FLIGHT READINESS STATEMENT
STS-107/ET-93
EXTERNAL TANK PROJECT
DELTA PRE-FLIGHT REVIEW

EXTERNAL TANK ET-93/STS-107, AS IDENTIFIED IN THE EXTERNAL TANK PROJECT PRE-FLIGHT DELTA REVIEW DATED DECEMBER 16, 2002, IS CONSIDERED READY TO SUPPORT FLIGHT UPON ACCEPTABLE DISPOSITION OF OPEN/PLANNED WORK AND/OR OPEN ACTIONS.

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J. W. SMELSER/MP31, CHAIRMAN

December 16, 2002

Space Shuttle
External Tank

Delta Pre-Flight Review

STS-107/ET-93

93ΔPFR.4250.ls.12/02

Agenda

Overview	***Lynn Servay***
Program Events Summary	
Prior Mission Performance Summary	
Current Mission/External Tank Highlights	
Special Topic - Vent Valve Relief Pressure	Brian Piekarski
SRM&QA Assessment	Terry McKeough
KSC Processing	Scott Otto
Verification/Certification	Lynn Servay
Mission Unique Assessment	
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Appendices

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Overview

This review includes an updated status of items relative to STS-107 and ET-93

- Summary of changes in the Shuttle mission manifest
- Updated assessment of the STS-107 mission
- Changes to the ET-93 baseline review
  - Requirement changes and items not previously reviewed / flown

FRR Series

• ET/SRB Mate Milestone Review	05/06/2002 (A)
• Michoud Operations President's Review	05/14/2002 (A)
• Pre-Flight Review	06/21/2002 (A)
• Delta ET/SRB Mate Milestone Review	11/01/2002 (A)
• Delta Pre-Flight Review	12/16/2002
• Space Shuttle Vehicle FRR	01/09/2003
• Mission Management Team (L-2 Day)	01/16/2003

Program Events Summary

ET-93 was initially scheduled to fly on STS-107 in July 2002

- ET-93 Project Pre-Flight Review was held in June 2002

Mission was delayed until January 2003 due to programmatic issues

- In June 2002 cracks in flow liners on the OV-104 during inspections of the feedlines
  - Subsequent inspections revealed flow liner cracks all Orbiters
- Delay in the STS-107 was required to develop rationale or repair methods for flow liner cracks, but effects on subsequent missions had to be considered
- Program evaluated options and determined best approach to meet program needs while assuring the safety of the vehicle
  - Mission objectives and available launch dates/windows considered
  - OV-102 had different flow liner configuration than other Orbiters
  - Reallocation of hardware was necessary to meet objectives
- Final manifest moved STS-112 and STS-113 ahead of STS-107
  - Demate of STS-107 was required due to booster stack availability

Prior Mission Performance Summary

STS-113/ET-116, Launch Scrubs

System	11/10/2002 *(High O2 concentration in Orbiter Midbody Compartment)*	11/22/2002 *(Weather violations at TAL site)*
• ***OMRSD***	• No ET violations	• No ET violations
• ***LCC***	• No ET violations	• No ET violations
• ***Instrumentation***	• Nominal performance	• Nominal performance
• ***MPS***	• No ET issues	• No ET issues
• ***ET Hazardous Gas***	• No ET violations	• No ET violations

• ***TPS***	• All observations acceptable per NSTS 08303
	  • Typical crack observed in -Y vertical strut closeout
	  • One crack observed on Intertank stringer panels
		• All observations acceptable per NSTS 08303
		  • Typical crack observed in -Y vertical strut closeout
		  • Ten cracks observed on Intertank stringer panels

Prior Mission Performance Summary

STS-113/ET-116, 11/23/2002 Launch

System	Performance
• ***OMRSD***	• No ET violations
• ***LCC***	• No ET violations
• ***Instrumentation***	• Nominal performance
• ***MPS***	• Nominal performance
• ***ET Hazardous Gas***	• No ET violations

