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

**EXTERNAL TANK ET-60, AS IDENTIFIED IN THE STS-61 DELTA FLIGHT READINESS REVIEW DATED NOVEMBER 3, 1993, IS CONSIDERED READY TO SUPPORT FLIGHT UPON ACCEPTABLE DISPOSITION OF OPEN WORK AND/OR OPEN ACTIONS.**

H. GARRETT/EB21

J. MITCHELL/EL01

M. PESSIN/EE31

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FOR R. BLEDSOE/CQ21

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P. V. COUNTS/SA31, CHAIRMAN 11/3/93

Delta ET Project

# STS-61/ET-60 Flight Readiness Review

BIPOD YOKE ICD VIOLATION
- PRCB APPROVED ON 10/12/93

# Agenda



| | |
|---|---|
| • ***Overview*** | ***D. Deel*** |
| • Prior Mission Performance Summaries | L. Hartley |
| • STS-61/ET-60 Highlights | |
| • Changes | R. Kimzey |
| • SMRBs: No new items | F. Ramsey |
| • SRM&QA Assessment | |
| • KSC Processing | B. Hale |
| • Verification/Certification | E. Newman |
| • Mission Unique Assessment | L. Hartley |
| • Readiness Statement | D. Deel |
| • Appendices | |
| - A: Minor Changes | |
| - B: SRM&QA | |
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# Overview



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

- This Delta review for STS-61/ET-60 includes:
  - Missions STS-57/ET-58, STS-51/ET-59 and STS-58/ET-57 Performance Summaries
  - Items not previously addressed at prior Block 9 FRRs
  - Items specific to mission STS-61
  - Details of previously addressed items are available in appendix

| • **FRR Series** | **STS-61/ET-60** |
|---|---|
| - Block 9 (ETs 51-60) | |
| • MMC Corporate | 10/21/91 |
| • ET Project/SRM&QA PFA (Baseline) | 10/22/91 |
| - Mission Specific Reviews | |
| • ET/SRB Mate | 10/4/93 |
| • Delta ET Project (Baseline) | 11/3/93 |
| • Associate Administrator FRR | 11/17/93 |
| • Mission Management Team (L-2 Day) | 11/29/93 |

# Agenda



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# Mission STS-57/ET-58 Performance Summary



Scrub/Launch

| System | Performance | |
|---|---|---|
| | Scrub (6/20/93)<br>at T-5 minutes due to RTLS weather | Launch (6/21/93) |
| OMRSD/LCC | No ET violations | No ET violations |
| Instrumentation | Nominal | Nominal |
| MPS | Nominal | Nominal |
| Hazardous Gas | Nominal | Nominal |
| TPS | Nominal | Nominal |
| ET Disposal | N/A | No issues |
| Orbiter Tile Damage | N/A | Average |

# Mission STS-51/ET-59 Performance Summary



Scrubs/Abort

| System | Performance | | |
|---|---|---|---|
| | **Scrub (7/17/93)** at ≈ T-1 hr due to PIC "B" false arm indication | **Scrub (7/24/93)** at T-19 sec due to erratic RH SRB HPU turbine speed | **Abort (8/12/93)** at T-3 sec due to SSME #2 fuel flowmeter violation |
| **OMRSD/LCC** | No ET violations | No ET violations | No ET violations |
| **Instrumentation** | • LH2 ullage pressure transducers exhibited intermittent dropout during replenish<br>- Within experience data base<br>- No OMRSD or LCC violation | | |
| **MPS** | Nominal | Nominal | Nominal |
| **Hazardous Gas** | Nominal | Nominal | Nominal |
| **TPS** | Nominal | Nominal | Nominal |

