NASA

SECTION 28

STS-107 (BI116)
Flight Readiness Review

Pending completion of normal operations flow, we certify the Booster Assembly hardware ready to support the launch of STS-107

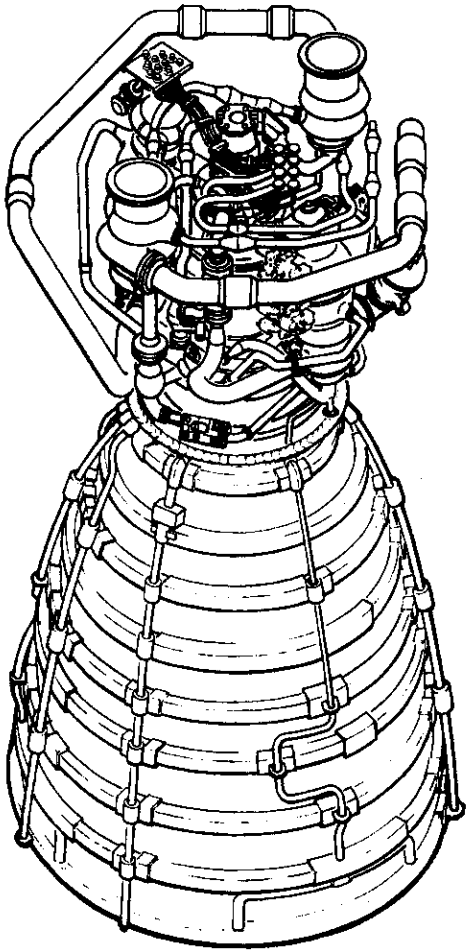
Original signed by Gordon Nielsen

Gordon P. Nielsen
Associate Program Manager/USA
SRB Element

Original signed by David Martin

A. A. McCool
Acting Manager,
SRB Project Office

United Space Alliance



Columbia STS-107

Space Shuttle Program

SSME Flight Readiness Review

January 9, 2003

G. HOPSON
09 January 2003

Columbia STS-107

Agenda

- Major Components
- First Flight ECP - Controller Coolant Duct
- Engine Performance
- Special Topic
  - STS-113 Nozzle Coldwall Leakage
- Material Review Reassessment

Columbia STS-107

SSME Major Components

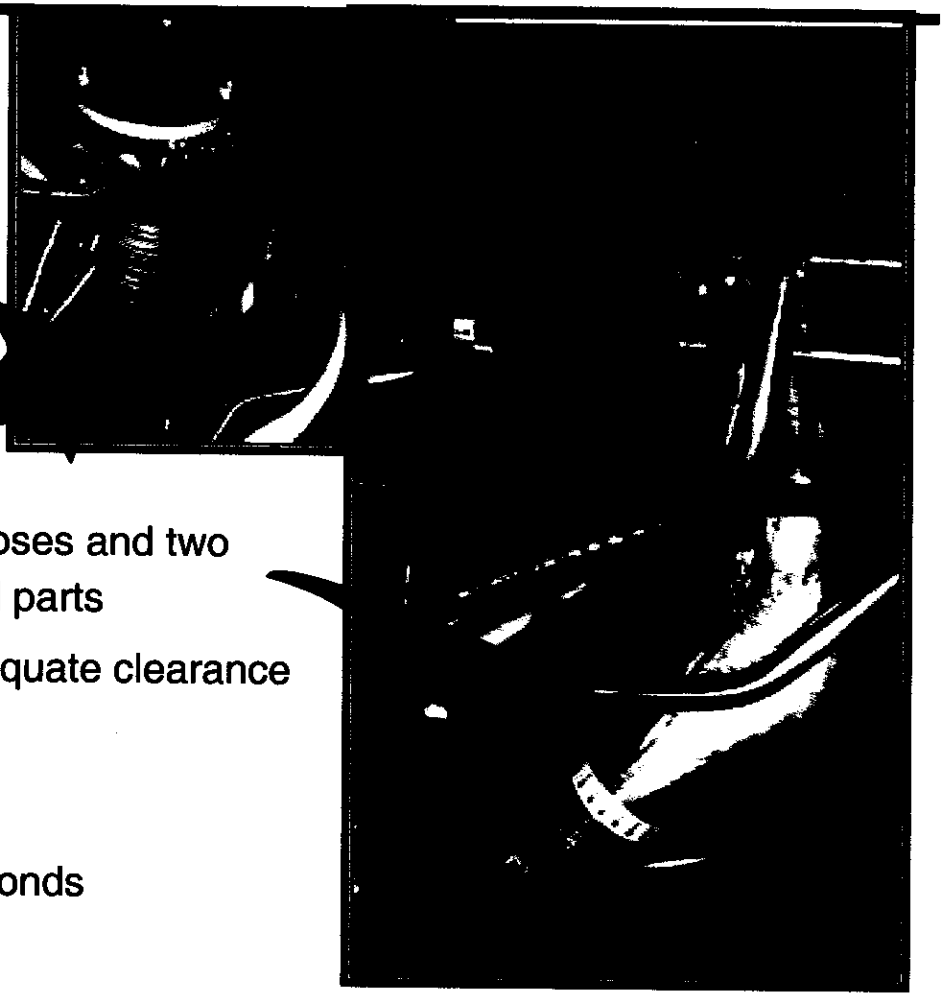
Engine	ME-1 / 2055 *Block II*	ME-2 / 2053 *Block II*	ME-3 / 2049 *Block II*
Last Hot-Fire	**902-830**	**STS-109**	**STS-108**
Powerhead	6022	6020	6019
Main Injector	6008	6020	6011
MCC	6024	6018	6015
Nozzle	2036	5006	4028
Controller	F50	F44	F41
HPFTP	8023	8026 (1)	8020R1 (1)
LPFTP	6007 (1)	5101	4210
HPOTP	8013R3	8031	8027 (1)
LPOTP	2227	2135	2133

(1) Changes after last hot-fire.

Controller Coolant Duct Redesign

ECP 1354

- **Issue**
  - Tight clearance where duct passes between the powerhead and the R0018052 line
  - Soft aluminum duct material susceptible to handling damage
- **Solution**
  - Redesigned duct using flexible silicone hoses and two nylon composite Selective Laser Sintered parts
  - Reduced parts count and maintained adequate clearance
- **Certification Status**
  - Certification by similarity and hot-fire
  - Total hot-fire time >29 starts / 17,030 seconds
  - VCR 586 Approved 10/22/01



Columbia STS-107

Predicted SSME Ignition Confirm Margins

Parameter	Margin Sigma		
	ME-1 (2055)	ME-2 (2053)	ME-3 (2049)
HPFTP Minimum Speed	5.3	5.2	4.4
Min/Max Ignition Pc	4.8	5.1	4.0
Antiflood Valve Min Open	26.0	26.1	24.7
HPFTP Max Turbine Temp	3.9	4.7	4.3
HPOTP Max Turbine Temp	5.4	4.6	5.2
HPOTP Min Turbine Temp	7.2	9.2	8.3
Preburner Max Purge Pressure	29.5	29.1	28.9
POGO GOX Min/Max Pressure	4.2	3.3	4.1

Columbia STS-107

Predicted SSME Performance at 104.5% P.L.

