VEHICLE ENGINEERING

	Presenter:
	Organization/Date: Orbiter/04-05-01

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

BACKUP INFORMATION

STS-100
FLIGHT READINESS REVIEW

APRIL 5, 2001

ORBITER

AGENDA

Presenter: Doug White
Organization/Date: Orbiter/04-05-01

• 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 Kit Status	No Constraints
• Safety, Reliability and Quality Assessment	No Constraints
• Special Topics	To Be Presented
• PRSD Cracked Valve Seat Issue	
• Castellated Nut Locking Feature Issue	
• White Residue Issue	
• Flight Readiness Statement	To Be Presented
• Backup Information	

	Presenter:
	Organization/Date: Orbiter/04-05-01

PREVIOUS FLIGHT ANOMALIES

	Presenter:
	Organization/Date: Orbiter/04-05-01

STS-102
IN-FLIGHT ANOMALIES

PREVIOUS IN-FLIGHT ANOMALIES

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

STS-102 In-Flight Anomalies, Previous Shuttle Mission:

- Two Orbiter problems identified as in-flight anomalies
  - STS-102-V-01: Degraded Freon Coolant Loop 1 Due to Radiator Icing
  - STS-102-V-02: ROMS Vapor Isolation Valve 2 Open Position Indicator Failed to Indicate Open
  - Details presented on following pages

All Anomalies and Funnies Have Been Reviewed and None Constrain STS-100 Flight

STS-102 RADIATOR FREEZING ISSUE

Presenter: Doug White

Organization/Date: Orbiter/04-05-01

Observation:

- Freon Loop 1 flow reduction due to icing in Freon, and consequently, flow restriction

Concern:

- Loss of radiator cooling if unable to remove ice

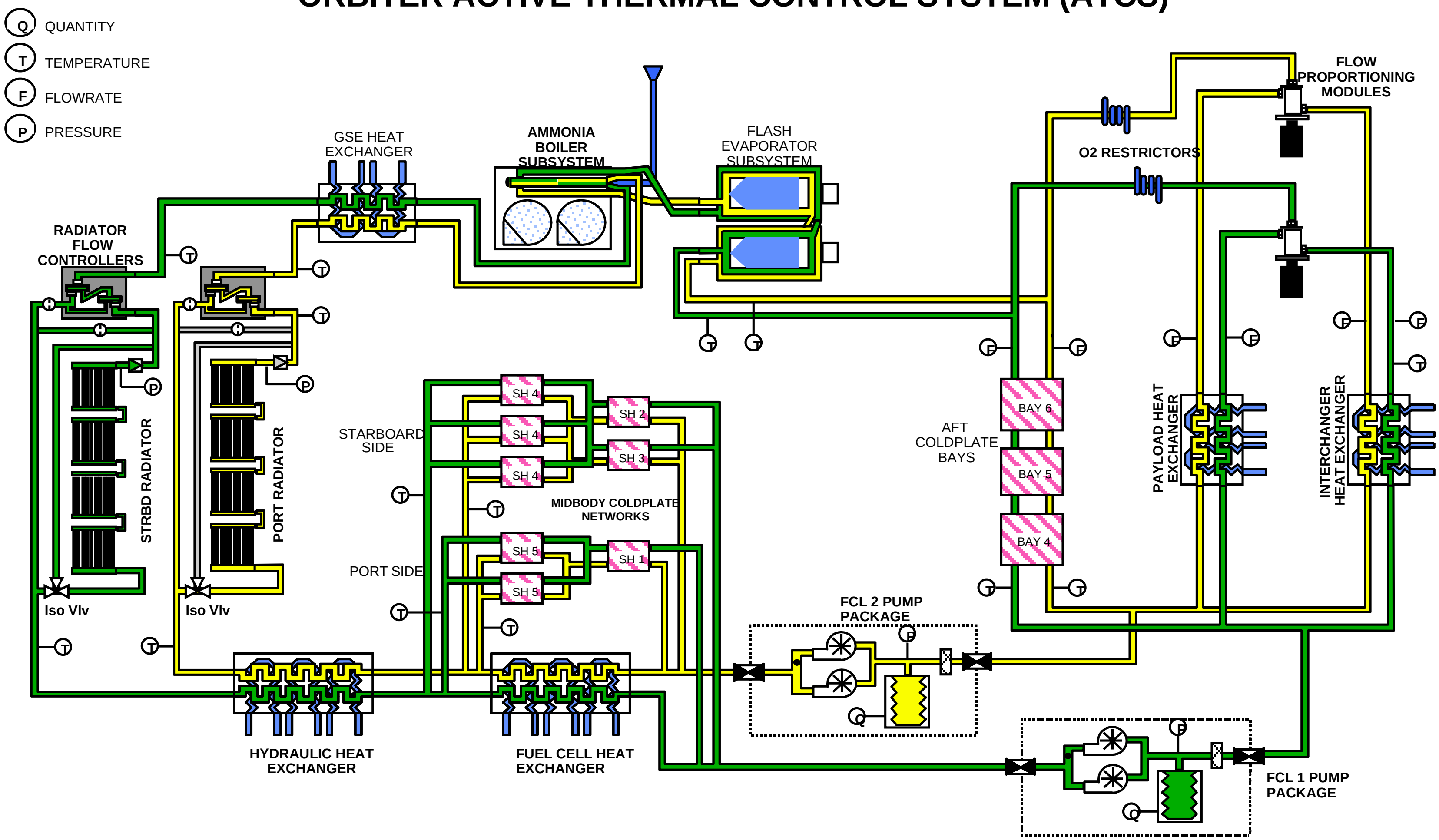
Discussion:

- Radiator system provides primary vehicle cooling on orbit
  - Consists of four radiator panels and a Radiator Flow Control Assembly (RFCA) per Freon loop
- Flight rule limits the temperature of the freon in the radiators to -85°F to prevent water (15 ppm allowable) from coming out of solution and freezing

STS-102 RADIATOR FREEZING ISSUE

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

ORBITER ACTIVE THERMAL CONTROL SYSTEM (ATCS)



STS-102 RADIATOR FREEZING ISSUE

Presenter: Doug White

Organization/Date: Orbiter/04-05-01

Discussion: (Cont)

- During the STS-102 docked period, a FES water dump was performed
  - FES water dump requires RFCA to operate at high temperature setting which reduces radiator flow and panel temperature
  - A change to a colder reboost attitude, combined with the temperature effects of the FES water dump caused the radiator Freon temp to drop from -18°F to -75°F and flow decreased
    - Flow reduction was caused by water coming out of solution and turning into ice, creating blockage at the FCV filter
    - Radiator outlet temperature transducer was verified to be performing nominally
- After the flow reduction was observed, the FES dump was terminated by switching the RFCA to the “Normal” temperature setting

STS-102 RADIATOR FREEZING ISSUE

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

Discussion: (Cont)

- Subsequent attempts to flow thru the radiator to warm it by resetting the RFCA controller were unsuccessful
- Bypass Valve control switch was placed to “Manual”, taking the controller out of valve’s control circuit, thereby establishing radiator flow
- Attitude change and additional vehicle equipment power up were performed to warm up radiator
- Normal flow was restored when radiator temperature reached approximately -60°F and was nominal for the remainder of the mission

STS-102 RADIATOR FREEZING ISSUE

Presenter:
Doug White

Organization/Date:
Orbiter/04-05-01

Evaluation - Actions Taken:

- Cause of flow reduction is attributed to the radiator being too cold, although current flight rule allows -85°F min Freon temperature
  - Radiator freon outlet temperature does not reflect a gradient across the radiator which is estimated to be ~50°F according to STS-35 data
    - Gradient is the result of variation in radiation environment temperature (caused by ISS shading and sun angle) seen by the radiator surface
    - Water can come out of solution in cold area and freeze
- Similar condition occurred during STS-28 where freon temperatures reached -77°F
- Review of STS-97 (OV-105 flt 15) showed that the same mission attitude as STS-102 was flown, however no freon loop freezing was observed
  - Outlet temperature was observed to reach -85°F

STS-102 RADIATOR FREEZING ISSUE

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

Evaluation - Actions Taken: (Cont)

- Review of STS-100 mission plan shows mission attitudes similar to STS-102 will be flown
  - However, the reboost attitude for STS-100 is somewhat warmer in radiator temperatures and shorter in duration
  - A chit will be implemented for STS-100 to modify the radiator outlet temperature limit to prevent freeze-up
  - Review of recent OV-105 freon loop servicing data verified that the freon water content has been below the allowable 15 ppm
  - OV-105 temperature transducer performance was verified to be nominal during its previous mission in-flight checkout

Actions Planned:

- Sample OV-103 freon to verify water content - ECD 4-16-01
- Long term, perform additional analysis and evaluation to validate the flight rule

STS-102 RADIATOR FREEZING ISSUE	Presenter: Doug White Organization/Date: Orbiter/04-05-01

Risk Assessment / Acceptable for STS-100 Flight:

- Cause of flow reduction is understood and will be avoided in the future by mission planning
  - No hardware issues
  - Mission procedures will be updated to modify the radiator outlet temperature limit to prevent freeze-up
- Procedure to correct the problem in flight, should it occur, exists
  - Additional vehicle equipment power up and attitude change to warm up radiator
- OV-105 freon sample data has been verified to spec requirement
- OV-105 temperature sensor performance was verified to be nominal during STS-97 in-flight checkout

OMS VAPOR ISOLATION VALVE FAILED CLOSED INDICATION

Presenter:
Doug White

Organization/Date:
Orbiter/04-05-01

Observation:

- Right OMS (RP03) vapor isolation valve #2 (LV506, S/N 25) failed to indicate open when commanded during the orbit adjust burn and the deorbit burn

Concern:

- Lack of insight into valve function without valve position indication (VPI)

Discussion:

- Vapor iso valves 1 and 2 were commanded open via single cockpit switch and GPC command prior to OMS engine burn
  - Valve 1 indicated open and valve 2 did not indicate open
- Valve function cannot be determined in-flight without VPI
  - Tank pressures verified at least one of two redundant, parallel flow paths was open

OMS VAPOR ISOLATION VALVE FAILED CLOSED INDICATION

Presenter:
Doug White

Organization/Date:
Orbiter/04-05-01

Discussion: (Cont)