# Mission STS-51/ET-59 Performance Summary



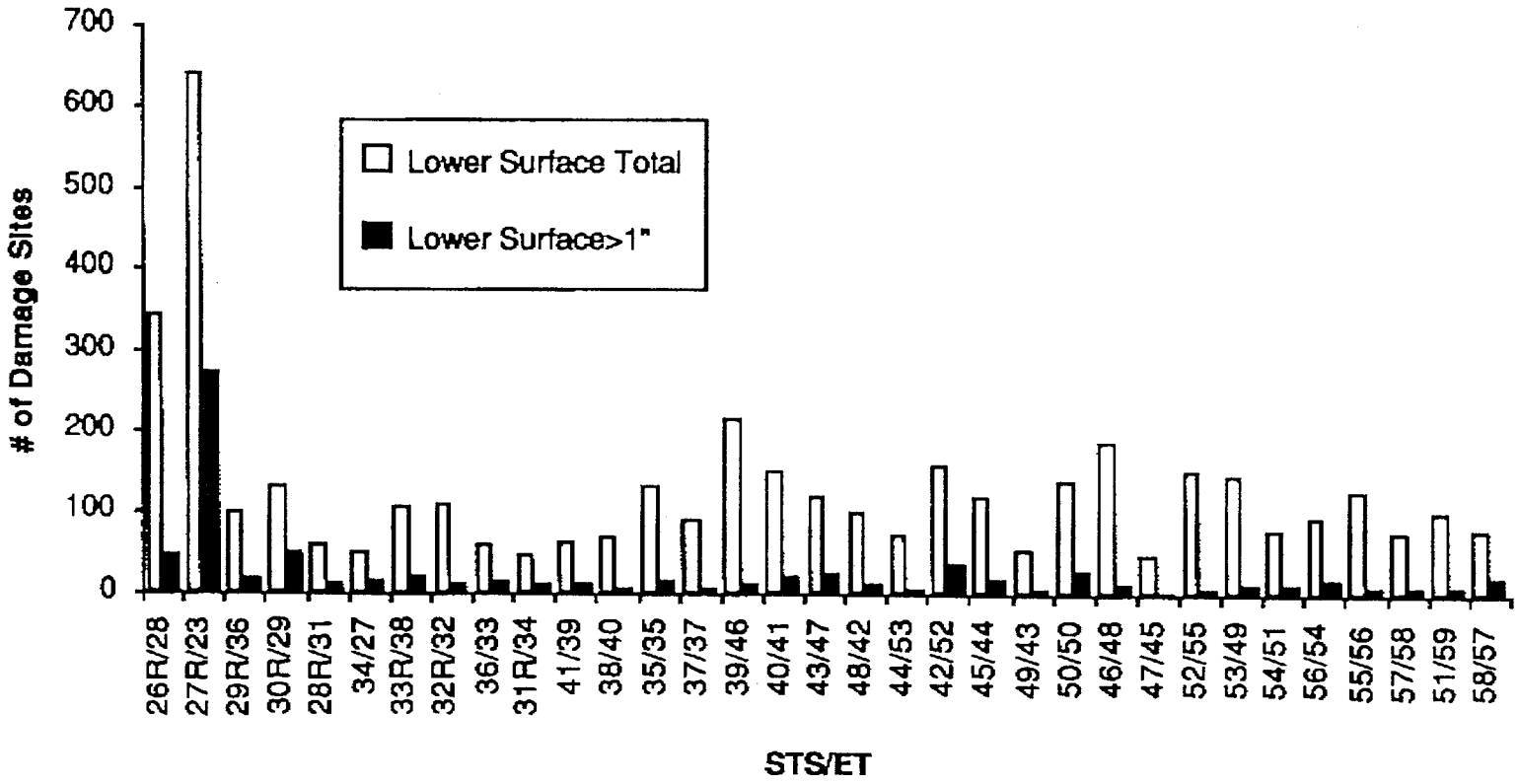
Launch, 9/12/93

| System | Performance |
|---|---|
| **OMRSD/LCC** | No ET violations |
| **Instrumentation** | Nominal |
| **MPS** | Nominal |
| **Hazardous Gas** | Nominal |
| **TPS** | Nominal |
| **ET Disposal** | No issues |
| **Orbiter Tile Damage** | Average |

# Mission Performance Summary



## Orbiter Tile Damage



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# Mission STS-58/ET-57 Performance Summary



Scrubs/Launch

| System | Performance | | |
|---|---|---|---|
| | **Scrub (10/14/93)** at T-31 sec due to RSS ground computer failure | **Scrub (10/15/93)** at T-9 min due to Orbiter transponder failure | **Launch (10/18/93)** |
| **OMRSD/LCC** | Intertank O2 concentration exceeded LCC limit during T-31 sec hold * | No ET violations | No ET violations |
| **Instrumentation** | Nominal | Nominal | Nominal |
| **MPS** | Nominal | Nominal | Nominal |
| **Hazardous Gas** | Nominal | Nominal | Nominal |
| **TPS** | Nominal | Nominal | GUCP separation film review revealed two areas of Interank foam loss adjacent to GUCP * |

* Discussed on subsequent charts

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# Mission STS-58/ET-57 Performance Summary



Scrubs/Launch

| System | Performance | | |
|---|---|---|---|
| | Scrub (10/14/93) | Scrub (10/15/93) | Launch (10/18/93) |
| **ET Disposal** | N/A | N/A | No issues |
| **Orbiter Tile Damage** | N/A | N/A | Lower surface<br>• >1" - above average<br>• Total - below average |



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# STS-58/ET-57 Intertank O2 Concentration



**Issue:**

- Intertank O2 concentration exceeded LCC limit during T-31 sec hold during 10/14/93 launch attempt

**Discussion:**

- LCC Haz-07 limit is 200 ppm (max) O2 concentration from start of cryo load to T-31 sec
  - Intertank normally monitored final time from T-5 min to T-3 min
  - Intertank purge terminated at 75 sec
  - During unplanned hold at T-31 sec, Intertank gas was sampled and measured > 2000 ppm O2
  - Intertank sample during hold at T-31 sec showed simultaneous increase in argon
- Assessment indicates air intrusion can be expected on pad after purge termination
  - O2 concentration in excess of 200 ppm is expected
  - Sensors located at three major Intertank vent locations
- Analysis for max in flight O2 concentration based on hold after purge termination
  - No violation of 4% concentration in flight
    - For 2nd and 3rd launch attempt an LCC waiver/deviation (PCIN 072379) was processed to terminate time period of Haz-07 effectivity at T-75 sec vs T-31 sec

**Status:**

- KSC has action to revise the LCC to stop Haz-07 effectivity at purge termination (T-75 sec)
- PSIG to evaluate effect of air intrusion on hold time; results could require future LCC updates

# STS-58/ET-57 Loss of Foam Near GUCP



**Issue:**

- Two areas of foam loss (≈ 10.0" x 1.5" and 5.0" x 1.5") occurred on Intertank adjacent to GUCP during GUCP separation

**Discussion:**

- Minimal clearance currently exists between GUCP and surrounding foam
  - Local foam damage common during GUCP installation
  - Clearance increased 0.5" effective ET-61
- Ice formation on GUCP legs common occurrence
  - Ice/small clearance resulted in interference and foam loss
- Similar TPS loss occurred/observed on STS-34/ET-27 and STS-29R/ET-36

**Conclusions:**

- Analysis shows local foam loss not ET structural concern
  - Low aeroheating/heavy structure
- Local foam loss not debris concern
  - Located on -Z/-Y quandrant
- ET-60 acceptable as is

# Agenda



| | |
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| • Changes | R. Kimzey |
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- Appendices
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# Mission STS-61/ET-60 Highlights



**Mission**

| | |
|---|---|
| • **Launch** | 12/01/93 |
| - Window | 04:57 - 06:08 EST |
| - Pad | A |
| - Orbiter | Endeavour (OV-105) |
| - Orbital inclination | 28.45 deg - Direct insertion at 310 NM |
| - ET photo coverage | • Crew photos from cockpit window<br>• Umbilical well cameras |
| • **Mission payload** | Hubble Space Telescope Service Mission-01 |
| • **Landing** | 12/13/93 |
| - Time | TBD |
| - Location | KSC |

**External Tank**

| | |
|---|---|
| • **DD250 Acceptance** | 6/27/91 |
| - Shipped to launch site | 6/3/93 |
| - Age at launch | 30 months |
| • Certification: 72 months | |

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# Changes - List



| Description | Presentation |
|---|---|
| • **Previously presented at Block 9 FRR, 10/22/91** | |
| - Reinstate 750 psig leak check of GO2/GH2 vent valve actuation line adapter (B01643K) | Appendix D |
| - New part number for GFP LO2 17" disconnect (B01903) | Appendix D |
| - Implement VPPA weld to LO2 tank forward fitting to ogive (B01887/J31004) | Appendix D |
| • **New change since Block 9 FRR, 10/22/91** | |
| - Periodic FMEA/CIL Update (B01788N) | See subsequent chart |

# FMEA/CIL Periodic Update (B01788N)



**Background/ Reason:**

- Reclassified 19 GO2 leakage CILs from crit 1 to 3 due to ground rule change
- Reclassified 7 potential debris generating failures in the Nose Cone from crit 1 to 3 by analysis
- Minor updates for compatibility with other documentation (OMRSD, drawings, etc.)