Parameter	ME-1 (2055) Sigma	ME-2 (2053) Sigma	ME-3 (2049) Sigma
HPFT Disch Temp A, Deg R	1.1	-0.1	0.5
HPFT Disch Temp B, Deg R	-0.3	-0.8	0.5
HPOT Disch Temp A, Deg R	0.6	1.3	1.0
HPOT Disch Temp B, Deg R	1.2	1.3	0.3
HEX Interface Temp, Deg R	1.2	1.7	0.7
HPFTP Speed, rpm	-0.1	1.0	1.0
LPFTP Speed, rpm	0.0	-0.8	-1.2
HPOTP Speed, rpm	-0.1	-0.2	0.4
LPOTP Speed, rpm	0.2	-1.0	1.2
OPOV Position, %	1.5	0.6	0.8
FPOV Position, %	1.0	-1.3	a **[-2.1]**
PBP Disch Pressure, psia	-0.4	-1.1	0.6
HPFTP Disch Pressure, psia	0.7	0.3	-0.1
HPOTP Disch Pressure, psia	1.2	-1.8	-0.5
HPFTP U/N	8023	* 8026	* 8020R1
LPFTP U/N	* 6007	5101	4210
HPOTP U/N	8013R3	8031	* 8027
LPOTP U/N	2227	2135	2133

* Change from last flight / acceptance test

[] Exceeds database two sigma

a High efficiency HPFT

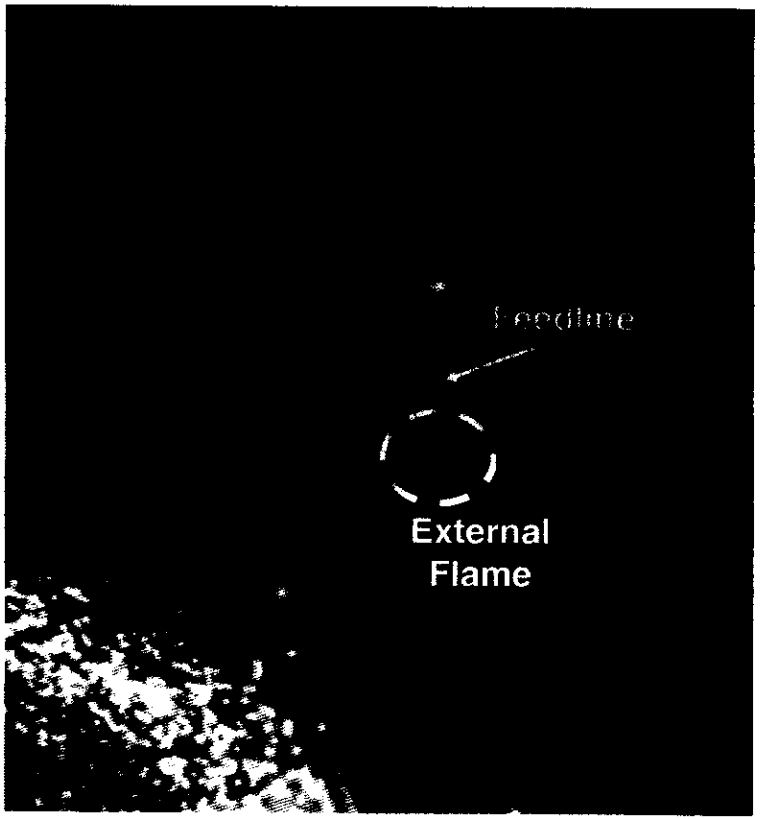
Columbia STS-107

Predicted Redline Margins at 104.5% P.L.

Parameter	Margin Sigma		
	ME-1 (2055)	ME-2 (2053)	ME-3 (2049)
HPFT Discharge Temp ChA, Deg R	5.9	6.9	6.4
HPFT Discharge Temp ChB, Deg R	6.8	7.2	6.1
HPOT Discharge Temp ChA, Deg R	7.1	6.6	6.7
HPOT Discharge Temp ChB, Deg R	7.6	7.6	8.4
HPOT Discharge Temp ChA, Deg R	7.5	6.8	6.5
HPOT Discharge Temp ChB, Deg R	8.3	7.2	6.6
HPOTP IMSL Purge Pr, psia	10.1	4.1	4.5
Low MCC Pc, psid			
Command-ChA Avg	21.9	19.6	21.5
Command-ChB Avg	24.1	24.1	24.7
FASCOS			
HPFTP	8.7	8.6	8.2
HPOTP	32.3	29.7	32.3

STS-113 Nozzle Coldwall Leakage

- **Issue**
  - STS-113 launch video footage shows an external flame near aft end of ME-1
- **Background**
  - Flame in an area of previously documented aft manifold leakage
    - Within allowable spec requirements
      - Total leakage < .015 lbm/sec
  - Leakage remained small throughout flight
    - No perceptible impact on engine performance during flight
  - Nozzle 5007 Hot Fire History
    - 6 starts / 3083 seconds