- Prior to STS-70 (OV-103 flt 21), ROMS vapor isolation valve 2 (S/N 17) experienced an intermittent VPI problem
  - Valve operation was nominal, but indicated open when commanded closed
  - Connector corrosion was cleaned and all retests were nominal
- During the STS-103 (OV-103 flt 27) flow, the VPI anomaly occurred again on S/N 17
  - Valve operation was still nominal
  - Problem was closed as a UA
- S/N 17 valve was R&R'd for potential intergranular corrosion problem, which may have caused the VPI anomaly, prior to STS-92 (OV-103 flt 28)
  - Failure analysis on S/N 17 showed no VPI microswitch problem or intergranular corrosion

OMS VAPOR ISOLATION VALVE FAILED CLOSED INDICATION

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

Discussion: (Cont)

- S/N 17 valve was replaced with S/N 25
  - No anomalies noted during OV-103 flight 28 (STS-92)
- There is no history of a vapor iso valve failing open or closed
  - The only two instances of vapor iso valve VPI problems are in the same position, (LV506) on OV-103

Actions Taken/Planned:

- Possible causes of failure evaluated -
  - Contamination/corrosion in the valve switch
  - Connector/wiring
  - MDM failure (FA4)
  - Valve failure
- OV-105 vapor iso valves have had no anomalies
  - LP04 - valves #1 and #2 have 22 flights each
  - RP01 - valves #1 and #2 have 29 flights each

OMS VAPOR ISOLATION VALVE FAILED CLOSED INDICATION

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

Risk Assessment:

- Failed close valve (Crit 1R/2)
  - Failed closed valve eliminates redundancy in the flow path
    - Ability to pressurize OMS oxidizer tank is lost if both vapor isolation valves fail closed
  - Worst case of valve failure is assumed if VPI anomaly (open/close) occurs due to inability to determine valve function without VPI
  - Propellant utilization would be per existing flight rules

OMS VAPOR ISOLATION VALVE FAILED CLOSED INDICATION

Presenter:
Doug White

Organization/Date:
Orbiter/04-05-01

Acceptable for STS-100 Flight:

- No history of valve function or VPI anomalies on OV-105 vapor iso valves
  - STS-100 OMRSD valve and VPI checkout was nominal
- No valve functional failure history and VPI anomalies are limited to one location on RP03
- Parallel paths exist for worst-case failed close vapor isolation valve
  - Flight rules exist for propellant utilization

	Presenter:
	Organization/Date: Orbiter/04-05-01

STS-97
IN-FLIGHT ANOMALIES

PREVIOUS IN-FLIGHT ANOMALIES

Presenter:
Doug White

Organization/Date:
Orbiter/04-05-01

STS-97 In-Flight Anomalies, Previous OV-105 Mission:

- One Orbiter in-flight anomaly identified
  - STS-97-V-01: Erroneous Vernier Thruster F5R Fuel Injector Temperature Readings
  - Details in backup

All Anomalies and Funnies Have Been Reviewed and None Constrain STS-100 Flight

	Presenter:
	Organization/Date: Orbiter/04-05-01

CRITICAL PROCESS CHANGES

STS-100 CRITICAL PROCESS CHANGE REVIEW SUMMARY

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

Item Reviewed	No. of Items Reviewed	Period or Effectivity Covered	No. Found To Be Critical Process Changes
OMRSD Changes (RCNs)	0	STS-100 Specific & Non-Flight Specific Changes Approved 1/26/01 – 3/01/01	0
OMRSD Waivers & Exceptions	8	STS-100 Specific	0
IDMRD Changes (MCNs)	13	Approved 1/26/01 – 3/01/01	0
IDMRD Waivers & Exceptions	0	Approved 1/26/01 – 3/01/01	0
EDCPs	5	Closed 1/26/01 – 3/01/01	2
Boeing Specifications	22	Released 1/26/01 – 3/01/01	2
Boeing Drawings	288	Released 1/26/01 – 3/01/01	0
Material Review	165	Approved 1/26/01 – 3/01/01	0

- All process changes were reviewed and none constrain STS-100

CRITICAL PROCESS CHANGES	Presenter: Doug White Organization/Date: Orbiter/04-05-01

EDCP 1414-4-0001, Two-Inch Disconnect Chrome Plating Changes

- Investigation of chipped chrome plating on ET two-inch disconnect poppets revealed that the base material was being over machined (undersized) and the chrome was being over plated (thicker), compensating for the over machining to meet the final poppet diameter dimension. To eliminate this situation, this ECDP adds requirements to the drawing for diameter measurements at intermediate steps to prevent chrome over plating in the future.
- Additionally, a failure analysis revealed that the chamfered area on the poppet stem had poor adhesion between layers, associated with delamination causing the chrome chipping. For this reason, the chrome plating will be on the poppet stem only, and no chrome buildup or sharp edges will be allowed at the stem/chamfer interface.

CRITICAL PROCESS CHANGES	Presenter: Doug White Organization/Date: Orbiter/04-05-01

EDCP HSC-002, Air Half Coupling (1/2”) Specification Substitutions

- Updates OSC drawing to replace outdated MIL specifications for TIG Welding and Dye Penetrant processes with AMS and ASTME industry equivalent standards to comply with DCAS requirement on use of current process specifications
- M&P engineering has evaluated the components to be welded/dye penetrated and found no issues with the specification substitutions. The form, fit, and function of the coupling will not be affected by implementation of the change

CRITICAL PROCESS CHANGES	Presenter: Doug White Organization/Date: Orbiter/04-05-01

Boeing Specifications:

MA00110-305 F02, Preparation of Surfaces for Adhesive Bonding

- The specification update added new procedure for aqueous cleaning of honeycomb core to replace old procedure which utilizes non-environmentally friendly solvent