• ***TPS***	• Conditions noted during previous tanking unchanged
	• Frost/crack observed on side of bipod ramp
	  • Acceptable per NSTS 08303
	• Cracks observed in -Y Longeron closeout
	  • MR rationale provided; no impact to countdown

• ***ET Disposal***	• Nominal
• ***Film Review – Post-Launch*** ***Post-Flight***	• No ET Issues • Film not available

• ***Orbiter Tile Damage***	• Lower surface hits forward of main landing gear
	  • STS-*113*: *43* with *6* > 1”
	  • Average: *30* with *6* > 1”

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Mission/External Tank Highlights

STS-107/ET-93, 01/16/2003

Mission

Launch

- Window
- Pad
- Orbiter
- Orbital Inclination
- ET Photo Coverage

Primary Payload

Landing

External Tank

DD250 Acceptance

Shipped to Launch Site

Mass Properties Update

**** Updates since ET-93 Baseline PFR***

STS-107

*** 01/16/2003**

2h 30m

** A*

Columbia (OV-102)

39° - Insertion at 150 NM

- Crew photos from cockpit window
- Umbilical well cameras

FREESTAR - Fast Reaction Experiments Enabling Science, Technology, Applications & Research

*** 02/01/2003 at KSC**

ET-93

11/02/2000

12/14/2000

* Coordination with Level II on December 4, 2002 indicates approximately 857 lbs. performance margin for STS-107

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Special Topic – Vent Valve Relief Pressure

Issue

- During review of requalification data from the new Vent / Relief Valve supplier, reduced relief pressures were observed for qualification testing
  - All data points were within the requirements in the Procurement Document
- When considering scatter in the valve cracking pressure, there is reduced margin to relief during LH2 tank pre-pressurization

Background

- At ET-101, the margin between the minimum ATP relief pressure and the maximum pressure allowed during pre-press was reduced to accommodate the use of three Block II SSMEs
  - Reduced margin applies only for missions using three Block II SSMEs
  - Four missions have flown with three Block II SSMEs
- Valve designer and engineers early in the program were aware that the valve can relieve at pressures lower than the ATP test pressures
  - Due to effects of environmental conditions (temperature, pressure, vibration) and wear