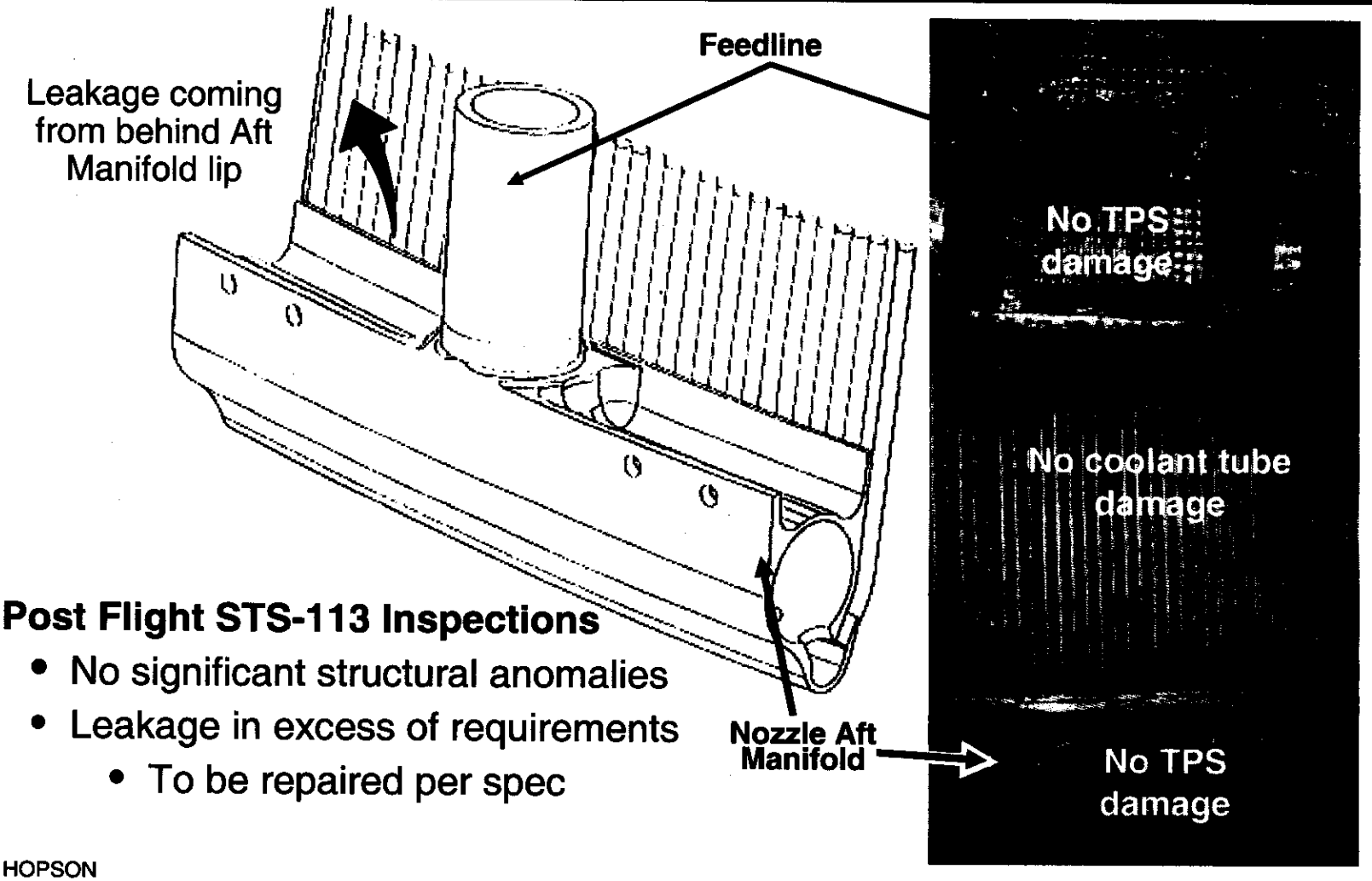
STS-113 Nozzle Coldwall Leakage

Assessment

- **Nozzle tube leakage monitored via standard post flight inspections**
  - Allowable leakage based on extensive hot fire experience and controlled by specification
    - Total leakage amount
    - Location and concentration of leaks within given area
- **Small coldwall leakage fires have negligible impact on nozzle**
  - Aspirated by the exhaust plume
    - Extinguished at ~ 50 seconds into flight (oxygen depletion)
  - Pressure vessels in vicinity of flame actively cooled by fuel flow
  - Non-cooled structures protected by insulation (TPS)
    - Designed for high temperature environments
- **External flames have been noted on prior flights with no resulting hardware damage or engine performance impact (STS-44 and –53)**

STS-113 Nozzle Coldwall Leakage

Post Flight Inspection Results



- **Post Flight STS-113 Inspections**
  - No significant structural anomalies
  - Leakage in excess of requirements
    - To be repaired per spec

STS-113 Nozzle Coldwall Leakage

- **STS-107 Rationale for Flight**
  - Small external fires caused by coldwall leakage are benign
    - Pressure vessels actively cooled
    - Non-cooled structures thermally protected by TPS
    - Supported by hot-fire experience – no anomalies
  - Coldwall leakage within specification well below levels necessary to negatively impact engine performance
  - STS-107 nozzles do not have coldwall leakage and do not have a history of coldwall leakage

Columbia STS-107

Material Review and Problem Report Reassessment

- **All Material Reviews and Problem Reports Reassessed**
  - Encompasses entire part / component histories
    - Fabrication
    - Assembly
    - Test
    - Flight
    - Recycle
  - Verified proper dispositions in light of current program sensitivities, knowledge and experience

- **All dispositions evaluated and judged acceptable for flight**

Columbia STS-107

SSME Certification of Flight Readiness

- **CoFR Exceptions**
  - None

Columbia STS-107

SSME Readiness Statement

- **The Columbia Main Engines are in a ready condition for STS-107**

G.D. Hopson
Manager
SSME Project

J. S. Paulsen
Program Manager
Space Shuttle Main Engine

STS-107
PROGRAM FLIGHT READINESS REVIEW

January 9, 2003

VEHICLE ENGINEERING

	Presenter:
	Organization/Date: Orbiter 01/09/03

ORBITER	To Be Presented
GFE	No Constraints
SOFTWARE	No Constraints
FCE	No Constraints
FLIGHT READINESS STATEMENT	To Be Presented
BACKUP	

ORBITER

AGENDA

Presenter:

Organization/Date:
Orbiter 01/09/03

- Engineering Readiness Assessment
  - Previous Flight Anomalies — To Be Presented
  - Critical Process Changes — To Be Presented
  - Engineering Requirement Changes — No Constraints
  - Configuration Changes and Certification Status — To Be Presented
  - Mission Kits — No Constraints
- Special Topics — To Be Presented
  - OV-102 MPS LH2 Feedline Flowliner
  - BSTRA Ball Cracks
- Flight Readiness Statement — To Be Presented
- Backup Information

	Presenter:
	Organization/Date: Orbiter 01/09/03

PREVIOUS FLIGHT ANOMALIES

	Presenter:
	Organization/Date: Orbiter 01/09/03

STS-113
IN-FLIGHT ANOMALIES

PREVIOUS IN-FLIGHT ANOMALIES

Presenter: Doug White
Organization/Date: Orbiter 01/09/03

STS-113 In-Flight Anomalies, Previous Shuttle Mission:

- Three Orbiter In-Flight Anomalies identified:
  - STS-113-V-01: O2 Concentration in the Mid-body Above Expected Baseline
  - STS-113-V-02: Right OMS Engine Bi-propellant Valve 2 Indicates Open
    - Details presented on following pages
  - STS-113-V-03: RMS Wrist Roll Sluggish Joint Response
    - RMS not installed for STS-107

STS-113-V-01: O2 CONCENTRATION IN THE MID-BODY ABOVE EXPECTED BASELINE	Presenter: Doug White
	Organization/Date: Orbiter 01/09/03

Observation:

- OV-105 secondary Pressure Control System (PCS) O2 bulkhead flex hose leaked during STS-113 countdown
- During STS-109 flow of OV-102, a blowing leak was discovered on the secondary PCS O2 bulkhead penetration flex hose
  - The O2 and N2 secondary hoses were replaced during the STS-109 flow