MT0501-524 A01, Requirements For Cleanliness Verification of Parts, Components and Systems

- This specification was updated to add new cleaning verification fluids as part of the Freon replacement effort

	Presenter:
	Organization/Date: Orbiter/04-05-01

CONFIGURATION CHANGES AND CERTIFICATION STATUS

CONFIGURATION CHANGES AND CERTIFICATION STATUS

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

16 Modifications Incorporated During the STS-100 Processing Flow:

- Two modifications are flying for the first time:
  - **MCR 19605 ODS Centerline Camera Harness Modification**
    - Harness modification relocates the three harness splices to be contained within the harness backshells to eliminate flexure induced damage
    - STS-106 harness failure was attributed to a wire stress failure near a splice location caused by harness flexure during handling, stowage and on-orbit installation
    - The primary centerline camera harness has been modified for STS-100
      - Both the primary and backup harnesses were verified during centerline camera functional test
      - The backup harness was also X-ray inspected prior to stowage for flight

CONFIGURATION CHANGES AND CERTIFICATION STATUS

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

16 Modifications Incorporated During the STS-100 Processing Flow:

- Two modifications are flying for the first time:
  - **MCR 19527 Convoluted Tubing of Aft Fuselage Wire Harnesses**
    - Engineering released requiring all aft fuselage harnesses protected with convoluted tubing be installed ‘continuously’ through harness clamps
    - Reduces potential for wire insulation damage and exposed conductors found at ends of convoluted tubing
    - Preventative action implemented as a result of OV-102 OMM findings
- **Total listing of STS-100 modifications and certification details is in backup**

	Presenter:
	Organization/Date: Orbiter/04-05-01

SPECIAL TOPICS

SPECIAL TOPICS FOR THE STS-100 FLIGHT READINESS REVIEW	Presenter: Doug White
	Organization/Date: Orbiter/04-05-01

Topic	Presenter
• PRSD Cracked Valve Seat Issue	Doug White
• Castellated Nut Locking Feature Issue	Doug White
• White Residue Issue	Karrie Hinkle

PRSD CRACKED VALVE SEAT ISSUE

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

Observation:

- Visible cracks found on the seat flange of S/N 74 H_2 T-0 valve opened at NSLD for TT&E of an internal leak

Concern:

- PRSD valve leakage could impact mission operations or be a safety of flight issue

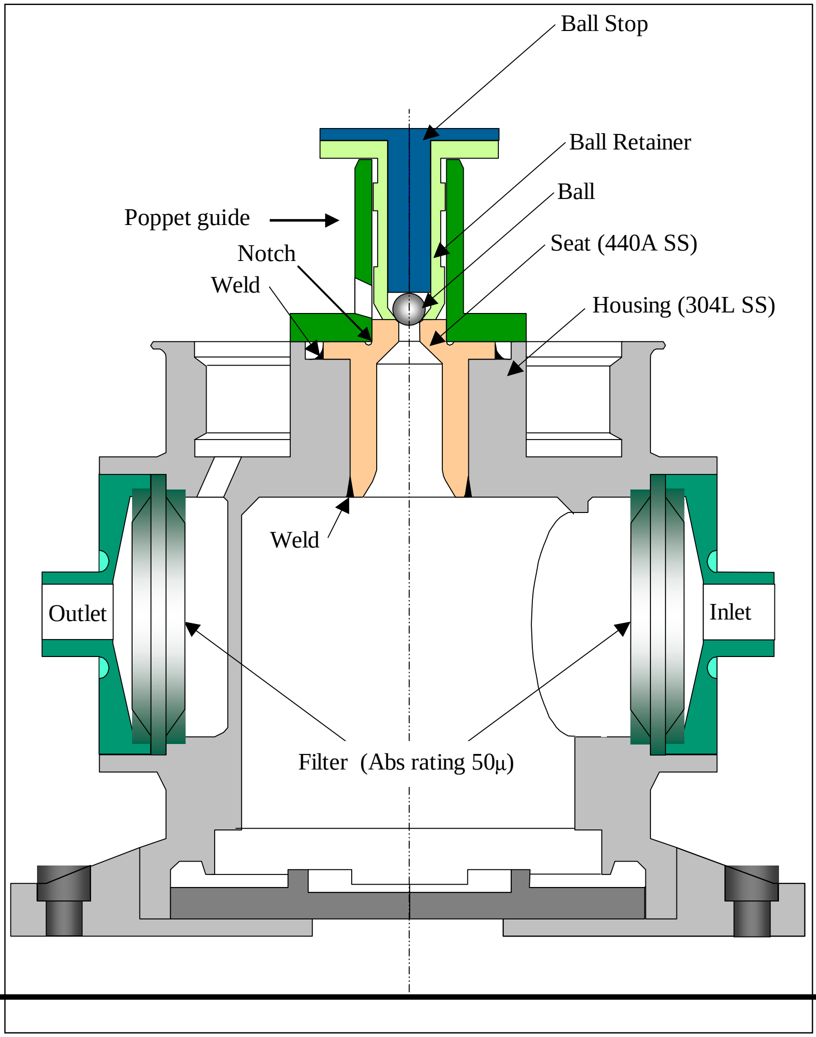
Discussion:

- The S/N 74 valve was removed from the panel and cut open for TT&E
- Cracks were visible on the flange of the seat
  - Testing confirmed leakage was through the seat cracks
- Cracks appear to originate at the outer weld and propagate inward toward the notch and then stay in the notch
- Cracks similar to those seen in earlier failed valves

PRSD CRACKED VALVE SEAT ISSUE

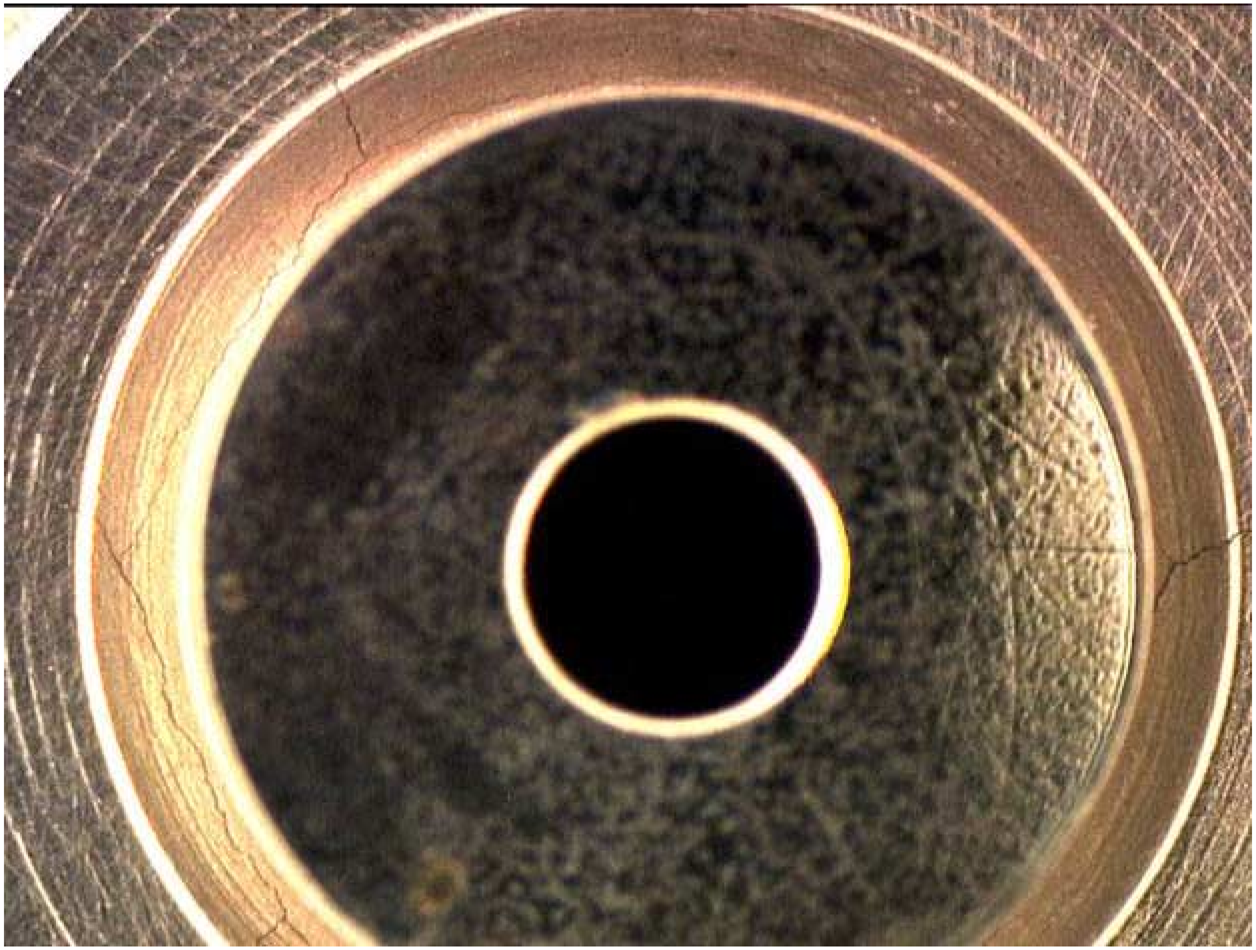
Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

Valve Housing and Seat Assembly



PRSD CRACKED VALVE SEAT ISSUE	Presenter: Doug White
	Organization/Date: Orbiter/04-05-01

S/N 74 Cracked Seat Assembly



PRSD CRACKED VALVE SEAT ISSUE	Presenter: Doug White Organization/Date: Orbiter/04-05-01

Discussion: (Cont)

- Cracking of valve seats attributed to hydrogen stress cracking
  - Failure analysis circa 1988 found 10 valves with same failure mechanism
  - H_2 stress cracking requires a susceptible material, hydrogen environment, and residual stress
    - Residual stresses can be from machining, welding, or assembly
    - Cracks will form and grow until residual stresses are relieved, stopping growth

PRSD CRACKED VALVE SEAT ISSUE	Presenter: Doug White Organization/Date: Orbiter/04-05-01

Discussion: (Cont)

- A review of historical data and vehicle leak test data indicated that H_2 valves manufactured prior to 12/1979 and after 12/1984 did not show evidence of seat cracking
- 10 H_2 valves manufactured after 12/1979 and prior to 12/1984 were screened, found to have cracked seats, and repaired with new housing and seat assemblies
  - Valve leakages on the order of 200-300 sccm after only 2-3 flights
  - No evidence of seat fragmentation
  - Seat is constrained by poppet guide

