

NASA

SECTION 27

45



STS-107 Flight Readiness Review

Space Station and Payloads Processing

STS-107

SPACEHAB-Research Double Module

FREESTAR

Jack Keifenheim

STS-107 KSC Mission Manager

January 9, 2003



Agenda

- Hardware Images To Be Briefed
- Milestone History To Be Briefed
- Open Work To Be Briefed
- Late Stowage Activities To Be Briefed
- Middeck Experiment Requirements To Be Briefed
- Launch Delay Requirements To Be Briefed
- Launch Commit Criteria To Be Briefed
- Engineering Status
Processing Status
Requirements
PRACA To Be Briefed
- Readiness Certification To Be Briefed
- Acronyms In Back-Up
- Master Milestone Schedule In Back-Up
- LCC Charts In Back-Up



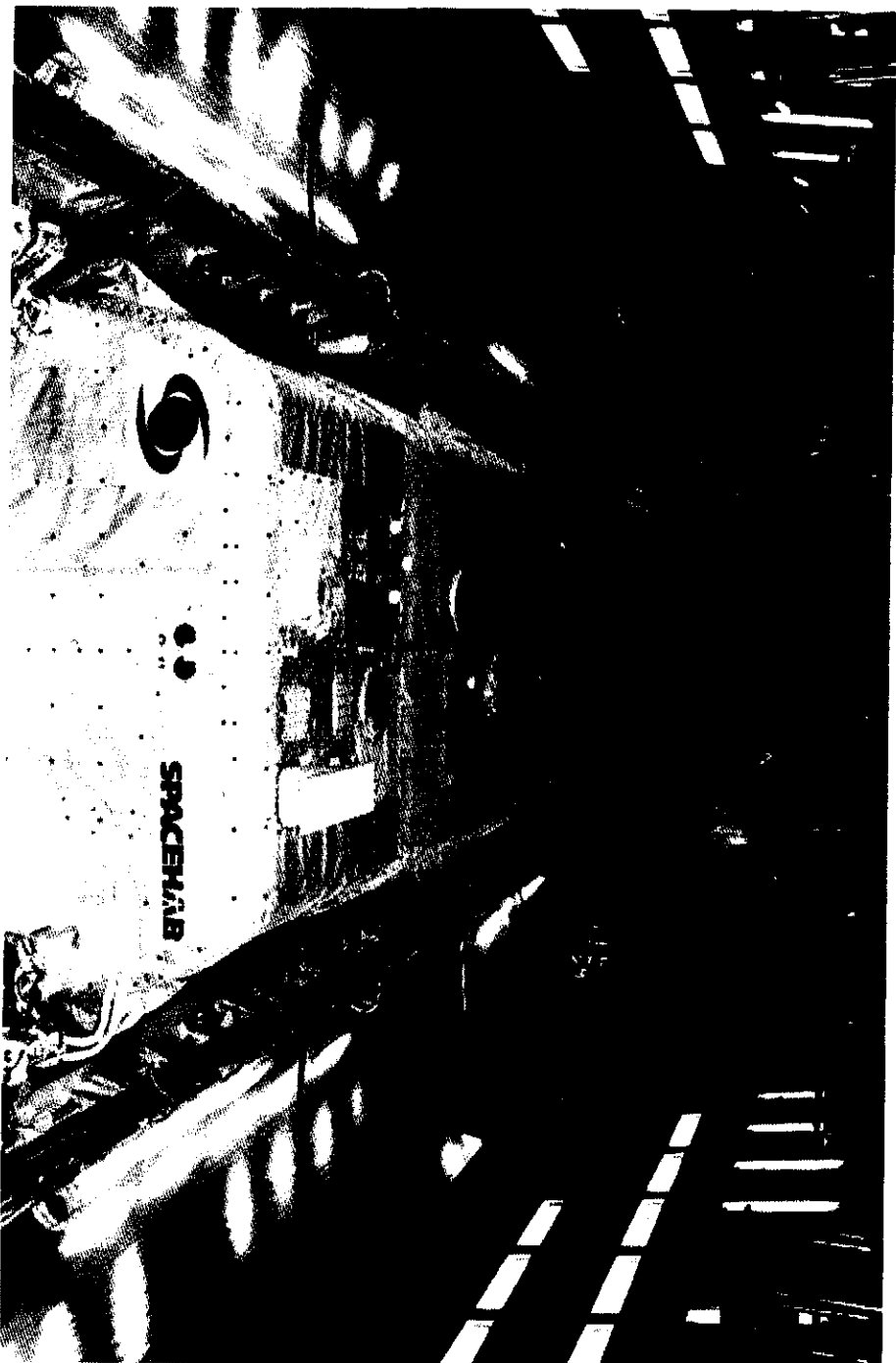
SPACEHAB-RDM and Tunnel



STS-107 FRR
J. F. KENNEDY SPACE CENTER



SPACEHAB and EDO Pallet





FREESTAR and SPACEHAB-RDM



STS-107 FRR
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Milestone History