Concern:

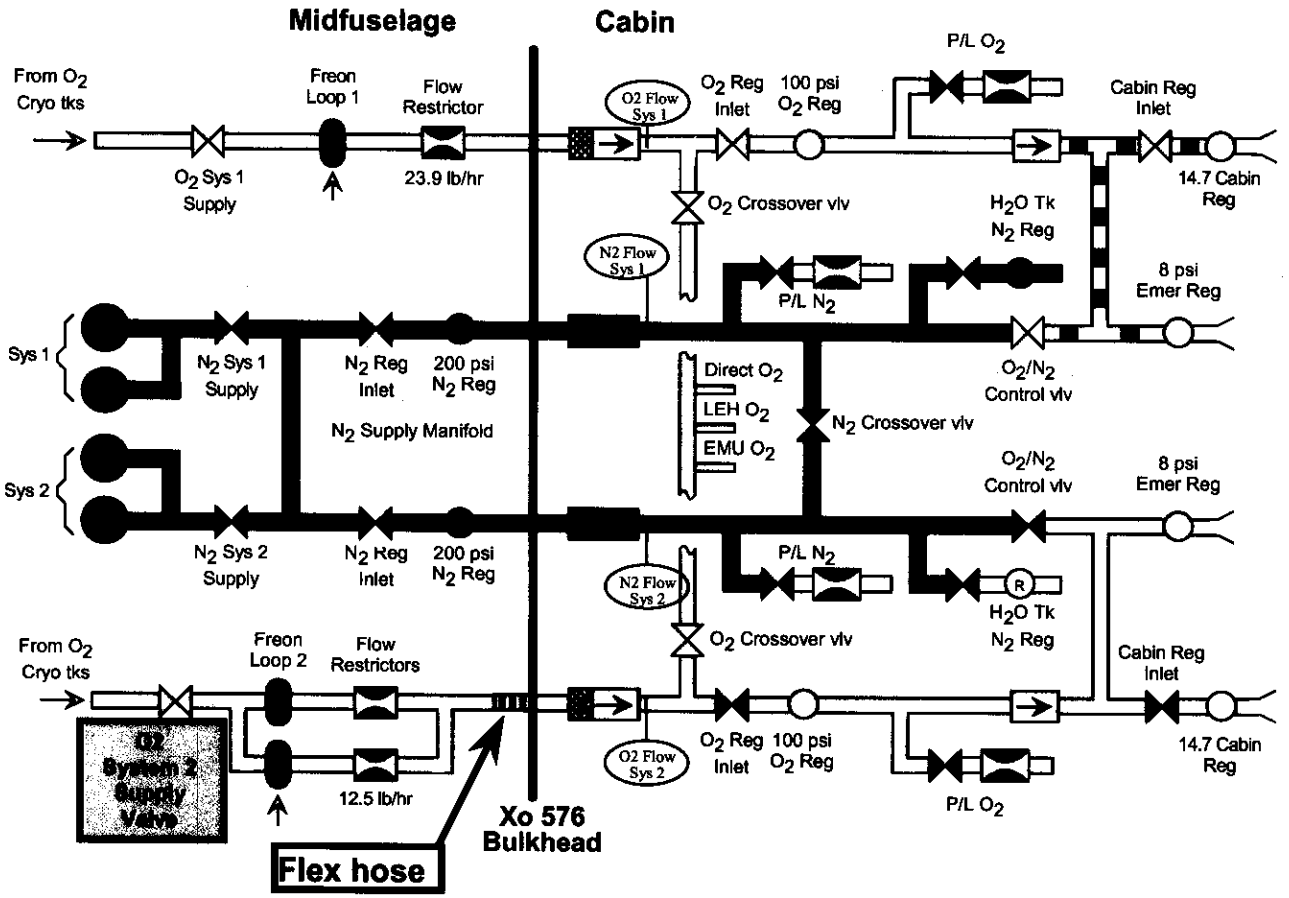
- An ECLSS system O2 leak has potential effects on crew safety and mission duration

STS-113-V-01: O2 CONCENTRATION IN THE MID-BODY ABOVE EXPECTED BASELINE

Presenter: Doug White

Organization/Date: Orbiter 01/09/03

Pressure Control System (PCS) Orbit Configuration (1st half)



STS-113-V-01: O2 CONCENTRATION IN THE MID-BODY ABOVE EXPECTED BASELINE	Presenter: Doug White
	Organization/Date: Orbiter 01/09/03

Concern:

- PCS O2 system provides breathing oxygen for crew in both the crew cabin atmosphere and launch and entry (LES) suits
- PCS O2 and N2 systems have redundant primary (system 1) and secondary (system 2) systems from the midbody O2 and N2 supply tanks
- PCS N2 system is Crit 1R3
  - Flight rules - press to NEOM with loss of first system
  - Crew cabin pressure will support next PLS for second system failure
- PCS O2 system is Crit 1R2
  - Single system flow restriction may not support 7-member crew "excited" usage requirement (5.5 lbs/hr/crew member)
  - For loss of one system, consideration will be given to performing a real-time LES manifold breathing test with all crew members breathing rapidly
    - NEOM if test passes; MDF if test fails

STS-113-V-01: O2 CONCENTRATION IN THE MID-BODY ABOVE EXPECTED BASELINE	Presenter: Doug White
	Organization/Date: Orbiter 01/09/03

Discussion:

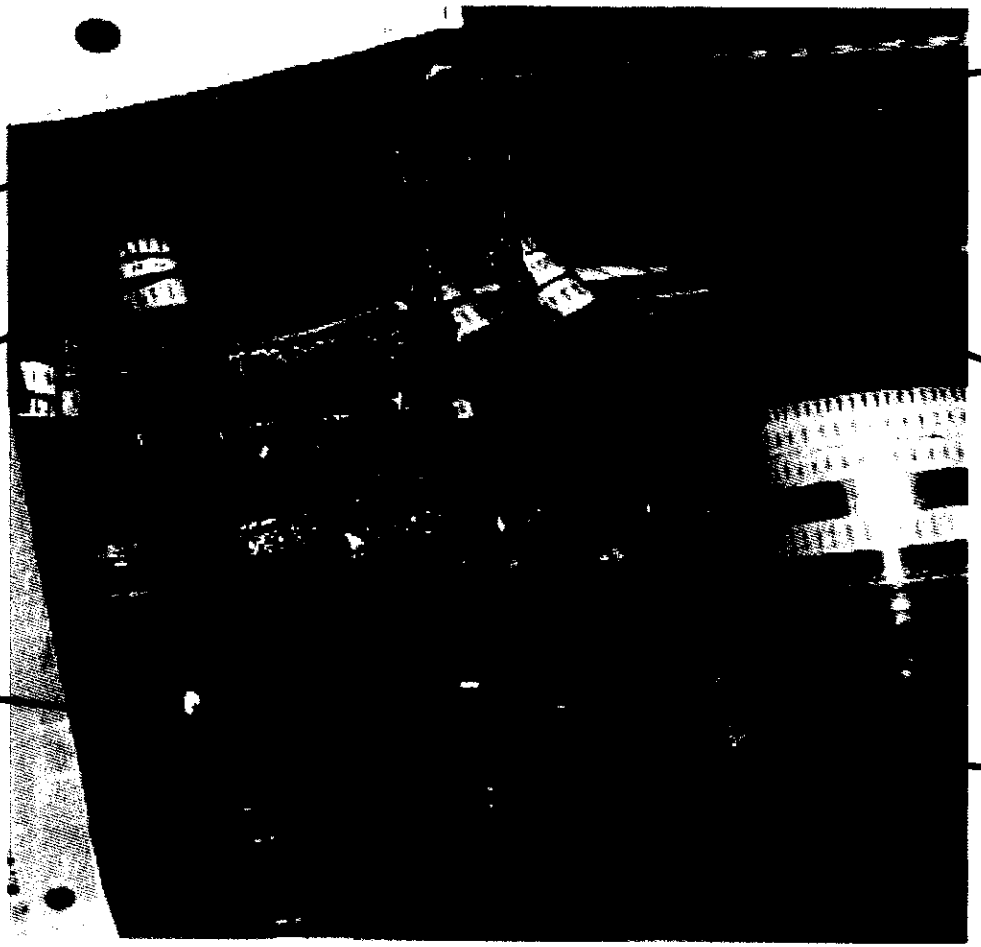
- Previous history with leakage of these (system 2) O2 and N2 PCS flex hoses
  - OV-104 N2 flex hose leakage: flight 21 flow - May, 1999
  - OV-102 O2 flex hose leakage: flight 27 flow - Jan, 2002
    - Leakage in both OV-102 and 104 were near the mid-body sections of the flex hoses
  - OV-105 O2 flex hose leakage: flight 19 flow - Nov, 2002
    - Leakage was near the Xo576 bulkhead fitting
  - Flex hose braiding showed signs of "bird caging" deformation, typically an indication the flex hose has been subjected to an applied external load
  - Numerous previous incidents of this type of damage in the MPS system flex hoses (same vendor, similar design)

STS-113-V-01: O2 CONCENTRATION IN THE MID-BODY ABOVE EXPECTED BASELINE

Presenter:
Doug White

Organization/Date:
Orbiter 01/09/03

Orientation View PCS O2 & N2 Secondary (System 2) Flex Lines
(Photo of leaking OV-102 installation before R&R)

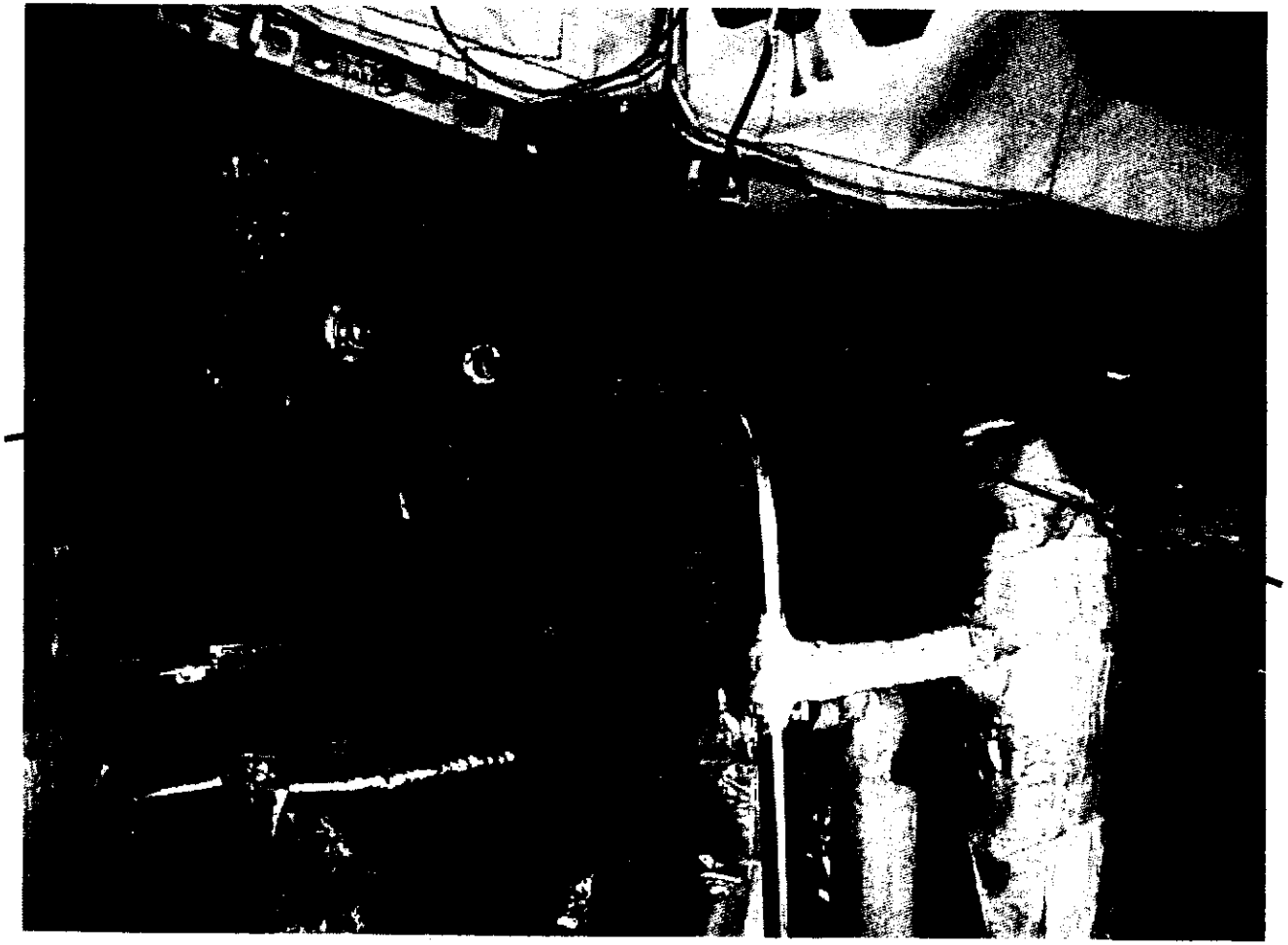


STS-113-V-01: O2 CONCENTRATION IN THE MID-BODY ABOVE EXPECTED BASELINE

Presenter: Doug White

Organization/Date: Orbiter 01/09/03

Close-up View PCS O2 Primary (System 1) Flex Line Configuration



STS-113-V-01: O2 CONCENTRATION IN THE MID-BODY ABOVE EXPECTED BASELINE

Presenter:
Doug White

Organization/Date:
Orbiter 01/09/03

Close-up View PCS Aux O2 & N2 Primary (System 1) Flex Line Configuration

STS-113-V-01: O2 CONCENTRATION IN THE MID-BODY ABOVE EXPECTED BASELINE	Presenter: Doug White
	Organization/Date: Orbiter 01/09/03