Special Topic – Vent Valve Relief Pressure

Discussion

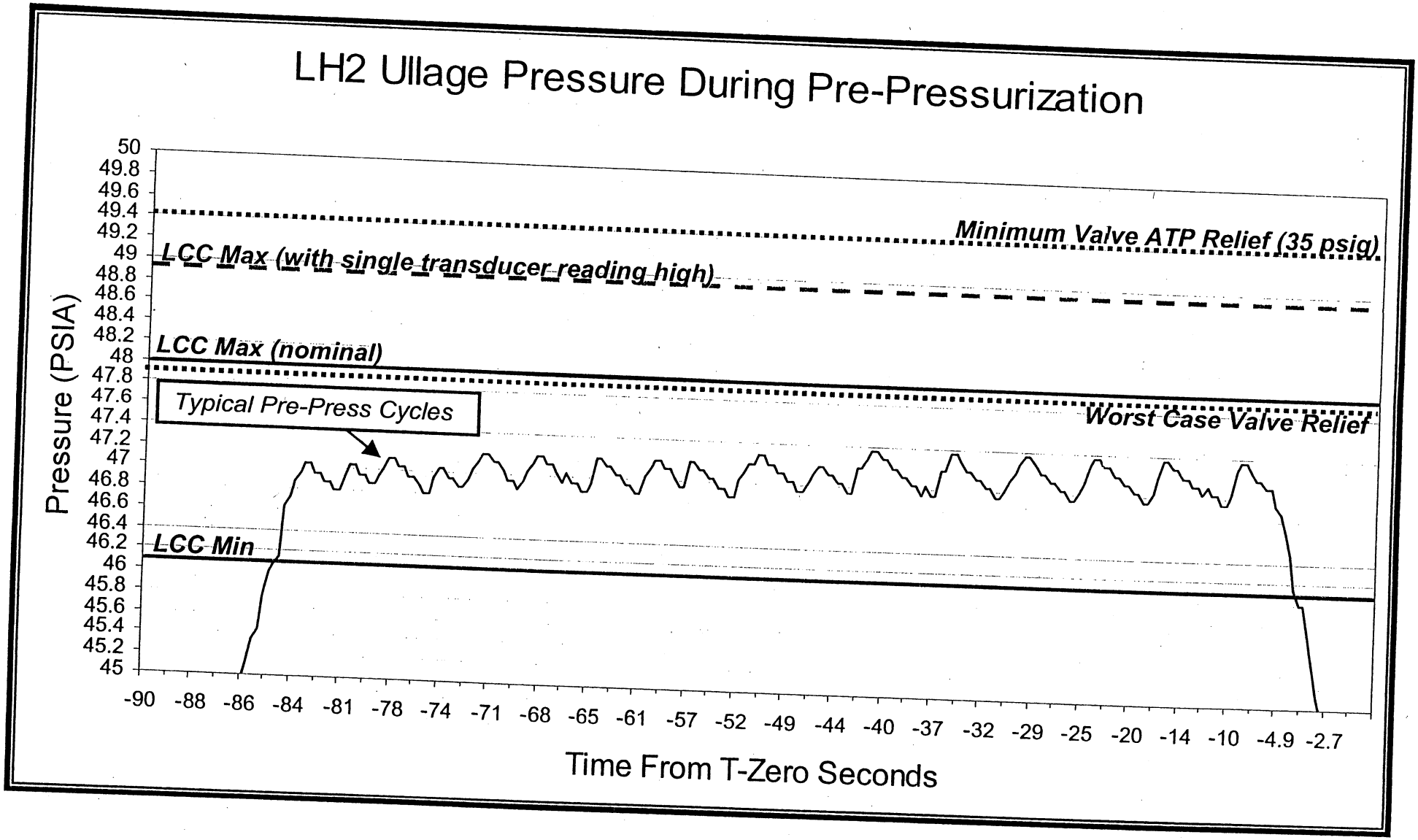
- After noting the scatter in the valve relief pressures during qualification, MAF conducted a review of data to determine significance
  - Minimum ATP relief pressures have historically been used for on-pad and in-flight venting analyses
  - Greatest deviation on a qualification unit was 1.52 psi below the average cryogenic ATP relief pressure

- Initial assessment of STS-107/ET-93 was performed using a worst case relief pressure of 1.52 psi less than the minimum relief pressure recorded for ET-93 ATP
  - GO2 valve performance during pre-press and flight
  - GH2 valve performance during pre-press and flight including 1 GH2 flow control valve failed open at engine start and multiple failure cases
  - 5 minute holds at T-31 seconds
  - RTLS
  - ET Separation

- LH2 tank during pre-pressurization was the only case showing insufficient margin when considering the potentially lower relief pressure

Special Topic – Vent Valve Relief Pressure

Summary of Requirements



Special Topic – Vent Valve Relief Pressure

Analysis Details

- Additional assessment using ET-93 ullage pressure transducer biases was performed to develop flight rationale
  - Analysis shows positive margin between minimum relief pressure and the maximum pressure allowed during pre-press
- When considering past performance of the H2 pressurization system, greater margin is expected

	Worst Case	**ET-93 Assessment**	
Minimum ATP Relief Pressure	35.00 psig	35.80 psig	
Ambient Pressure	14.53 psia	14.53 psia	
	49.53 psia	50.53 psia	
Elevation correction	-0.10 psi	-0.10 psi	
	49.43 psia	50.23 psia	
Potentially Lower Relief	-1.52 psi	-1.52 psi	
	47.91 psia	48.71 psia	
		Worst Case	*Expected*
Max Pre-Press pressure	48.90 psia	48.66 psia	47.83 psia
Margin to Relief	***-0.99 psi***	***0.05 psi***	***0.88 psi***

Special Topic – Vent Valve Relief Pressure

Analysis Details (continued)

- Assessment of past system performance on missions with the higher pre-pressurization band required for Block II SSMEs