SPACEHAB-RDM Tunnel New Hardware O/D	1/4
Tunnel Reconfiguration	1/17 - 5/10
FREESTAR MPPF O/D	3/18
SPACEHAB/FREESTAR/Tunnel Installation into Orbiter	5/23
FREESTAR IVT	5/24
SPACEHAB-RDM IVT	6/3-6/10
Orbiter PLBD Closure for Flight	6/14
STS Orbiter LH2 Flowliner Crack Investigation	6/20-8/5
SPACEHAB-RDM / Experiments Health Check Testing	7/24, 10/29-30 11/11
SPACEHAB Experiments Health Check (drag on power)	8/28 VAB, 9/25
PLBD Open (Orb. Camera Rmvl for STS-112)	9/17
PLBD Closed for Flight	10/31
SPACEHAB-RDM Stow and Closeouts	11/12
SPACEHAB-RDM LCC CITE Simulation (SSPF)	12/5
S0044 LCC Simulation	12/6
OV-102 Rollout with SPACEHAB-RDM and FREESTAR	12/9
FREESTAR MEIDEX Video Test	12/12
SPACEHAB-RDM Early MVAK Stow	1/6



Open Work

Pad A

SPACEHAB Late MVAK Stow / Internal Closeouts

1/14-15

Middeck Late Stowage and IVTs

1/15

Launch

1/16

FREESTAR has no open Pad work



Late Stow Activities

Late MVAK Activities

- MVAK Pre-operation (January 6) (Complete)
- Reconfigure MVAK / Open D Hatch (January 13)
- SPACEHAB-RDM Activation (L-51 hours) (January 14)
- SPACEHAB-RDM Late Stow and Closeouts (to L-31 hours)
- Close D Hatch (to L-29:30)
- Remove MVAK (following tunnel/airlock C/O, to L-24)
 - 20 hours of activity from SPACEHAB activation to D Hatch closure
 - MVAK training in March and October 7 & 8
 - Early MVAK Stow Jan. 6 provided experience
 - MVAK equipment thoroughly inspected and certified

Late Middeck Stowage

- FCE Stowage (following com. act.) starts at L-22:30
 - Middeck Experiment Stowage from L-19 to L-16
 - 14 lockers total
 - 4 powered lockers requiring IVTs
- Stowage contingency plans and security arrangements are developed
-



Middeck Experiment Requirements

Middeck	Installation	IVT	Ascent Power	Launch Delay	Destow
CEBAS	< L-17 Hrs	Yes	Yes	48 Hrs	Runway
CEBAS Stowage	Nominal	No	No	None	Runway
CMPCG	< L-24 Hrs	Yes	Yes	48 Hrs	Runway
OSTEO	< L-19 Hrs	Yes	Yes	24 Hrs	Runway
Biopack Facility Contents	< L-17 Hrs	No	No	24 Hrs	Runway
Biopack Glovebox Tray	< L-24 Hrs	No	No	48 Hrs	Runway
Biopack PTCUs, 5 deg C (2)	< L-17 Hrs	No	No	24 Hrs	Runway
Biopack PTCUs, -10 deg C (2)	< L-17 Hrs	No	No	48 Hrs	Runway
HLS Phab-4	< L-24 Hrs	No	No	48 Hrs	Runway
HLS Stowage	< L-24 Hrs	No	No	48 Hrs	Runway
BDS-05 Stowage	< L-24 Hrs	No	No	48 Hrs	Runway
BRIC	< L-17.5 Hrs	Yes	Yes	24 Hrs	Runway
ZCG Autoclaves	< L-22 Hrs	No	No	48 Hrs	Runway
SH FDF	< L-48 Hrs	No	No	None	Runway
Jettison Stowage Bag	Nominal	No	No	None	Runway



Launch Delays

SPACEHAB-RDM

MVAK access to the SPACEHAB-RDM is required for experiment refurbishment, if the launch is delayed for 48 hours or greater from the initial T-0.

A 96 hour scrub turnaround is required for this effort

- 18.5 hours (launch window, pad safing, FCE destow, MVAK set-up, open D hatch
- 13 hours of SPACEHAB destow
- 18 hours of experiment refurbishment to L-46.5 hours
- 16 hours of SPACEHAB restow to L-30.5
- 6.5 hours (hatch closing, MVAK removal, AL closeout) to L-24
- SPACEHAB remains powered through 96 hour scrub
- For scrub durations longer than 96 hours, SPACEHAB would power-down

FREESTAR

No launch delay requirements

MIDDECKS

Experiment refurbishment is required for 24 and 48 hour delays. (See Middeck Requirements)



Launch Commit Criteria

Launch Commit Criteria

- 11 Mission Success LCCs
- 3 Payload safety LCCs

A full CITE simulation was performed on December 5 to exercise the launch team in the protocol and flow of the LCCs

- NTD, SPE, SPACEHAB engineering, PLM and mission management attended
- The payload launch team participated in S0044 on December 6 which involved multiple payload problems and simulations
- This provided further simulation and exercise of the payload launch team in an integrated environment

The prime and backup payload launch teams have simulated the LCCs and protocol and are ready to support launch activities



Engineering Status

Processing Status

SPACEHAB-RDM Experiment Health Checks

All SPACEHAB-DM powered up health checks were performed without anomalies or issues

MEIDEX Video Camera Retest

Post Freestar IVT evaluation of the video tapes from the MEIDEX experiment revealed color banding in the images

OMRS P488FJ.020 – MEIDEX Video signal was successfully bought off in the Freestar IVT Subsequent evaluation by JSC DTV experts determined that there were anomalies in the video tape recorded by the MEIDEX cameras

GSFC initiated a CR to the PIP to perform further video testing at the pad and TPS VT-STS-107-PLD-T106 was written to perform this testing on December 12.

A post test evaluation of the video tapes recorded during this testing will be used to determine any on-orbit configuration required for optimum video performance

The results of this test showed no color banding or problems with the recorded video

Summary

All required work has been completed with no outstanding issues



Engineering Status

Requirements

OMRS

No open RCNs

All remaining open requirements are incorporated into appropriate scheduled procedures.