PRSD CRACKED VALVE SEAT ISSUE	**Presenter:** Doug White
	Organization/Date: Orbiter/04-05-01

Discussion: (Cont)

- Valve assembly process was changed in 1986 and 1988
  - Press fit of seat was changed to shrink fit and parts selected for minimum interference fit - may have had effect on reducing residual stress
  - In 1990, all valves manufactured outside the suspect period had accumulated 2 – 14 flights without any failures and no further action was taken

PRSD CRACKED VALVE SEAT ISSUE	Presenter: Doug White Organization/Date: Orbiter/04-05-01

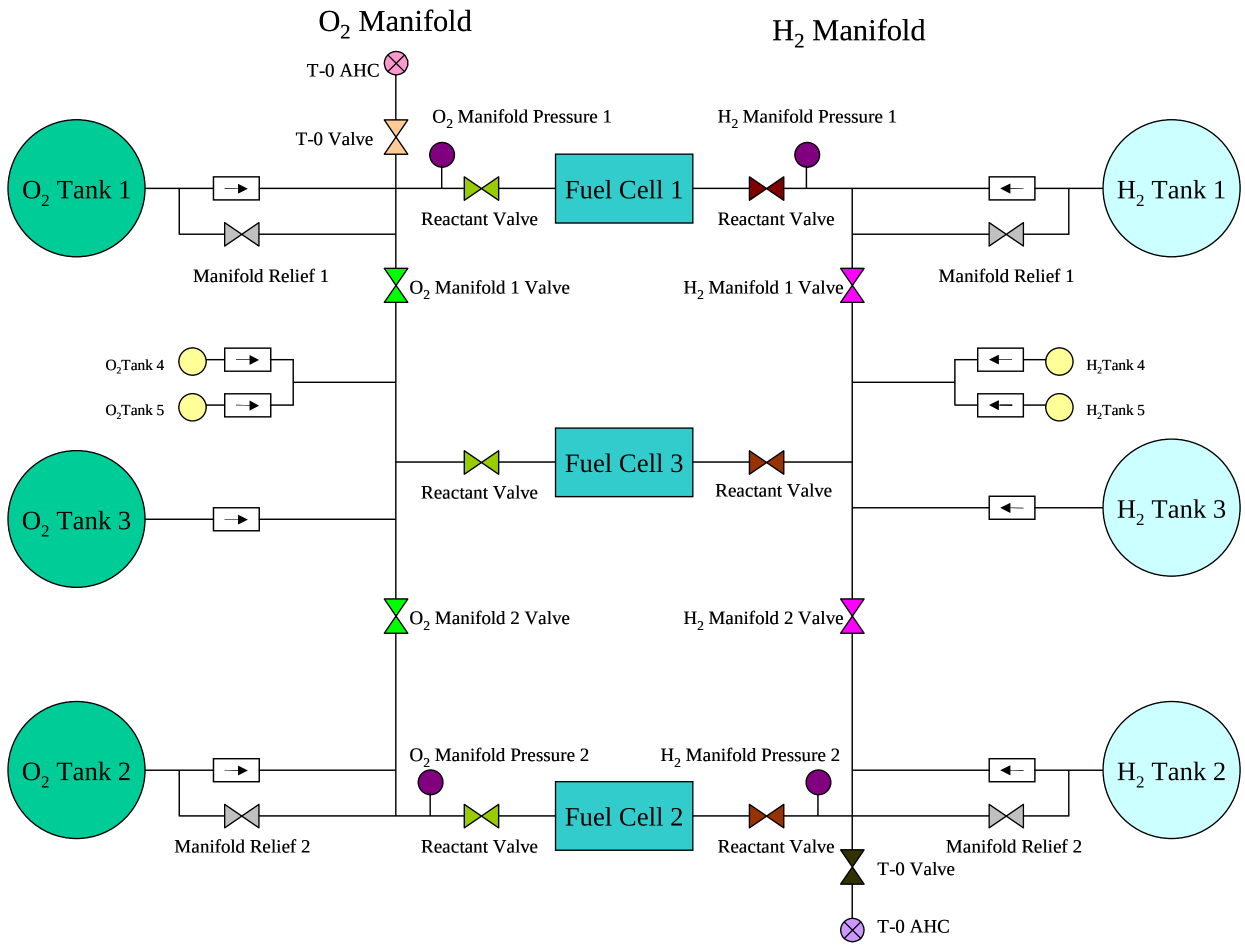
Discussion: (Cont)

- PRSD has 6 H_2 valves mounted in the mid-body
  - 3 Fuel Cell reactant supply valves
    - Normally open, closed as required for ground operations or for fuel cell shutdown
  - 2 Manifold isolation valves
    - Normally open for two shift crew missions, closed alternately during sleep periods on one shift crew mission
  - 1 T-0 gas supply valve
    - Open until T-2 minutes 35 seconds, then closed for remainder of mission
  - Leak requirements
    - All Valves: 18 sccm – component level NSLD
    - Reactant Valves: 50 sccm – OMRSD every OMM
    - T-0 Valve: 500 sccm – OMI 1040 every flow at pad
    - Manifold Valve: function check / pressure differential, File IX, every flight

PRSD CRACKED VALVE SEAT ISSUE

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

PRSD System Schematic



PRSD CRACKED VALVE SEAT ISSUE

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

Discussion: (Cont)