	STS-110	STS-111	STS-112	STS-113
ATP Relief Pressure	35.80 psig	36.00 psig	35.80 psig	36.00 psig
Ambient Pressure	14.77 psia	14.64 psia	14.62 psia	14.77 psia
	50.57 psia	50.64 psia	50.42 psia	50.77 psia
Elevation correction	-0.10 psi	-0.10 psi	-0.10 psi	-0.10 psi
	50.47 psia	50.54 psia	50.32 psia	50.67 psia
Potentially Lower Relief	-1.52 psi	-1.52 psi	-1.52 psi	-1.52 psi
	48.95 psia	49.02 psia	48.80 psia	49.15 psia
Max Pre-Press pressure	47.91 psia*	47.73 psia*	47.86 psia*	47.81 psia*
Margin to Relief	1.04 psi	1.29 psi	0.94 psi	1.34 psi

* Corrected for transducer biases

Special Topic – Vent Valve Relief Pressure

Rationale for Flight

- Analysis of STS-107/ET-93 shows margin between the minimum predicted valve relief pressure and the maximum ullage pressure during prepress allowed in the LCC
  - Based on a review of the vent valve ATP relief pressures and the transducer biases for ET-93

- Review of historical LH2 pressurization performance shows the system does not typically operate near the upper LCC limit

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SRM&QA Assessment

as of 12/12/2002

Item	Status
ALERTS	***None***
MRB Assessment	***Complete -*** *No issues/no impact to hazard controls*
Hazard Assessment	***Complete -*** *All hazard reports were re-assessed and hazard controls verified*
CIL Retention Rationale	***Complete -*** *No issues/no impact to CIL retention rationale*
Corrective Action Problem Summary (CAPS)	
- S-089, Undersized Intertank Stringers	ET-93 cleared – Part thickness inspected upon completion of fabrication
- E-170, Level Sensor ATP Failure	ET-93 cleared –Sensors passed ATP

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KSC Processing - Status

as of 12/12/2002

STS-107 Demate

- TPS on aft ET/SRB fairings was damaged as a result of STS-107 demate activities
  - Fairings successfully refurbished at MAF and returned to KSC

Discrepancy Reports (DRs)/Problem Reports (PRs) Review

- PR/MRB discrepancies/dispositions similar to previously flown vehicles
  - All KSC/MRBs have been reviewed by MAF Reliability for potential SMR
  - No items were elevated to the SMR

Limited Life Component/ET Status

- Updated assessment of limited life components complete
  - All within required life through scheduled launch date plus 90 days

OMRSD Exceptions/Waivers: None

KSC Processing –Status

as of 12/12/2002 – Updates to ET-93 Baseline PFR

Changes		**STS-107/ET-93**
• ET modifications		
- Mod Kits	0	
- DC&R	0	
- Bldg 45	0	
- FEC	0	
- OMRSD	2	• Description on subsequent chart - *RCN SS15815 – ET Sensor Requirements* - *RCN SS15970 – ET/Orb Visual Leak Monitoring*
- LCC	1	• Description on subsequent chart - *LCN 01109 – ET/ORB Visual Leak Monitoring*
• Software	0	
• GSE Modifications	0	
SIM Launch (S0044)	12/06/02	
SIM Load (S0056)	12/17/02	

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KSC Processing

Program Requirement Changes

Two proposed requirement updates for the upcoming mission affect ET systems

- Changes pending approval

ET Sensor Requirements for LO2 Loading (OMRS – RCN SS15815)

- Added/revised tables to clarify the functional requirements of the point level sensors
  - Updates will allow certain level sensor failures during LO2 loading without a waiver
  - Updates do not compromise the intent of the requirement
  - Sensor failures will still be documented in PRACA for recurrence control

ET/Orbiter Propellant Leak Visual Monitoring during cryogenic load

- Relocate requirements for from OMRSD to LCC
- No change in the requirement to visually monitor
  - OMRSD – RCN SS15970 deleted requirement to monitor leakage during cryo load and created a requirement to monitor propellant leakage during a scrub turnaround (OMRSD RCN SS15970)
  - LCC – LCN 1109R1 deleted visual leak monitoring from HAZ-12 and created SSID ICE-04 for the visual leak monitoring