Exception/Waivers

EKP10288 – Biopack Data Verification – OMRS P1426FL.100

Exception to allow for Biopack data cable disconnection due to damage

This exception has been approved and incorporated

The Biopack cable has been repaired and reinstalled

A protective cover has been developed to preclude further damage



Engineering Status

PRACA

VT-STS-107-PLD-P010 – SPACEHAB FORWARD LINK NOT RECEIVED AT SPACEHAB-RDM.

DESCRIPTION – During the interface verification of the Orbiter KUSP Channel 2 interfaces with the SPACEHAB-RDM, uplink commands were not being received at the SPACEHAB EDSMU.

ACTIONS TAKEN – Troubleshooting discovered that the clock signal from the Orbiter KUSP to the forward link had a reversed polarity. SPACEHAB engineering modified the J13 connector on the harness to the EDSMU to swap the pins for the clock signal. Retest was successful.

ACTIONS PLANNED – USA engineering and SPACEHAB engineering have an action to review the As-Build drawings of the cables from the KUSP to the SPACEHAB to determine where the reversed polarity of the clock signal occurred. SPACEHAB is investigating timing signal inputs and outputs on the EDSMU.

RISK ASSESSMENT – No constraint to launch. Modifications of the SPACEHAB harness assured interface verification for the STS-107 mission.

SUMMARY – Pending completion of SPACEHAB testing at ESTL, if the problem is not isolated to SPACEHAB systems, the PR will be deferred. Post mission testing will be performed at the SIP to determine the location of the swapped signal.



Engineering Status

PRACA

Lost & Found PR

VT-STS-107-PLD-P009 – Lost SPACEHAB FOD Bag

Detected during powered up experiment operations

The SPACEHAB customer has performed an extensive investigation and verified that the FOD bag is most probably not in the SPACEHAB module and this was a procedural error in the ingress/egress logs

Closure of the SPACEHAB non-conformance is "No constraint to flight"

No open IPRs/PRs effecting forward work (VT-STS-107-PLD-P010 deferred)

No Unexplained Anomalies

No Significant Crew Squawks

No LOLI Issues



Readiness Statement

Pending completion of the planned forward work the KSC ISS / Payloads Processing Directorate is ready to proceed with the launch of STS-107.