**Description:**

- NSTS 22206 Change No. 13 (PRCBD S050107K, 2/6/92) eliminated lightning as a potential ignition source for FMEA/CIL purposes
  - 19 of the GO2 leakage failure modes are in the Nose Cone where lightning is considered the only ignition source
- Nose Cone debris analysis considered failed item size, shape, density and position relative to escape paths
  - Worst case condition, including flight, was for STS on the pad with purge operating
  - Results indicate seven baselined failure modes are no longer considered credible to produce Orbiter damaging debris

- Documentation:
  - Revised EIS, Part I to delete non-critical item from certification table
  - Revised EIS, Part II to remove CI inspection data associated with FMEA item codes no longer critical
  - Revised HCS(s) to remove FMEA item codes no longer critical

# FMEA/CIL Periodic Update (B01788N)



**Status:**

- CIL revised, DCN 034
- EIS, Part I approved, CCBD ET3-00-8978 (7/28/93)
- EIS, Part II revision to be submitted after engineering release, ECD 1/94
- HCS(s) submitted to MSFC, pending approval

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# SMRBs - List



| Description | Presentation |
|---|---|
| **Previously presented at Block 9 FRR, 10/22/91** | |
| • **SMRB** | |
| - 0.090" porosity, 0.040" lack of fusion and 0.075" lack of fusion in GO2 pressure line lower flexible BSTRA (T107193) | Appendix D |

# SRM&QA Assessment



| Item | Status |
|---|---|
| • **Alerts** | None |
| • **MRB Assessment**<br>- MRB MARS Items<br>- PR/MRBs | Complete - No issues/no impact to hazard controls<br>• 619<br>• 8 |
| • **Hazard Assessment** | Complete - All hazard reports were reassessed and hazard controls verified |
| • **Corrective Action Problem Summary (CAPS)** | See subsequent chart |

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# Corrective Action Problem Summary (CAPS)



OPEN CAP

| CAPS/No. | Crit | Title/Description | Vehicle Clearance | Status/ECD |
|---|---|---|---|---|
| E-152B | 3 | Tavis LO2 ullage pressure transducer failed MAF acceptance test | • Not installed on ET-60 - First flight, ET-64<br>• No evidence of lot problem based on component lot failure analysis and retest of delivered transducers to date (60/82)<br>• Installed transducers successfully passed test | • Remaining LH2 transducer test in progress, ECD 12/6/93<br>• Test of 10 transducers to determine long term stability in progress, ECD 12/96 |
| S-076C | 3 | LH2 tank webs do not meet thickness requirements | • ETs 60-68, 70, 71, 72, 73 and 75 cleared by test and analysis<br>• ETs 69 and 74 cleared by DC&R inspection<br>• ET-76 & subs cleared by MAF stock | Corrective action in progress, ECD 1/3/94 |

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# Corrective Action Problem Summary (CAPS)



| CAPS/No. | Crit | Title/Description | Vehicle Clearance | Status/ECD |
|---|---|---|---|---|
| E-155 | 1R | Gulton LH2 ullage pressure transducer failed vibration test of supplier acceptance test plan | All ETs cleared<br>• Delivered parts have passed supplier ATP | Pending results of the failure investigation, ECD 12/3/93 |



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# KSC Processing - Status



as of 10/27/93

- **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 C

# KSC Processing - Status



as of 10/27/93

- **Changes ***

  - ET modifications
    - Mod Kit 1
    - DC&R (Discrepancy Check and Report) 1
    - Bldg 45 1
    - FEC (Field Engineering Change) 0

  - Software 1
    - SIM Load 11/16/93
    - SIM Launch 11/10/93

* Included in Appendix C

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# Verification/Certification



| Item | Status |
| --- | --- |
| • **NSTS 07700, Volume X Baseline**<br>- Revision L, Change 197 | **No constraints** |
| • **Certification documentation**<br>- Hardware Certification Sheets (HCS)<br>- Certificates of Qualification (COQ) | **Complete - No issues** |
| • **Waivers/Deviations**<br>- ET bipod yoke fitting ICD violation * | **Complete - No issues** |

* See subsequent charts

# ET-60 Bipod Yoke Fitting ICD Violation



**Issue:**

- OMRS File III bipod fitting maximum bolt protrusion requirement violated during STS-61ET/Orbiter mate
  - Requirement = 0.467" max
  - Actual = 0.472"
- Height dimension from ET bipod fitting to back of spherical washer violates ICD requirements
  - ICD requirement = 7.80" ± 0.030" from ET bipod fitting to back of spherical washer
  - Actual dimension = 7.729"

**Discussion:**

- Bipod yoke manufactured at outside vendor
  - Vendor MARS reported drawing violation of dimension from top of ET bipod fitting to center of spherical radius
    - Requirement = 11.150" ± 0.010"
    - Actual = 11.094"
  - Violation compared to combined 0.060" interpreted ICD tolerance
  - Concluded no ICD violation
- Subsequent discussion determined 0.060" combined tolerance was not appropriate ICD interpretation

**Conclusion:**

- Waiver to ICD approved by PRCB (10/12/93) to acccept ET bipod fitting for flight
  - Ultimate factor of safety
    - Required = 1.4, Actual = 4.62

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# Mission Unique Assessment



as of 10/27/93

| Category/Item | STS-61/ET-60 |
|---|---|
| • Vehicle loads | Complete - No issues |
| • Thermal assessment<br>- Ascent<br>- Intact abort and reentry | Complete - No issues |
| • Review of MRB actions using updated loads and environmental data | Complete - No issues |
| • MPS Preflight Prediction Package | ECD 11/19/93 |

RSRM PRESS SPIKE LAST FLIGHT
WORKING

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# ET-60 Readiness Statement



**The External Tank, ET-60, is hereby certified and ready for STS-61 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/Substitutions

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

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

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

# 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 |
|---|---|
| **Structures** | |
| H34809-695 | Revised flatness tolerance on forward LH2 and LO2 dome caps to agree with existing note callout |
| -689 | Clarified method of fastener installation to agree with STP requirements |
| **Mechanical Design** | |
| B01917G-911 | Remove GFP LH2 umbilical disconnect and replace with different part number umbilical |

# STM/STP Changes - List



## Material Science

| Change No. | STM/STP | Description |
|---|---|---|
| H34809-679 | E767 & E768 | Cancelled E767 Silver Plated wire specified for certification of crimping tools and replaced with E768 Nickel Plated wire used for flight |
| H34809-680 | MMSK951 | Added different abrasive paper to specification because vendor ceased making previously specified material |
| H34809-683 | 33L9 | Revised the minimum radial float requirement for capped nut plates from 0.020" to 0.010" to meet vendor's build dimensions |
| H34809-692 | MIL-P-85582 | Allow usage of MIL-P85582 water base epoxy primer to replace Zinc-Chromate primer on non-cryogenic Intertank parts to meet Connecticut EPA requirements |