Discussion:

- The OV-105 leaking O2 flex hose was R&R'd and failure analysis was performed
  - Findings indicated the presence of fatigue striations across fracture face and no indications of ductile overload
  - Tooling marks found in all convolute valleys
    - In violation of vendor (Coast Metal Craft) acceptance criteria
  - Crack site aligns with tooling marks
- Scope of investigation was expanded to evaluate other similar configuration, "dog boned" ECLSS flexhose installations in this area
  - Primary N2 and O2 lines
  - Auxiliary O2 line
  - Secondary O2 and N2 flex hoses from other vehicles
    - Included flex hoses removed from OV-102 during the STS-109 flow

STS-113-V-01: O2 CONCENTRATION IN THE MID-BODY ABOVE EXPECTED BASELINE

Presenter: Doug White

Organization/Date: Orbiter 01/09/03

CMC Flex Hose Failure M&P Analysis Summary

OV-	Manuf Date	Part #	S/N	Description	Size	Flight Qty.	Leaks ?	Tooling Marks	Fatigue	Over-load	Braid Bulge	Micro Cracks	Lab
105	Jul-88	MC271-0085-1013	11	ECL Sec O2	1/4"	18	Yes	Yes, .001"-.003"	Yes	No	Yes	Yes	BNA
105	Jul-88	MC271-0085-1016	9	ECL Sec N2	3/8"	18	No	Slight	No	No	Slight	No	NSLD
104	Sep-83	MC271-0085-1013	4	ECL Sec O2	1/4"	20	No	Can't Locate Hardware for testing					
104	Sep-83	MC271-0085-1016	52054-00004	ECL Sec N2	3/8"	20	Yes	Yes	Yes	No	Yes	Yes	BNA
102	Feb-78	MC271-0085-1013	1	ECL Sec O2	1/4"	26	Yes	Yes	Yes	Yes	Yes	Yes	BNA
102	Feb-78	MC271-0085-1016	1	ECL Sec N2	3/8"	26	No	Yes, Floor Side	Yes	No	Yes	Yes	USA
103	Jan-82	MC271-0085-1012	2	ECL Pri O2	1/4"	30	No	Slight	No	No	Yes	No	BNA
103	Jan-82	MC271-0085-1014	3	ECL Aux O2	3/8"	30	No	No	No	No	No	No	NASA
103		MC271-0077-0015	52054LOT027	MPS LO2 sense line	1/4"	10	No	No	Yes	No	Yes	Yes	NASA
104	Nov-83	MC271-0085-1012	4	ECL Pri O2	1/4"	26	No	Slight, floor side	No	No	No	weld seam eval	USA

STS-113-V-01: O2 CONCENTRATION IN THE MID-BODY ABOVE EXPECTED BASELINE	Presenter: Doug White
	Organization/Date: Orbiter 01/09/03

Summary of Flex Hose Failure Analysis:

- Findings reveal the presence of cracks and fatigue striations in some flex hoses which are a result of relatively low frequency reverse bending fatigue
- All flex lines examined to date that have exhibited fatigue cracking have had associated damage on the exterior of the line
  - Consistent with corrective actions already taken in MPS subsystem to inspect for and replace flex hoses with wire braid damage
- Some flex hoses with exterior damage that have been examined do not exhibit fatigue cracking
- All flex hoses removed due to leakage have had evidence of exterior line damage
  - Leaks were caused by relatively low frequency reverse bending fatigue cracks through the wall of the convoluted flex hoses

STS-113-V-01: O2 CONCENTRATION IN THE MID-BODY ABOVE EXPECTED BASELINE	Presenter: Doug White
	Organization/Date: Orbiter 01/09/03

Risk Assessment:

- Although evidence from recent CMC metal bellows flex hose failure analysis strongly points to a problem with the secondary O2/N2 supply configuration, a possible fatigue problem with all metal bellows flex hoses on the vehicle cannot be ruled out
  - Approximately 210 metal bellows flex hoses on each vehicle
  - Other configurations may be susceptible to reverse bending fatigue
- Review of entire Program metal bellows flex hose leakage shows 25 total metal bellows flex hose leaks to date
  - 10 associated with 1992 OV-102 OMDP (all ECLSS)
  - 9 PVD monoball purge
  - 1 MPS LO2 sense line
  - 1 alternate fuel cell water relief line
  - 1 LCG loop 1
  - 2 secondary O2 line
  - 1 secondary N2 line
- None of the leakage failures were detected in flight

STS-113-V-01: O2 CONCENTRATION IN THE MID-BODY ABOVE EXPECTED BASELINE	Presenter: Doug White
	Organization/Date: Orbiter 01/09/03

Risk Assessment: (cont)

- All previous failure analyses (with the exception of some overload failures) have been attributed to relatively low frequency reverse bending fatigue
- STS-107 represents a risk management decision knowing that we have a low frequency concern
- Root cause is unknown
  - Most likely cause of low frequency bending is the ground environment
    - Traffic/handling
    - Roll to VAB or pad
  - Flight environment is a possible cause, but is less likely based on the frequency
- Review of ECLSS flex hose qualification records confirms that we did not adequately qualify flex hoses for this relatively low frequency environment

STS-113-V-01: O2 CONCENTRATION IN THE MID-BODY ABOVE EXPECTED BASELINE	Presenter: Doug White
	Organization/Date: Orbiter 01/09/03

Flight Rationale:

- Criticality of all metal bellows flex hoses reviewed
  - 4 criticality 1 MPS flex hoses
    - MPS has instituted a comprehensive program of line protection, damage screening, and mass spec leak checks which ensure that flex hoses are replaced before fatigue damage becomes a problem
  - 8 criticality 1 OMS flex hoses (4 unique to OV-102)
    - Configuration, line size, low traffic areas, and PRACA history show these lines are not suspect
  - 28 criticality 1 RCS flex hoses
    - Configuration, line size, low traffic areas, and PRACA history show these lines are not suspect
- Based on our PRACA history, the low likelihood of this being a flight environment problem, redundancy, low traffic, and the protective steps taken by the MPS system, this problem represents a low risk to flight

STS-113-V-01: O2 CONCENTRATION IN THE MID-BODY ABOVE EXPECTED BASELINE	Presenter: Doug White
	Organization/Date: Orbiter 01/09/03