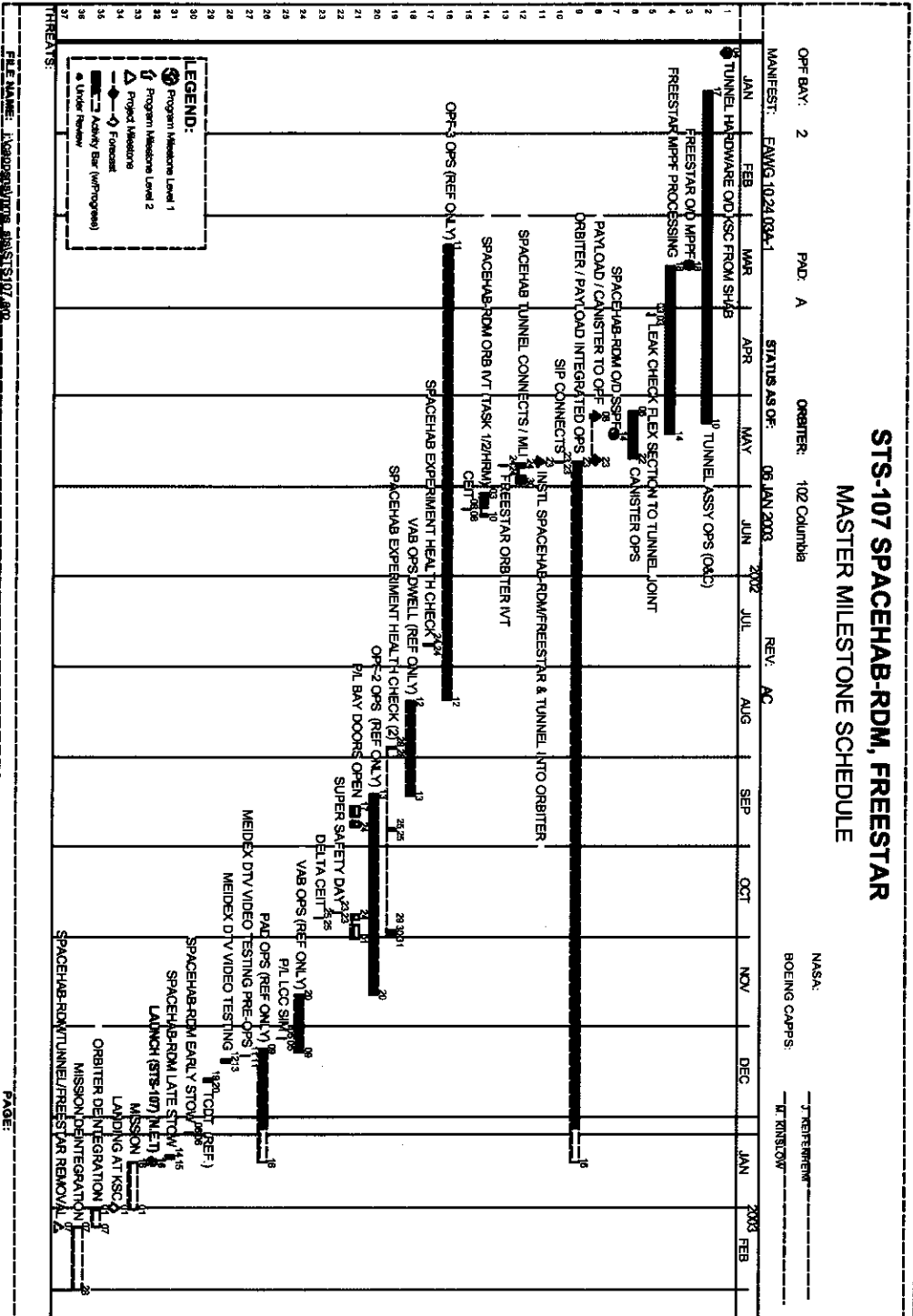


BACK-UP CHARTS



Master Milestone Schedule

STS-107 SPACEHAB-RDM, FREESTAR MASTER MILESTONE SCHEDULE





Acronyms

BDS	Bioreactor Development System
BRIC	Biological Research in Canisters
CEBAS	Closed Equilibrated Biological Aquatic System
CMPCG	Commercial Macromolecular and Protein Crystal Growth
HLS	Human Life Sciences
IVT	Interface Verification Test
MPFE	Microbial Physiological Flight Experiment
MVAK	Module Vertical Access Kit
OSTEO	Osteoporosis Experiment in Orbit
PTCU	Passive Thermal Containment Unit
RMD	Research Double Module
SH FDF	SPACEHAB Flight Data File
FREESTAR	Fast Reaction Experiment Enabling Science Technology Applications and research
ZCG	Zeolite Crystal Growth



Launch Commit Criteria

SSID Number	RDM Title	Mission Success/Safety	LCC Timeframe	Monitored By
RDM-01	SPACEHAB HPA FAN ANOMALY	Safety	T-6 hrs to T-31 sec	NASA/KSC
RDM-02	SPACEHAB EMERGENCY BUS VOLTAGE ANOMALY	Safety	T-6 hrs to T-31 sec	NASA/KSC
RDM-03	SPACEHAB SMOKE/FIRE ANOMALY	Safety	T-6 hrs to T-31 sec	NASA/KSC
RDM-04	SPACEHAB DMU INTERFACE/POWER FAILURE	Mission Success	T-6 hrs to T-31 sec	Customer from NASA/KSC console
RDM-05	PAILOD AFT MAIN B CRITICAL POWER ANOMALY	Mission Success	T-6 hrs to T-9 min	Customer from NASA/KSC console
RDM-06	SPACEHAB MAIN POWER ANOMALY	Mission Success	T-6 hrs to T-31 sec	Customer from NASA/KSC console
RDM-08	SPACEHAB SUBSYSTEM WATER LOOP FLOW RATE ANOMALY	Mission Success	T-6 hrs to T-31 sec	Customer from NASA/KSC console
RDM-09	SPACEHAB WATER PUMP ACCUMULATOR QUANTITY (DUAL/DOW) ANOMALY	Mission Success	T-6 hrs to T-5 min	Customer from NASA/KSC console
RDM-10	SPACEHAB WATER PUMP INLET PRESSURE (DUAL/DOW) ANOMALY	Mission Success	T-6 hrs to T-3 min	Customer from NASA/KSC console
RDM-11	SPACEHAB WATER PUMP OUTLET PRESSURE (DUAL/DOW) ANOMALY	Mission Success	T-6 hrs to T-3 min	Customer from NASA/KSC console
RDM-12	CEVPP ACCUMULATOR QUANTITY ANOMALY	Mission Success	T-6 hrs to T-9 min	Customer from NASA/KSC console
RDM-13	CEVPP INLET PRESSURE ANOMALY	Mission Success	T-6 hrs to T-4 min	Customer from NASA/KSC console
RDM-14	CEVPP OUTLET PRESSURE ANOMALY	Mission Success	T-6 hrs to T-3 min	Customer from NASA/KSC console
RDM-15	SPACEHAB HPA FAN COMMAND ANOMALY	Mission Success	T-6 hrs to T-9 min	Customer from NASA/KSC console



SPACE SHUTTLE PROGRAM
Space Shuttle Projects Office (MSFC)
NASA Marshall Space Flight Center, Huntsville, Alabama



STS-107/ET-93

Flight Readiness Review

External Tank Project



January 9, 2003



SPACE SHUTTLE PROGRAM
Space Shuttle Projects Office (MSFC)
NASA Marshall Space Flight Center, Huntsville, Alabama



External Tank Status

Presenter	
Terry Greenwood, NASA/ET-MP31	
Date	January 9, 2003
Page	2

- **First LWT to fly with three Block II SSMEs**
 - LWT LH2 configuration previously certified for SSME Block II implementation on ET-92
 - Block II engine cluster requires higher pressures for LH2 tank pre-press
 - Analysis showed that critical structural margins of safety are unaffected for the higher pressures
- **Mission Specific Assessment**
 - GO2 ullage pressure prediction showed LO2 tank ullage pressure exceeding ICD limits
 - LWT ICD limits are more constraining than SLWT
 - Program changes since last LWT mission reduced margin to the limits
 - Block II SSME tags, 100.15% sensor loading ground rule, and SRB burn rate prediction methodology update
 - Analysis showed that critical structural margins of safety are unaffected for the new predicted maximum and minimum ICD limits – Approved by PRCBD S061917
- **Limited Life Component Status**
 - All items within required life through scheduled launch date plus 90 days
- **No Significant Processing Anomalies**
- **No Significant Changes**
- **Readiness Statement**



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NASA Marshall Space Flight Center, Huntsville, Alabama