# STM/STP Changes - List



## Material Science

| Change No. | STM/STP | Description |
|---|---|---|
| H50001-714 | STP-3003/ -3004 | Allow abrasion of Epoxy primer defects after 6 hours cure, allow restoration of areas abraded for electrical resistance measurements with undiluted epoxy primer per STP-7001, and allow further processing of tank before full primer cure when not directly effected |
| H50001-723 | M043 | Clarify RPM requirements for silicone sealant viscosity measurements and limit shelf life to 6 months. |

# ET-60 Substitution



| Substitution/ Authorization No. | Description |
|---|---|
| S/A LWT053-001 | • Replaced asbestos thermal wrap ET/SRB cable harness (-080) with fiberglass thermal wrap ET/SRB cable harness (-180)<br>- (-080) harness failed 2 ohm resistance check<br>• Replacement required<br>• No additional (-080) harnesses<br>- (-180) harness scheduled for implementation at ET-61 and subs<br>- Parts functionally interchangeable |

# MRB Assessment Criteria

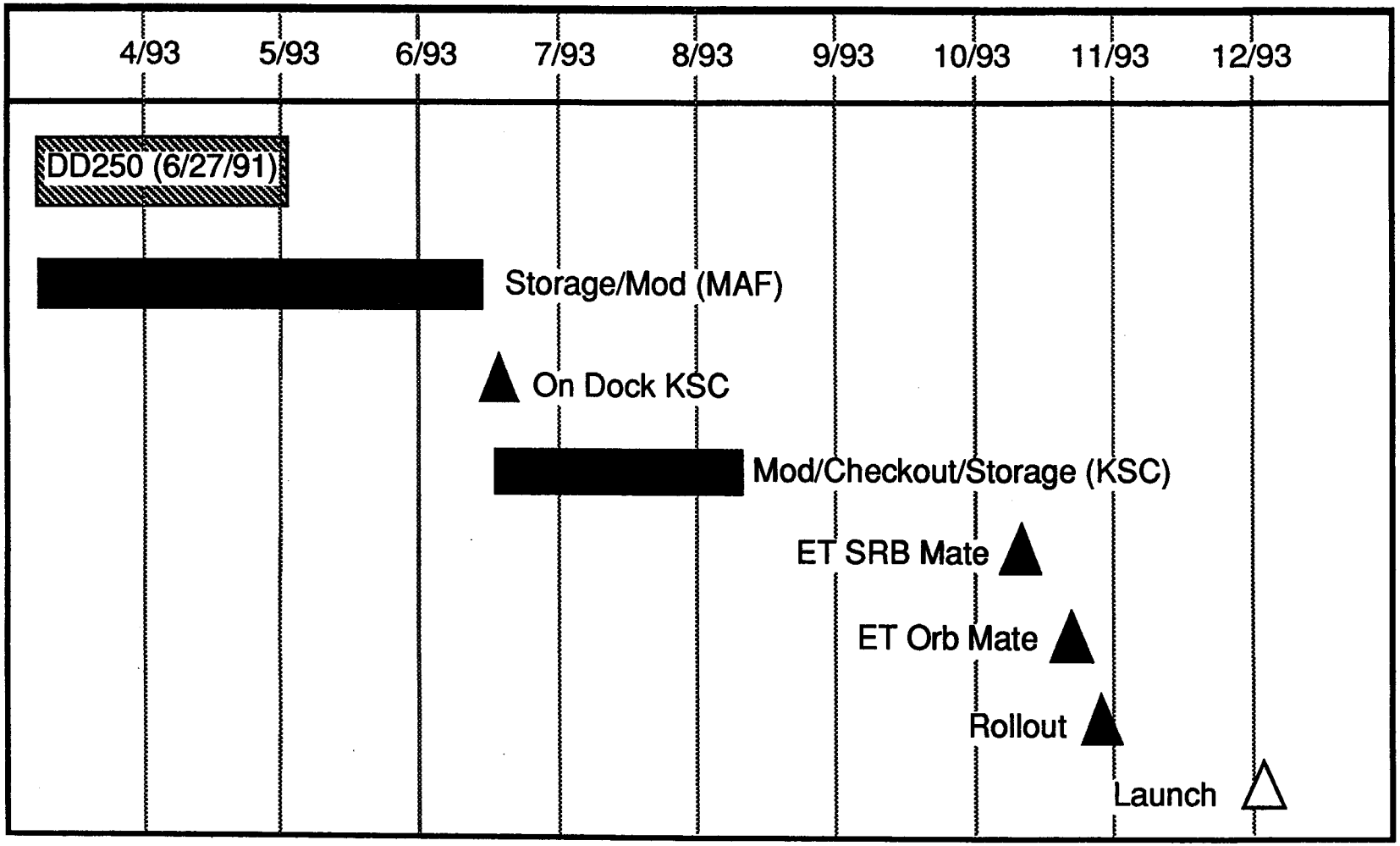


- First assessment of all MARS Items
  - Adequacy of technical dispositions
  - Completeness of required repair/retest
  - First time occurrences/SMR