Flight Rationale: (cont)

- OV-102 Secondary O2 and N2 flex hoses were replaced during the STS-109 flow (1 flight ago)
  - Represent the configuration most likely to exhibit fatigue
- PCS O2 and N2 systems passed a 10 day decay check as part of the STS-107 flow (May 2002)
- O2 Supply System 1 & 2 external leak check (V61AS0.046) has been performed at the OPF and at the pad (Extra test added after STS-113)

Long-Term Actions:

- Determine the root cause of the fatigue problem
- Determine the necessary delta-qualifications required
- Develop a comprehensive flex hose maintenance program

STS-113-V-02: ROMS ENGINE BIPROP VALVE 2 INDICATES OPEN

Presenter:	Doug White
Organization/Date:	Orbiter 01/09/03

Observation:

- During the OMS Assist burn, the right engine (S/N 109) bipropellant valve #2 indicated failed open following the burn
  - Valve position at 95.8%, S/B ~0%

Concern:

- Failed open valve results in limited use of the affected engine
  - Unable to determine in-flight if failure is instrumentation only

STS-113-V-02: ROMS ENGINE BIPROP VALVE 2 INDICATES OPEN

Presenter:	Doug White
Organization/Date:	Orbiter 01/09/03

Discussion:

- Failure occurred on 1st OMS burn (Assist)
  - At engine shutdown, BPV#2 position indicated valve was still open
  - Unable to determine in-flight if valve is actually failed open or just indication due to other BPV redundancy
- Slight negative drift of valve position indication seen just after failure
- Right engine only used for deorbit burn per flight rules
  - Nominal engine performance
  - BPV 2 open indication remained at 95.1% during burn then drifted up to 95.8% prior to landing
- Ball valve cavity drain/purge operations post-flight confirmed the valve was closed and the failure was position indication only

STS-113-V-02: ROMS ENGINE BIPROP VALVE 2 INDICATES OPEN

Presenter:	Doug White
Organization/Date:	Orbiter 01/09/03

Discussion: (cont)

- Fifth flight of OME S/N 109 and its biprop valve since refurbishment at WSTF
  - 28 total flights for this biprop valve with same LVDT
- WSTF performed complete biprop valve disassembly, cleaning, reassembly and ATP prior to reinstallation
  - LVDT assemblies removed and cleaned
  - Shaft seal leakage was in-spec, in the "open" and "closed" positions
- Engine reassembled and full ATP performed
  - Shaft seal leakage was, again, in-spec, no LVDT anomalies, no biprop valve timing anomalies
- Delivered to KSC in 3/00
  - KSC bench check performed on engine prior to installation on RP01 following STS-99

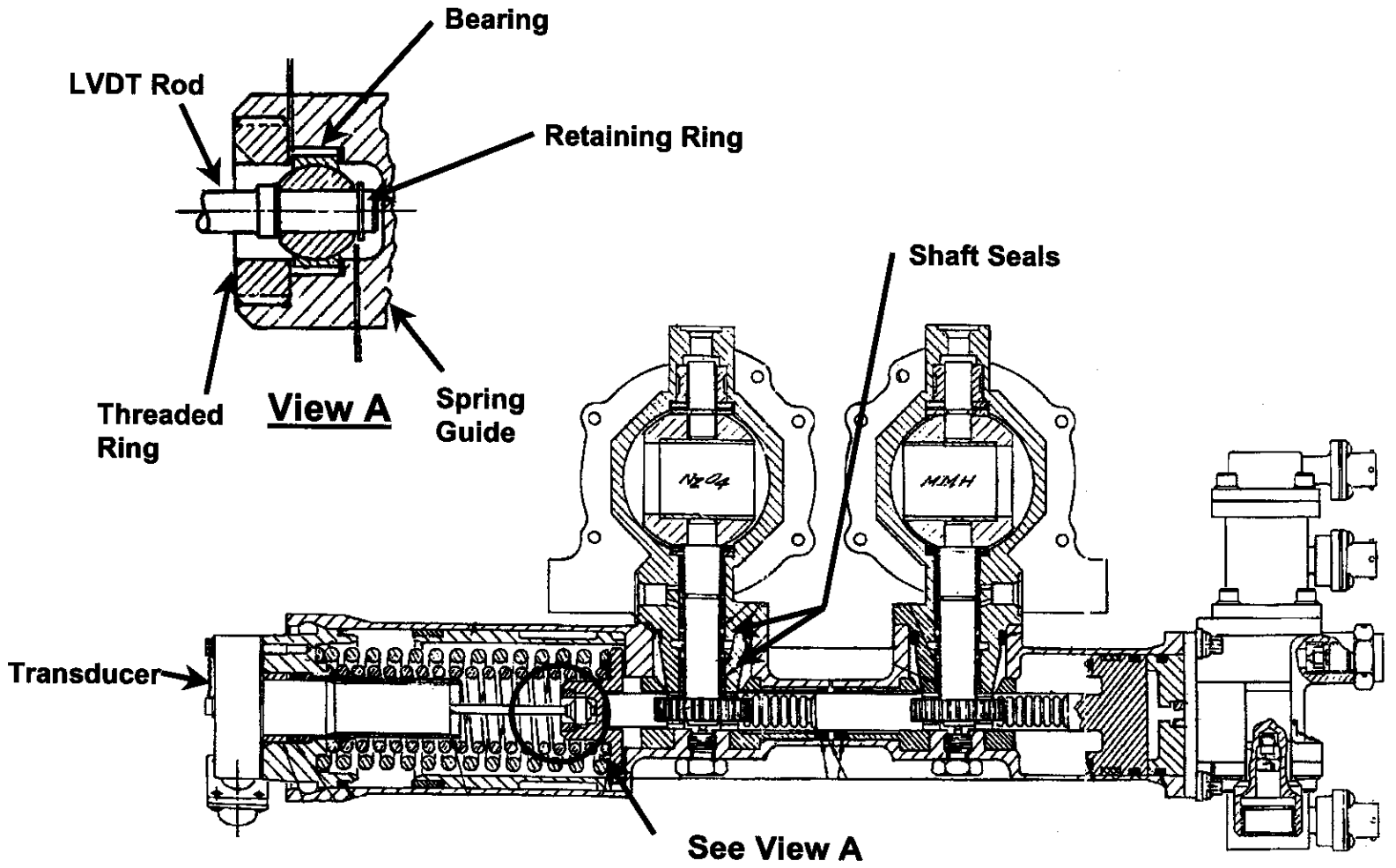
STS-113-V-02: ROMS ENGINE BIPROP VALVE 2 INDICATES OPEN	Presenter: Doug White
	Organization/Date: Orbiter 01/09/03

Discussion: (cont)