Readiness Statement

		Presenter Terry Greenwood, NASA/ET-MP31
Date	January 9, 2003	Page 3

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

TWR-77414
ECS SS12948



SPACE SHUTTLE PROGRAM
Space Shuttle Projects Office (MSFC)
NASA Marshall Space Flight Center, Huntsville, Alabama



Reusable Solid Rocket Motor STS-107 Flight Readiness Review/CoFR

Motor Set RSRM-88

9 January 2003

Presented by Terry Boardman



ATK THIOKOL PROPULSION

P.O. Box 707, Brigham City, UT 84302-0707 (435) 863-3511



RESEARCH SPACE RESEARCH BOARD



SPACE SHUTTLE PROGRAM
Space Shuttle Projects Office (MSFC)
NASA Marshall Space Flight Center, Huntsville, Alabama



Agenda

STS-107 (RSRM-88)

Flight Readiness Review/CoFR

- 1.0 Previous Flight Assessment—STS-113
 - 2.0 Certification Status—**No Constraints**
 - 3.0 Changes Since Previous Flight—**None**
 - 4.0 Configuration Inspection
 - 4.1 As-Built Versus As-Designed, Hardware, and Closeout Photo Review Status—**No Issues**
 - 4.2 Hardware Changeouts Since ET/SRB Mate Review—**None**
 - 5.0 SMRB Nonconformances—**None**
 - 6.0 Technical Issues/Special Topics—**None**
 - 7.0 Readiness Assessment
- Backup LCC and Contingency Temperatures for STS-107



ATK THIOKOL
PROPULSION



REPAIR/REWORK/REWORK



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NASA Marshall Space Flight Center, Huntsville, Alabama



Previous Flight Assessment—STS-113

STS-107 (RSRM-88)
1.0-1

Disassembly Evaluation Summary—Status of Disassembly Activity

	LH RSRM	RH RSRM	Remarks
KSC Operations			
Initial LH/RH SRB viewing	* Complete	Complete	
SRB/RSRM walkaround assessment	* Complete	Complete	
Demate/evaluate aft exit cone (AEC)	* Complete	Complete	
Remove/evaluate S&A and OPTs	* Complete	Complete	PEAR 360W086B-01, Plug Washer In RH Aft Dome 120-Deg Radial Bolthole PEAR 360W086B-02, Flashing on Nozzle-to-Case Joint Packing-With-Retainer NO FLIGHT CONCERNS IDENTIFIED
Remove/evaluate nozzle	* Complete	Complete	
Remove/evaluate stiffener rings/stubs	Complete	Complete	
Remove/evaluate igniter	* Complete	Complete	
Demate/evaluate field joints/evaluate insulation	* Complete	Complete	
Utah Operations			
Disassemble/evaluate nozzle (joint No. 4 and 5)	* Complete	Complete	
Disassemble/evaluate nozzle (joint No. 2 and 3)	* Complete	Complete	
Disassemble/evaluate S&A	* Complete	Complete	
Washout nozzle phenolics	Jan 2003	Jan 2003	
Washout nozzle AEC phenolics	Jan 2003	Jan 2003	
Measure/evaluate aft dome insulation	Mar 2003	Mar 2003	

* RSRM Project committed to complete prior to next launch

- No constraints to STS-107 flight



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PROPULSION



**ATK THIOKOL
PROPULSION**



STS-107 Readiness Assessment

Pending satisfactory completion of normal operations flow (per OMRSD), the RSSRM hardware is ready to support flight for mission

STS-107

9 January 2003

/s/ T. A. Boardman

T. A. Boardman
RSSRM Deputy & Chief Engineer
Thiokol

/s/ E. C. Ralston

E. C. Ralston
Vice President
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/s/ R. K. Burt

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REPAIRABLE REPAIRMENT



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Space Shuttle Projects Office (MSFC)
NASA Marshall Space Flight Center, Huntsville, Alabama



Current Flight Predictions

STS-107 (RSRM-88)

Backup-1

LCC and Contingency Temperatures for STS-107

Heater Location	LCC	Minimum Allowable Sensor Temperature*	
		LH	RH
Igniter	74° F	72° F	72° F
Forward Field Joint	86° F	68° F	70° F
Center Field Joint	86° F	70° F	73° F
Aft Field Joint	86° F	67° F	69° F
Nozzle-to-Case Joint	75° F	62° F	66° F

*LCC contingency temperature in the event of heater failure

Note: Calculation includes all standard repair conditions



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PROPULSION

Terry Boardman 088-FRR/CoFR Backup-1

**STS-107 (B1116)
FLIGHT READINESS REVIEW**

Program

January 9, 2003

Solid Rocket Booster

AGENDA

Presenter:

Roger Elliott

Organization/Date:

USA-SRB/1-9-03

- Special Topic
 - Qualified New Forward and Aft Separation Bolt Vendor
- Technical Issues
 - Defective Cable Connector Sockets
 - Suspect Paint Foreign Object Debris (FOD) in Booster Separation Motors (BSMs)
- Readiness Assessment

SPECIAL TOPIC NEW SEPARATION BOLT VENDOR

Presenter:
Roger Elliott

Organization/Date:
USA-SRB/1-9-03

Topic

- First flight use of Pacific Scientific forward and aft separation bolts

Background

- Pacific Scientific Engineering Materials Company new vendor for separation bolts
 - Previously supplied by Hi-shear and Teledyne McCormick Self
 - Pacific Scientific currently supplies 8 other SRB pyrotechnic components