- 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

# ET-60 Processing Schedule





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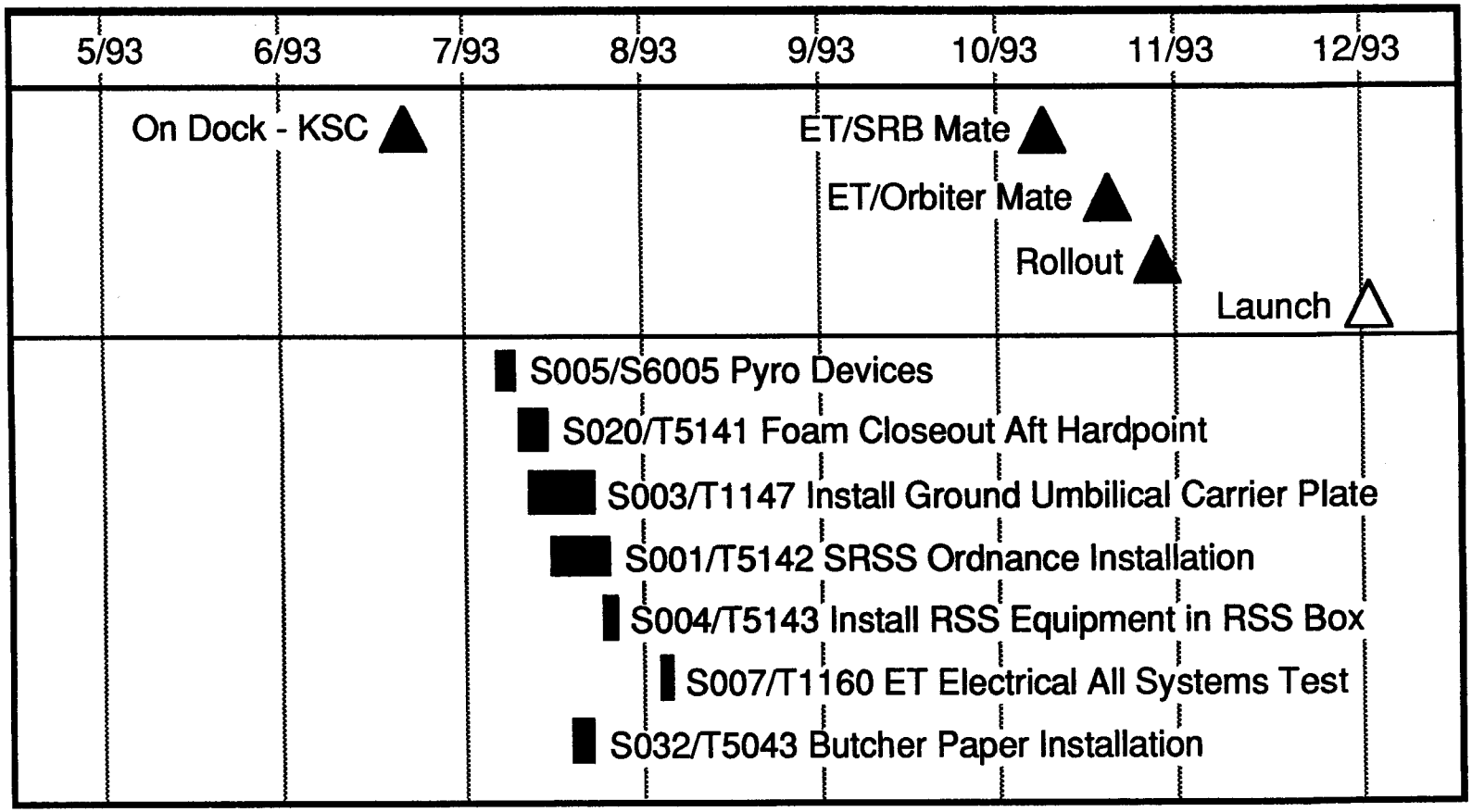
# ET-60 Planned Work



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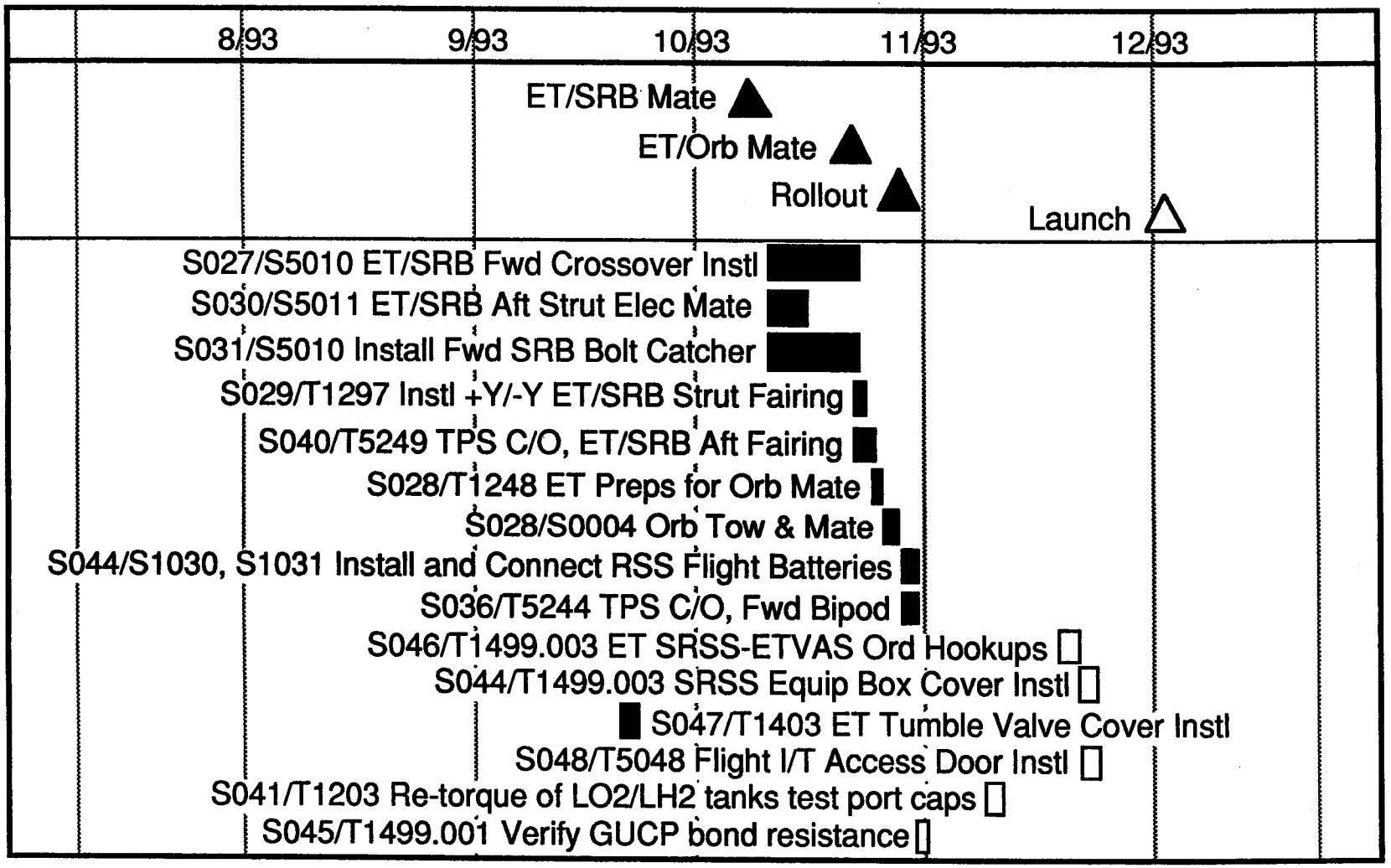
# ET-60 Planned Work