- Two previous similar in-flight failures
  - STS-91 and STS-101
  - Cause was detached LVDT rods in both failures
  - Contamination found inside LVDT bores during TT&E
    - Contamination ultimately caused by ball valve shaft seal leakage/permeation of oxidizer into actuator cavity
    - Rods seized up in LVDT bores due to contamination
- Other possible failure causes (fail open indication)
  - Transducer anomaly – Off scale high/low

STS-113-V-02: ROMS ENGINE BIPROP VALVE 2 INDICATES OPEN

Presenter: Doug White
Organization/Date: Orbiter 01/09/03



STS-113-V-02: ROMS ENGINE BIPROP VALVE 2 INDICATES OPEN	Presenter: Doug White
	Organization/Date: Orbiter 01/09/03

Discussion: (cont)

- Failed LVDT had only five flights since cleaning
  - Cleaning process (simple water flush & dry) may not be adequate for some LVDTs
  - Needs improvement to fully remove existing contamination built up over time
- Status of OV-102 OME LVDTs
  - ROME S/N 114 and LOME S/N 116 LVDTs have had only 1 flight since cleaning
    - Mitigates near-term problems
- No LVDTs have failed before 5 flights after preventative maintenance cleaning

STS-113-V-02: ROMS ENGINE BIPROP VALVE 2 INDICATES OPEN	Presenter: Doug White
	Organization/Date: Orbiter 01/09/03

Actions Planned:

- R&R of failed LVDT will be performed by WSTF personnel (~2/03)
  - OME removal from pod not required
  - Spare LVDT assemblies available
  - R&R of other LVDT on right OME being evaluated
- Investigating improved cleaning procedures for transducer bores
- Considering the possibility of an LVDT R&R interval (e.g. every OMDP as part of the established OME PM)

STS-113-V-02: ROMS ENGINE BIPROP VALVE 2 INDICATES OPEN	Presenter: Doug White
	Organization/Date: Orbiter 01/09/03

Risk Assessment:

- Both OMEs have recently cleaned LVDTs installed
  - Only flown one mission - STS-109
  - Potential for residual contamination in LVDT bore is low
- Flight rules allow use of OMS engine with failed open (>70%) bipropellant valve for deorbit burn only
  - Biprop valve #1 provides redundant isolation which protects against failed open biprop valve #2
  - NEOM for STS-107 possible with LVDT failures on both engines
- Other OMS engine and +X RCS thrusters provide system redundancy
- OMS engine criticality is 1R/2 (failed open/closed bipropellant valve)
  - LVDT criticality is 3/3

STS-113-V-02: ROMS ENGINE BIPROP VALVE 2 INDICATES OPEN	Presenter: Doug White
	Organization/Date: Orbiter 01/09/03

Flight Rationale:

- OV-102 OMEs have recently cleaned LVDTs
  - Low potential for contamination in bore
- Failure is visible and manageable in flight
  - Flight rules allow use of engine with failed open indication for deorbit burn (>70% open)
  - Nominal deorbit burn performed with affected engines on STS-91, 101, and 113
- Subsystem redundancy exists – 2 OMS engines and 4 +X RCS thrusters

	Presenter:
	Organization/Date: Orbiter 01/09/03

STS-109
IN-FLIGHT ANOMALIES

PREVIOUS IN-FLIGHT ANOMALIES

Presenter: Doug White
Organization/Date: Orbiter 01/09/03

STS-109 In-Flight Anomalies, Previous OV-102 Mission:

- Seven Orbiter in-flight anomalies identified:
  - STS-109-V-01: Freon Coolant Loop 1 Degraded Aft Cold Plate Flow
  - STS-109-V-02: Airlock A-Hatch Locking Device Difficult To Actuate
  - STS-109-V-03: MPS LH2 4-Inch Recirculation Disconnect Slow-to-Close
  - STS-109-V-04: Forward THC -X Contact Lost During One Burn
  - STS-109-V-05: FES Accumulator/Hi-Load Feedline B Heater System 2 Failure
  - STS-109-V-06: Primary RCS Thruster R3R Failed Off
  - STS-109-V-07: EV1 EMU Water Leak & Suspect DPS&BC Voltage Spike
- Summary presented on following pages, details in back-up

PREVIOUS IN-FLIGHT ANOMALIES

Presenter: Doug White

Organization/Date: Orbiter 01/09/03

STS-109 In-Flight Anomalies, Previous OV-102 Mission:

- STS-109-V-01: Freon Coolant Loop 1 Degraded Aft Cold Plate Flow
  - Freon coolant loop (FCL) 1 aft cold plate (ACP) flow dropped from 305 to 225 lbs/hr after MECO
    - Analysis determined that adequate flow would still be available to provide sufficient cooling for the remainder of STS-109
  - Post-flight troubleshooting isolated the cause of the anomaly to a piece of debris stuck in the upstream side of the orifice between the FES and the ACP network
    - FCL 1 was de-serviced and debrazed and the debris (braze preform) was removed
  - Additional x-rays taken at potential debris traps in both loops and visual inspection of FCL 1 FPM & pump inlet filters verified acceptable system cleanliness
    - FPM 1 and pump inlet filters replaced

PREVIOUS IN-FLIGHT ANOMALIES

Presenter: Doug White

Organization/Date: Orbiter 01/09/03

STS-109 In-Flight Anomalies, Previous OV-102 Mission:

- STS-109-V-02: Airlock A-Hatch Locking Device Difficult To Actuate
  - On-vehicle post-flight troubleshooting revealed that the actuator handle release tabs did not spring back after being depressed
  - The actuator/handle was replaced, and functional verification has been completed
- STS-109-V-03: MPS LH2 4-Inch Recirculation Disconnect Slow-to-Close
  - Disconnect was removed and replaced
    - Post-landing borescope inspection revealed Fluorogold spacer damage and scuff mark on housing
  - New disconnect was borescope inspected and verified to have no damage

PREVIOUS IN-FLIGHT ANOMALIES

Presenter: Doug White

Organization/Date: Orbiter 01/09/03

STS-109 In-Flight Anomalies, Previous OV-102 Mission:

- STS-109-V-04: Forward THC -X Contact Lost During One Burn
  - Post-flight testing has shown that the reported anomaly is an unexpected, but normal, characteristic of the THCs
- STS-109-V-05: FES Accumulator/Hi-Load Feedline B Heater System 2 Failure
  - Problem was isolated to a bad thermal switch which has been replaced and successfully retested
- STS-109-V-06: Primary RCS Thruster R3R Failed Off
  - Manifold 3 thrusters were removed and replaced
- STS-109-V-07: EV1 EMU Water Leak & Suspect DPS & BC Voltage Spike
  - EMU DPS & BC was replaced with upgraded unit, redesigned to limit output voltage overshoot
    - Prevents inadvertent energizing of an EMU shutoff solenoid valve