Discussion

- Hardware underwent full qualification program
 - Thermal shock, sine and random vibration, ambient and low temperature functional, stress corrosion and failure load test
- Aft bolts successfully used in tail service mast application on STS-112
- No increased risk for STS-107 and subsequent

TECHNICAL ISSUE CABLE CONNECTOR SOCKETS	Presenter: Roger Elliott
	Organization/Date: USA-SRB/1-9-03

Issue

- Defective connector sockets on cable assemblies

Concern

- Loss of Criticality 1R power to SRB

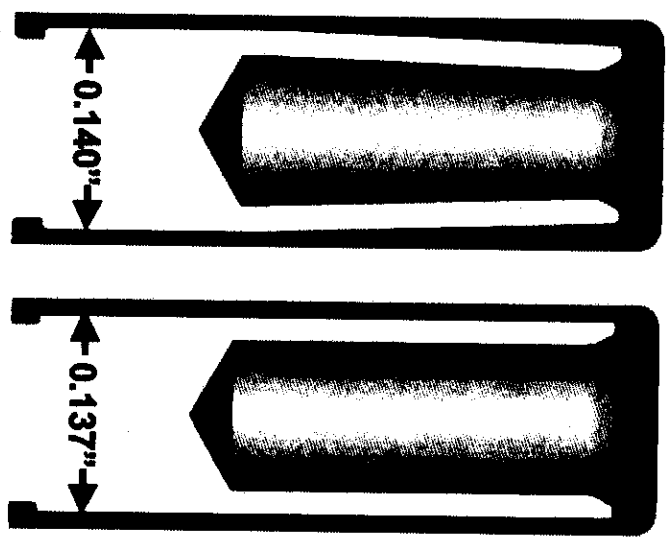
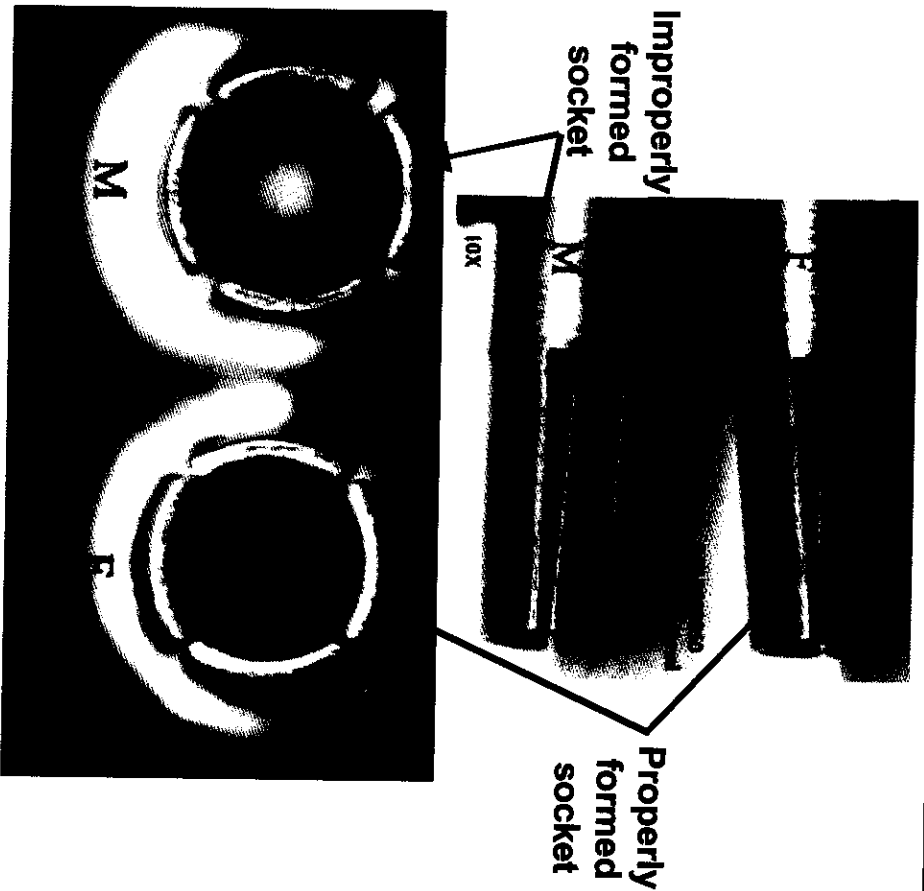
Background

- Cable found with intermittent continuity during flex testing
- Cable provides Orbiter power to SRB
 - Two cables of this type per SRB (A & B buses at aft IEA)
 - Cables utilize NAS6CR24-19S/SA connector
 - Unique SRB connector design
 - Connector uses 12 gage sockets

TECHNICAL ISSUE CABLE CONNECTOR SOCKETS

Presenter:
Roger Elliott

Organization/Date:
USA-SRB/1-9-03



Visual Comparison of Properly and Improperly Formed Sockets

SRB-5

TECHNICAL ISSUE CABLE CONNECTOR SOCKETS

Presenter:
Roger Elliott

Organization/Date:
USA-SRB/1-9-03

Discussion

- Formed joint anomaly resolution team
 - Representatives from MSFC, USA and Amphenol
- Identified connector socket manufacturing anomaly
 - Undersized socket barrel outside diameter resulted in improper forming of socket
 - Machined by Amphenol at Sidney NY facility (October 1997)
 - In-process inspection
 - Operator required to verify six per hour (approximately 10%)
 - Contact sockets and hoods shipped to Nogales, Mexico facility for final assembly/inspection and lot acceptance testing
 - 100% burnished and gauged – manual operation
 - Required to perform separation force test on entire lot
 - Final lot acceptance testing at 1% Acceptance Quality Level (AQL)
 - First time Nogales facility used for final assembly process
 - No changes to assembly process paper
 - Language barriers existed during first time operation
 - Process paper unclear
 - On-site support not provided

SRB-6

TECHNICAL ISSUE CABLE CONNECTOR SOCKETS

Presenter:

Roger Elliott

Organization/Date:

USA-SRB/1-9-03

Discussion (cont.)