# ET-60 DR/PR/OMRSD Waivers/Exceptions - Summary C4

as of 10/26/93

| | Discrepancy | Problem | | | | |
|---|---|---|---|---|---|---|
| | | | MRB Items | | Waivers/Exceptions | |
| System | Total | Total | Total | Open | Total | Open |
| • Electrical | 0 | 0 | **0** | **0** | 0 | 0 |
| • Propulsion/ Pneumatics | 2 | 8 | **4** | **0** | 0 | 0 |
| • Range Safety | 0 | 0 | **0** | **0** | 0 | 0 |
| • Structures | 4 | 14 | **2** | **0** | 0 | 0 |
| • Thermal (TPS) | 1 | 15 | **2** | **0** | 0 | 0 |
| **Total** | **7** | **37** | **8** | **0** | **0** | **0** |

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MANNED SPACE SYSTEMS

# ET-60 PR/MRBs - Summary



Propulsion/ Pneumatics

| PR No./Status | Title/Description | Disposition |
|---|---|---|
| PET-60-FP-0003 Closed | LH2 4" disconnect - (12) bolts were replaced with drilled head bolts<br>• Bolts had oversize lockwire holes to be utilized if lockwire was required | Use as is - Bolts did not require safety wire |
| PET-60-FP-0005 Closed | -Y side of LH2 umbilical purge barrier seal does not align with the existing purge barrier seal<br>• Seal trimmed to align with edge of existing seal | Use as repaired - Orbiter half of umbilical will accommodate the misalignment with no affect to sealing capability |
| PET-60-FP-0006 Closed | LH2 umbilical purge barrier seal is nicked in 2 places (inboard edge of seal)<br>• Max size 0.50" x 0.25"<br>• Nicked areas were filled with RTV to return seal to original shape | Use as repaired - Repair will restore the shape, strength, and functional performance equivalent to the original purge barrier seal |
| PET-60-FP-0007 Closed | GO2 2" disconnect has raised metal outside the mating area | Use as is - Raised metal is not located where it will affect sealing capabilities of the QD |

# ET-60 PR/MRBs - Summary



Thermal (TPS)

| PR No./Status | Title/Description | Disposition |
|---|---|---|
| PET-60-TS-0007-1<br>Closed | LH2 4 in. recirc line BX-250 closeout has area of overtrim<br>• Area is approximately 5" L x 2" W x 0.875" D<br>• Area repaired using BX-250 with the sidewalls chamfered | Use as repaired - Additional bond line associated with the additional closeout will not affect the thermal or aero properties of the closeout |
| PET-60-TS-0007-2<br>Closed | LH2 4 in. recirc line BX-250 closeout has a void<br>• Void is 0.875" L x 0.5" W x 1.75" D<br>• Void was repaired using PDL | Use as repaired - PDL repair of this size at this location does not affect the thermal or aero properties of the closeout |

# ET-60 PR/MRBs - Summary

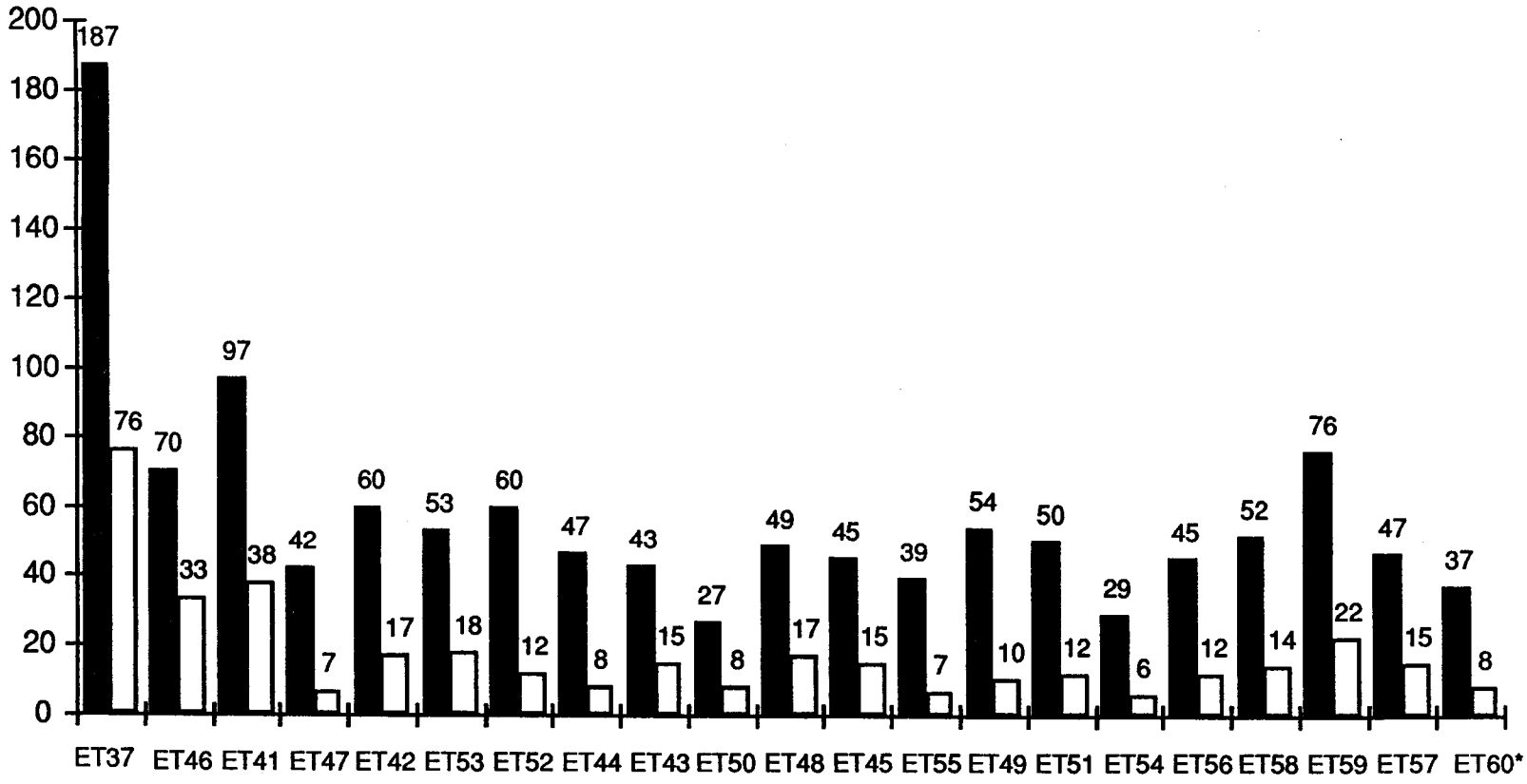


Structures

| PR No./Status | Title/Description | Disposition |
|---|---|---|
| PET-60-ST-0003<br>Closed | Washer missing at 45 degree cable tray installation (sta 2040)<br>• Fastener is used to install a flow restricter inside the c/t. | Use as is<br>• Fastener is fully threaded<br>• Removal for installation of washer not feasible |
| PET-60-ST-0007<br>Closed | 36L12-1 spherical bearing at the EB-7 location has a nick/displaced metal (0.026 in. deep) on the edge of the bore surface<br>• Raised metal (0.007 high) was removed | Use as repaired - Defect will not affect the function of the spherical bearing |

