effectivity
NSTS 07700 -10- MVP 01 Shuttle Master Verification Plan - Acceptance Criteria and GH2 Vent Valve Certification	3.7.1	013	ETs 23, 27-29 & 31-999
NSTS 08060, Space Shuttle System Pyrotechnic Specification - Design Pyrotechnic for Reliability No Redundant Tumble Valve	3.1	060	
NSTS 08123, Certification of Flexible Hoses & Bellows - LH2 Feedline Bellows	1.2	003 002 (retired)	ETs 42-45 & 47-999 ETs 23, 27-29, 31-41, & 46

MARTIN MARIETTA
MANNED SPACE SYSTEMS

Level III Deviations, Baseline

Document/Requirement	Para	DAR No.	Effectivity
External Tank End Item Spec			
• Four GH2 pressurization line assemblies require NDE after proof because of an increase in the design loads. Current certification is based on the pre-proof test NDE	Table 3.2.3	177	ETs 33-35, 37, 39-60
• Cleaning requirement specifies a maximum of 1000 microns in any direction without restrictions to number of particles - Kapton insulated wire in the LH2 Tank has the potential to emanate fiber-like Telfon particles above the contamination requirements. Cryogenic flow test show contamination was negligible.	3.3.10	179	ETs 53-60

Level III Deviations, Baseline

Document/Requirement	Para	DAR No.	Effectivity
ICD-2-12001 • LH2 feedline flange dimension violates ICD requirement for flange 48 bolt hole pattern at EO-4 - Reqmt = 0.469"+0.004"/-0.001" position tolerance within 0.010" to the basic pattern diameter - Actual = 0.467" to 0.468" position tolerance is 0.009" to 0.023" to the basic pattern diameter • Seal position verified by fit check utilizing guide pins to be within acceptable range for mating with the class I surface • Sucessfully passed acceptance leak tests	Fig. 3.1-7 View AS-AS Rev M	185	ET-59

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