- Investigation identified one additional unique connector socket utilized by SRB, NAJ-12-16
 - Manufactured using similar processes/inspections by Amphenol
 - Utilized for nose cap separation and nozzle extension severance
 - Criticality 3 functions
 - Fourteen cables and eight loose contacts inspected with no discrepant contacts identified
 - Total of 92 contacts
- Assembled hardware not inspected
 - Criticality 3 functions
 - Nose cap separation
 - Nozzle extension severance

TECHNICAL ISSUE CABLE CONNECTOR SOCKETS

Presenter:
Roger Elliott

Organization/Date:
USA-SRB/1-9-03

Discussion (cont.)

- Identified improper machining of socket as primary root cause of anomaly
 - Identified quality escapes as secondary root cause
 - In-process checks – six per hour required
 - Burnish and gauge operation – 100% requirement
 - Lot acceptance tests – 1% AQL
- Completed inspection and pin retention test of all available hardware
 - No discrepancies found on STS-107, inspected 12-18-02
 - Replaced two cables on STS-114, inspected 12-16-02
 - STS-115 aft boosters still to be inspected and tested
 - Identified one unused contact on STS-116 as discrepant on 12-11-02

TECHNICAL ISSUE CABLE CONNECTOR SOCKETS

Presenter:
Roger Elliott

Organization/Date:
USA-SRB/1-9-03

Flight Rationale

- STS-107 NAS6CR connectors successfully passed inspection and pin retention test
- All other uses of NAS6CR connectors on future missions will be inspected and non-conformances corrected
- Investigation data supports isolated quality escapes limited to NAS6CR connector sockets
- Inspection of NAJ-12-16 sockets indicates no similar concern
 - NAJ-12-16 sockets only used in Criticality 3 applications
- All SRB system's functionality and redundancy verified before and after vehicle assembly
- Critical systems verified during pre-flight testing
- STS-107 and subsequent safe to fly

TECHNICAL ISSUE SUSPECT PAINT FOD IN BSM	
Presenter:	Roger Elliott
Organization/Date:	USA-SRB/1-9-03

Issue

- Suspect paint FOD in Booster Separation Motors (BSM)

Concern

- BSM performance
- FOD ejected during BSM firing at SRB separation

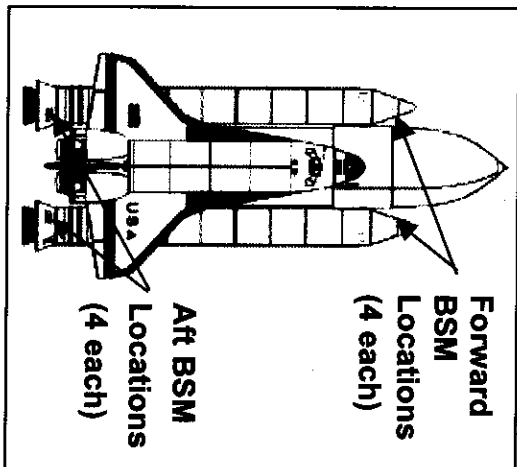
Background

- Five small paint chips detected in propellant premix for SRB BSM propellant batch at vendor
 - Identified prior to mix operation
 - Chips loosened from painted lip of 400 gallon mix bowl when chemical addition cover removed

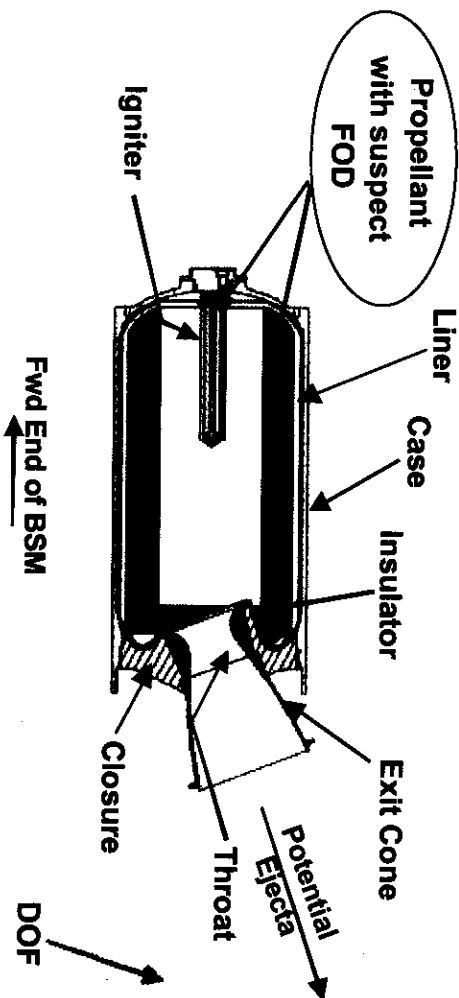
TECHNICAL ISSUE SUSPECT PAINT FOD IN BSM