# PR/MRB History (1991 - Present)






* Incomplete data

Total PRs
Total MRBs

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# ET-60 Limited Life Components



Cycle Sensitive

| Description | Part No. | Serial No. | Limit | Required | Remaining |
|---|---|---|---|---|---|
| LH2 Manhole Cover Assy | 80914081488 -019 | 00000099 | 100 | 2 | 100 |
| LO2 Mechanical Assy | 80912002000 -019 | 00000053 | 100 | 1 | 100 |
| LH2 Mechanical Assy | 80914002000 -009 | 00000053 | 100 | 2 | 100 |
| LO2 Manhole Cover Assy | 80911001205 -010 | 00000147 | 100 | 1 | 100 |
| LO2 Fwd Ogive Cover Plate | 80911001207 -020 | 00000181 | 100 | 1 | 100 |
| LH2 Manhole Cover Assy (Aft Dome) | 80911001444 -010 | 00000316<br>00000317 | 100<br>100 | 2<br>2 | 100<br>100 |

# ET-60 Limited Life Components



Age Sensitive

| Description | Part No. | Serial No. | Limit | Initiation | Expiration |
|---|---|---|---|---|---|
| External Tank | 80901000000 -229 | 00000053 | 6 Yrs | 6/91 | 6/97 |
| RSS Battery A | 10406-0133 -801 | 2000120 | 2 Yrs 90 Days | 8/5/92 10/20/93 | 8/5/94 1/8/94 |
| RSS Battery B | 10406-0133 -801 | 2000121 | 2 Yrs 90 Days | 8/5/92 10/20/93 | 8/5/94 1/8/94 |
| Tumble Valve Nozzle Flight Cover | PD4700193 -004 | 0000779 | 5 Yrs 180 Days | 7/89 9/93 | 7/94 3/94 |

# ET-60 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 | 292 | 1/93 | 3/96** |
| | -826 | AAB | 249 | 1/93 | 3/96** |
| | -827 | AAB | 205 | 1/93 | 3/96** |
| | -828 | AAB | 161 | 1/93 | 3/96** |
| | -829 | AAB | 339 | 1/93 | 3/96** |
| | -830 | AAB | 379 | 1/93 | 3/96** |
| | -831 | AAB | 434 | 1/93 | 3/96** |
| Confined Detonating Fuse Manifold | 10312-0002-803 | AAT | 2002131 | 4/92 | 7-Yr, 3/95* |
| | | AAT | 2002132 | 4/92 | 7-Yr, 3/95* |
| Safe & Arm Device | 10311-0001-803 | AAH | 2000413 | 9/92 | 1/95*** |
| NSD | SEB26100094 | JEJ | 0000341 | 10/90 | 4-Yr, 10/94 |
| | -201 | JEJ | 0000342 | 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-60 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 | 0000799 | 5/92 | 4-Yr,5/96 |
| Cartridge Assy | PD500020 -030 | AAF<br>AAF | 69908<br>69909 | 5/92<br>5/92 | 4-Yr, 5/96<br>4-Yr, 5/96 |
| Linear Shaped Charge | PD500016 -050 | AAJ | 0001562 | 2/91 | 4-Yr, 4/94 |

# ET-60 KSC Component Replacement List



| Part Name | Part Number | Serial Number Removed | Serial Number Installed | Authority |
|---|---|---|---|---|
| CDF Manifold | 10312-0002-803 | 0000626<br>0000629 | 2002132<br>2002131 | ET-60-RSS-001/<br>H0595B |

# KSC Software Revision Verification/Validation Process C16

- 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 C17

- 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

# Reinstate 750 psig Leak Check(B01643K)



## MAF Acceptance (TMO4k-B)

**Background/Reason:**

- Leak check of K-seal of GO2/GH2 vent valve actuation line adapter inadvertantly deleted for ET-11 and subs (B01591)
  - Prior change deleted MAF checks also performed at vendor and not disturbed at MAF
  - Actuation line adapter and K-seal installed at MAF
    - Should have retained leak check at MAF

**Description:**

- Reinstate 750 psig helium leak check of K-seal at actuation line adapter to GO2/GH2 vent valves