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Verification/Certification

as of 12/12/2002 – Updates to ET-93 Baseline PFR

Item	Status
NSTS 07700, Volume X, Book 1, Baseline • Revision M, Change **287**	Complete - No Issues
Certification documentation • Hardware Certification Sheets (HCS) • Certificates of Qualification (COQ)	No new items since baseline review
Waivers/Deviations	No new items

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STS-107 Mission Unique Assessment - Update

as of 12/12/2002

Category/Item	**Status**
STS-107 Liftoff Loads Environments • One ET indicator exceeded the defined limit - Assessment shows exceedance is acceptable • ET EIS design FS requirements not violated	• Assessment complete and response documented • No Issues
Review of MRB actions using updated loads	• Assessment complete • No issues
MPS Preflight Prediction • Mission specific trajectories provided for STS-107	• Boeing assessment indicates potential ICD pressure violations - Discussed in subsequent chart
Debris from BSM during SRB Separation • Boeing identified that contaminant (RTV) in BSM would potentially impact ET	• Assessment complete • No ET issues identified

**All items were identified at the ET-93 Baseline PFR with open status*

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STS-107/ET-93 Status

Mission Unique Assessment

LO2 Tank Predicted ICD Pressure Violation

- Boeing performed preflight mission specific MPS predictions and identified potential ICD pressure violations for the LO2 tank for nominal and RTLS missions
  - Predictions used 100.15% liquid load and updated trajectory and hardware performance data
    - Normal Mission Max Limit: 0.15 psi violation between 82 and 102 seconds
    - Normal Mission Min Limit: 0.85 psi violation between 0 and 1 seconds
      0.25 psi violation between 2 and 8 seconds
    - RTLS Mininimum Limit: 0.3 psi violation between 0 and 0.5 seconds
      0.15 psi violation between 3 and 7 seconds

- Analysis has been performed for the predicted LO2 tank ICD ullage pressure violations for the STS-107 mission (ET-93) with no issues identified
  - Critical structural margins of safety are unaffected for the new predicted maximum and minimum ICD limits

- Waiver to LO2 Ullage Pressure ICD requirement was processed
  - IRN written by Boeing Propulsion Integration (KSC/JSC)
    - Approved by PSIG and Loads Panel on 12/2/2002
  - CR S061917 was approved at the 12/10/2002 ICB

Readiness Statement

The External Tank, ET-93, is certified and ready for STS-107 flight pending completion/closure of open and planned work

Appendices

A: Minor Changes
- No updates to ET-93 Baseline PFR

B: SRM&QA Assessment
- No updates to ET-93 Baseline PFR

C: KSC Processing – Updates to ET-93 Baseline PFR
- PR/MRB Summaries

D: Level II Waivers/Level III Deviations
- No updates to ET-93 Baseline PFR

ET-93 DR/PR/OMRSD Waiver/Exceptions

as of 12/12/2002 – Update to ET-93 Baseline PFR

System	Discrepancy	Problem	MRB Items	Exceptions/ Waivers
• Electrical	0	2	0	0
• Propulsion/ Pneumatics	0	4	0	0
• Structures	4	14	0	0
• Thermal (TPS)	0	16	4	0
Total	4	36	4	0

ET-93 PR/MRBs

as of 12/12/2002 – Items Assessed Since ET-93 Baseline PFR

PR No.	Title/Description	Disposition
ET-93-TS-0008	Foam Damage Aft of ET/SRB Fitting (+Y/-Y)	MRB approved for use-as-is Subsequent closeout will accommodate localized defects
ET-93-TS-0009	Foam Damage Fwd of ET/SRB Fitting (+Y/-Y)	MRB approved for use-as-is Subsequent closeout will accommodate localized defects
ET-93-TS-0014	Voids in Fwd periphery Closeout of –Y ET/SRB Fairing	MRB approved to rework and repair periphery closeout