Presenter:
Roger Elliott

Organization/Date:
USA-SRB/1-9-03



BSM Orientation



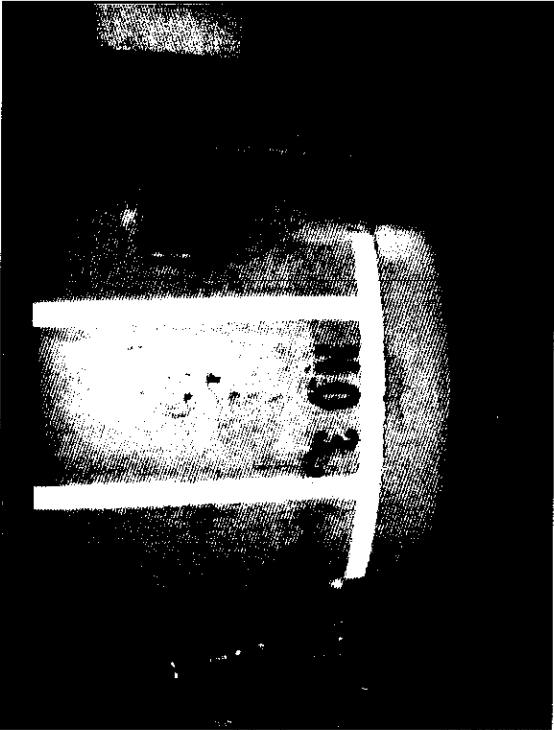
Forward BSM Cross Section

SRB-11

TECHNICAL ISSUE
SUSPECT PAINT FOD IN BSM

Presenter:
Roger Elliott

Organization/Date:
USA-SRB/1-9-03



400 Gallon Mix Bowl



Chemical Addition Cover
(paint removed from rim of bowl)

SRB-12

TECHNICAL ISSUE SUSPECT PAINT FOD IN BSM

Presenter:
Roger Elliott

Organization/Date:
USA-SRB/1-9-03

Discussion

- Anomaly resolution team formed
 - USA, NASA, Boeing and Pratt & Whitney Space Propulsion
 - Independent USA Chief Engineer's team formed for oversight
- All BSMs in inventory suspect
- Inspection of mix bowl showed areas of missing paint
 - Materials analysis positively identified FOD as paint from mix bowl
- Analysis reveals no affect on BSM performance
 - Structural, thermal and ignition interval
- Debris transport analysis determined BSM ejecta with similar properties as virgin paint chips would be flight concern for Orbiter windows
- Analysis alone unable to show sufficient paint consumption during BSM burn
 - Test program required

TECHNICAL ISSUE SUSPECT PAINT FOD IN BSM

Presenter:
Roger Elliott

Organization/Date:
USA-SRB/1-9-03

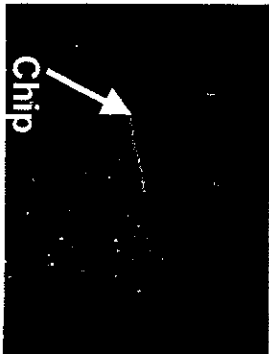
Discussion (cont.)

- Test program initiated to determine thermal effects of BSM propellant burn on imbedded paint
 - Seven successful window bomb tests performed on propellant samples
 - Window bomb testing allows high speed photography of propellant during burn
 - Propellant cast into ¼ by ¼ by ½ inch samples with paint chips inserted prior to cure
 - Paint chips inserted both horizontally and vertically to flame front
- Photographic review shows paint burning with red glow of a heated carbonized structure when released into flow stream

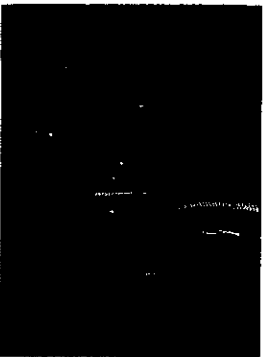
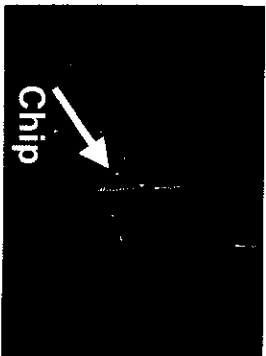
TECHNICAL ISSUE SUSPECT PAINT FOD IN BSM

Presenter:
Roger Elliott

Organization/Date:
USA-SRB/1-9-03



Window Bomb Test for Paint Chip Planar with Flame Front



Window Bomb Test for Paint Chip Perpendicular to Flame Front

SRB-15

TECHNICAL ISSUE SUSPECT PAINT FOD IN BSM

Presenter:
Roger Elliott

Organization/Date:
USA-SRB/1-9-03

Discussion (cont.)

- Five of seven tests resulted in released material captured on 250 micron filter screen
 - Released material on other two tests passed through filter
 - Captured residue examined by scanning electron microscope and determined to be highly porous, fragile, carbonized structure
 - Energy Dispersive X-Ray confirms paint tint material (titanium oxide) is captured in carbonized particles
- Analysis determined that released material would not withstand forces imparted during BSM nozzle entry
 - Results in rendering particles to dust, or ash, like configuration similar to nominal BSM exhaust from combustion of propellant

**TECHNICAL ISSUE
SUSPECT PAINT FOD IN BSM**

Presenter:
Roger Elliott

Organization/Date:
USA-SRB/1-9-03



**SEM Results for Captured Residue
(hollow, carbonized structure)**

SRB-17

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Flight Rationale

- BSM performance not affected by presence of paint FOD
- All Orbiter/ET debris impact concerns cleared by testing and analysis
- No increased risk to flight safety or mission success for identified paint FOD
- STS-107 and subsequent safe to fly