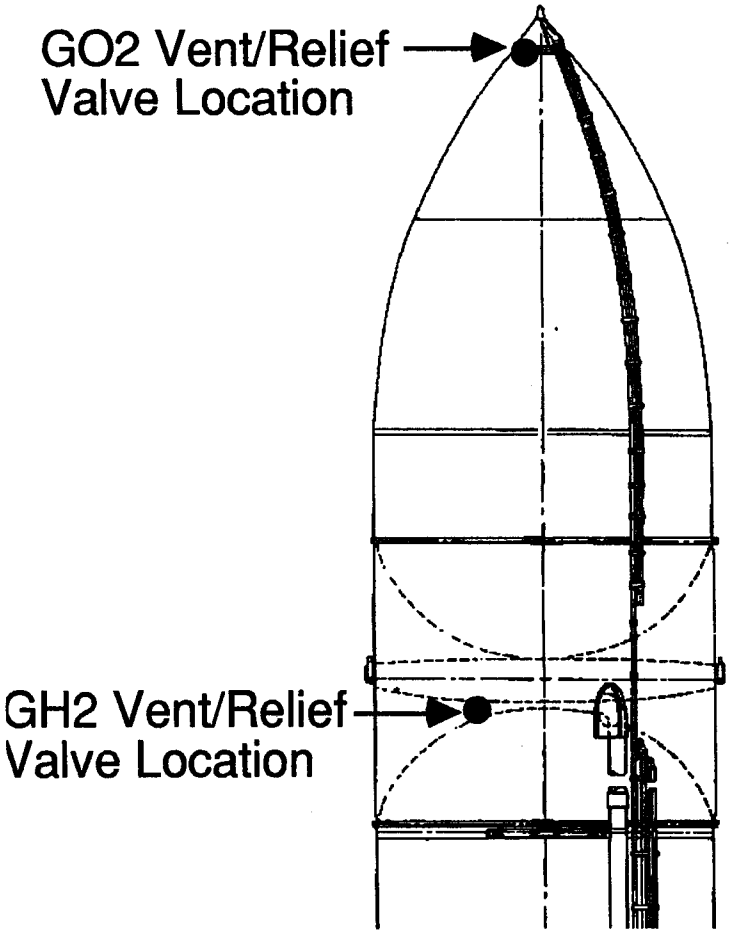
**Basis for Certification:**

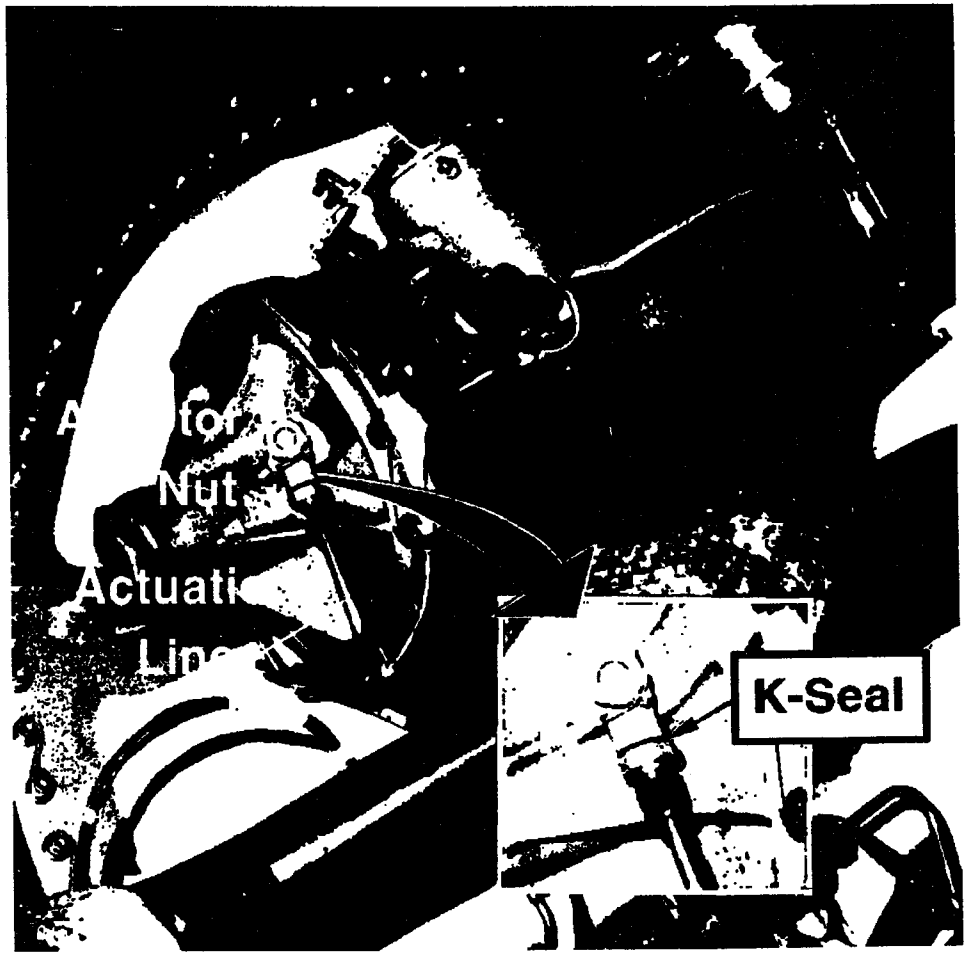
- Similarity

# Reinstate 750 psig Leak Check(B01643K)



## MAF Acceptance (TMO4k-B)

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# Changes - Summary



| Description | Reason | Basis for Certification |
|---|---|---|
| Revise documentation to incorporate new part number for GFP LO2 umbililical disconnect<br>• K-seal on umbilical changed from K-6 alloy to gold plated | Reliability - Alloy not O2 compatible at high temperatures and pressure | • Analysis - Gold plated seal is O2 compatible<br>• Rationale for acceptance of prior builds - Alloy seal installations preclude environments (pressure/ temperature) causing O2 reaction |
| Replace TIG weld process with VPPA process on LO2 tank forward fitting to ogive (B01887/J31004) | Reliability (continued implementation of VPPA welds)<br>• Reduce weld preparation and rework activity<br>• Reduce cost and schedule time | • Test<br>- Certification/confidence panels<br>- Proof<br>• Inspections<br>- X-ray<br>- Penetrant<br>- Leak<br>- Visual<br>• Similarity to previously flown hardware |

P.06
MMC/MAF FRR
5042573090
11-03-1993 08:49

# SMRB - Summary



## Description

- GO2 Pressure line lower flexible BSTRA weld defects (T107193) - 21-6-9 stainless steel
  - 0.090" porosity and 0.040" lack of fusion
  - 0.075 lack of fusion

## Disposition/Vehicle Clearance

- Use as is based on fracture mechanics analysis
  - 119 missions to burst - missions to leak not applicable
  - 445 missions to burst - missions to leak not applicable

# 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 |

# 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 II ICD Waiver - Baseline



| Document/Requirement<br>ICD 2-12001 | CCBD | PRCBD No. | Effectivity |
|---|---|---|---|
| Bipod yoke at Orbiter/ET forward attach point violates ICD<br>• Height dimension<br>- Requirement - 11.150"±0.030"<br>- Actual = 11.094"<br>• Use as is - No adverse affect on performance of separator bolt<br>- Required FS = 1.4<br>- Actual FS = 4.62 | TBD | S083726J | ET-60 |

# Level III Deviations - Baseline



| Document/Requirement | Paragraph | Deviation No. | Effectivity |
|---|---|---|---|
| **CPTO1M09A, External Tank Contract End Item Specification** | | | |
| Four GH2 presure line assemblies require NDE after proof because of an increase in design loads<br>• Current certification is based on pre-proof test NDE | Table 3.2.3 | 177 | ETs 33-35, 37, 39-60 |
| Cleaning requirement specifies maximum of 1000 microns in any direction without restrictions to number of particles<br>• Kapton insulated wire in LH2 tank has potential to emanate fiber-like Teflon particles above the contamination requirements. Cryo flow test show contamination neglible | 3.3.10 | 179 | ETs 53-60 |