- All OV-105 valve housings / seats were assembled in 1989/1990 time period
- Manifold #1 H_2 panel was installed at Palmdale during vehicle build (7/1990) and has flown all 15 OV-105 missions with only in-spec leakage
- Leak test history (sccm):

Build Date	Valve	S/N	OEM	10/89 DNY	6/97 KSC/OMM
8/89	FCP 1	79	0**	1.5**	13.4***
6/89	MNF 1	31	14.0**	0.03**	NR

** 18 sccm max allowable leakage at the component level
*** 50 sccm max allowable leakage for reactant valves on-vehicle during OMM

PRSD CRACKED VALVE SEAT ISSUE

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

Discussion: (Cont)

- Manifold #2 H_2 panel was installed at KSC (9/1993) and has flown 11 OV-105 missions (5-15) with only in-spec leakage
- Leak test history (sccm):

Build Date	Valve	S/N	OEM	2/90 NSLD	8/93 NSLD	6/97 KSC/OMM	3/23/01 KSC
9/89	FCP 2	47	0**	0**	0**	0***	NR
10/89	FCP 3	48	0**	0.086**	0.4**	0***	NR
1/90	MNF 2	26	0**	1.11**	0.15**	NR	NR
11/89	T-0	49	0**	0.61**	0.13**	NR	0*

* 500 sccm max allowable leakage on-vehicle
** 18 sccm max allowable leakage at the component level
*** 50 sccm max allowable leakage for reactant valves on-vehicle during OMM

- Chit has been issued to perform manifold decay tests to verify acceptable valve leakage rates
- OV-105's H_2 T-0 AHC passed leak test on 3/23/01
  - 148 sccm (max allowable is 900 sccm)

PRSD CRACKED VALVE SEAT ISSUE

Presenter: Doug White	**Organization/Date:** Orbiter/04-05-01

Risk Assessment:

- Fuel Cell H_2 reactant valve with a cracked seat
  - First failure – Fuel Cell requires shutdown and safing
    - O_2/H_2 reactant valves closed
    - Fuel cell O_2/H_2 pressure vented to ambient through the purge valves
  - Second failure – H_2 reactant valve leaks H_2 to the fuel cell regulator
  - Third Failure – regulator second stage leaks
    - However, the regulator wants to maintain H_2 pressure below O_2 pressure and will vent the H_2 pressure as required to accomplish this
    - There is no safety concern to the fuel cell since there is no oxygen present in the fuel cell
      - Results in only minor venting overboard
- H2 manifold isolation valve with a cracked seat
  - Leaking valve results in the inability to isolate a PRSD system external leak
    - Line rupture, break or puncture is a highly improbable failure

PRSD CRACKED VALVE SEAT ISSUE	Presenter: Doug White
	Organization/Date: Orbiter/04-05-01

Risk Assessment: (Cont)

- H_2 T-0 gas supply valve with a cracked seat
  - Leaking after closure at T-2 minutes 35 seconds results in pressure build-up to the T-0 air half coupling (AHC) – no cap
  - T-0 valve is leak checked at the pad (500 sccm max allowable)
  - T-0 AHC is also leak checked at the pad (900 sccm max allowable)
  - If both leak, this would result in overboard H_2 venting
  - A 900 sccm leakage rate is not a consumables issue
  - KSC has procedures to handle H_2 concentration at the T-0 post-landing

PRSD CRACKED VALVE SEAT ISSUE	Presenter: Doug White
	Organization/Date: Orbiter/04-05-01

Acceptable For STS-100 Flight:

- Leak test history of both of OV-105's H_2 panels show leakage rates well within component spec
  - No indication of cracked seats
- Individual valve leakages will be verified before flight
- No potential for particle generation that prevents valve operation
- No potential for valve seat failure resulting in gross leakage
- No safety or operational issues exist, even with out-of-spec internal leakage

Forward Action Plan to be developed

- Failure analysis to be completed
- Need for long term corrective action to be determined

CASTELLATED NUT LOCKING FEATURE ISSUE

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

Observation:

- During installation of the castellated nuts on the remotely operated fluid umbilical (ROFU) mechanism at Palmdale, it was noted that the nuts could be installed (spun down) with little or no resistance
  - Examination of the nuts revealed that the locking feature had worn

Concern:

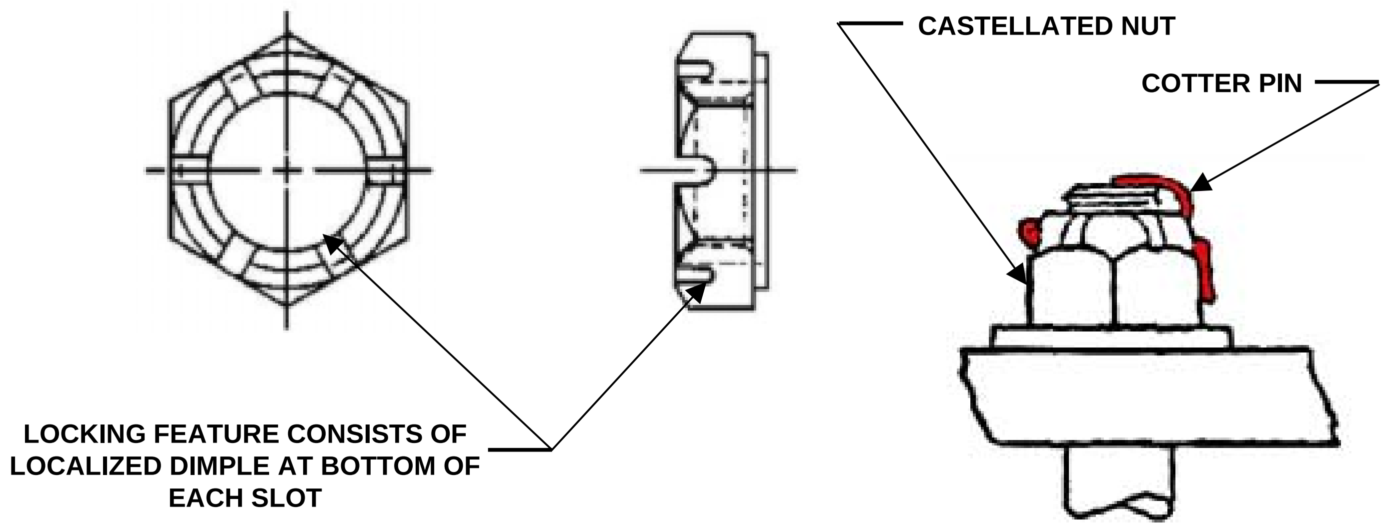
- Loss of castellated nut self-locking feature may impact positive retention of nut

CASTELLATED NUT LOCKING FEATURE ISSUE

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

MD114-1002

A286, THIN, SELF-LOCKING CASTELLATED NUT



INSTALLED CASTELLATED NUT WITH COTTER PIN

CASTELLATED NUT LOCKING FEATURE ISSUE

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

Discussion:

- Castellated nuts are used in mechanisms in shear applications where freedom of movement is required
  - Fastener is not loaded in tension
- Two types of castellated nuts, self-locking and non-self-locking, are available for utilization in design, both of which utilize cotter pins as their primary nut retention feature

CASTELLATED NUT LOCKING FEATURE ISSUE

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

Discussion: (Cont)

- Cotter pins are removed and replaced each time a castellated nut is reinstalled
- Inspection verifies all cotter pins are installed correctly
  - Fastener installation specification (MA0101-301) requires inspection verification of cotter pin during assembly/installation
  - Pins are inspected for proper installation, cracks and nicks
  - Fastener installation specification requirements are used in development of training classes for technician/ inspector certification
  - Any fastener installation hole without a cotter pin or safety wire is automatically questioned by technicians/inspectors

CASTELLATED NUT LOCKING FEATURE ISSUE

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

Discussion: (Cont)

- OMRSD dictated inspections confirm cotter pin installations are proper
- All Orbiter zones and selected vehicle areas have requirements to specify level and frequency of inspections required
- All levels employ the same inspection criteria guidelines
  - Includes inspection of attachment hardware for missing cotter pins, loop pins and/or loose safety wire
- Two of the three specific inspection levels are employed for mechanical systems and secondary structure
  - Surveillance Inspection Guidelines
    - A visual check along the zonal inspection guidelines which may include obscured structure and installations
    - Removal of panels/insulation only as specified by OMRS
  - Detail Inspection Guidelines
    - Intensive hands-on visual check along zonal inspection guidelines of a specified detail, assembly or installation

CASTELLATED NUT LOCKING FEATURE ISSUE

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

Typical OMRS Inspections for Mechanical Systems

Subsystem	Inspection Every Flow	Inspection at less than OMDP interval (1 yr, 3 yr. or 5 flight)	Inspection at OMDP
Landing Gear	detail		detail
NLG Wheel Well	detail		detail
ET Door	detail		detail
Vent Doors (fully open)	surveillance		detail
PLB Doors mechanisms	surveillance		detail
PLB Door radiators	detail		detail
Crew hatches	detail		detail
Aft Fuselage Penthouse Area	surveillance	detail	detail
Ext Airlock/Tunnel Adapter	detail		detail
Zonal Inspections of Secondary Structure and other Installed Hardware	surveillance		detail

CASTELLATED NUT LOCKING FEATURE ISSUE

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

Actions Taken:

- Special inspection performed on OV-105 at the launch pad of approximately 360 payload bay mechanism fastener installations utilizing castellated nuts and cotter pins
  - PLB door and latch mechanisms, radiator hinges, radiator latch mechanisms (partial), MPMs and PLB door retention latches were inspected
  - All locations had cotter pins installed

CASTELLATED NUT LOCKING FEATURE ISSUE

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

Actions Taken: (Cont)

- Review of cotter pin PRACA history performed
  - Results of inspections performed on Orbiters shows no history of component/linkage/ mechanism failure or structural failure due to a missing cotter pin
  - Of several thousand applications per vehicle only 16 cases of cotter pin related non-conformances have been documented
    - Majority of these PR’s are associated with inspection activities designed to detect improper installations and were detected and corrected prior to flight
    - Number of non-conformances represents a statistically insignificant PR history based on total vehicle usage

CASTELLATED NUT LOCKING FEATURE ISSUE

Presenter:
Doug White
Organization/Date:
Orbiter/04-05-01

Acceptable for STS-100 Flight:

- Castellated nut with cotter pin provides a positive locking device
- Requirements are in place to verify proper cotter pin installation by inspection during hardware assembly and as required by OMRS
- PRACA history indicates extremely low probability of a missing or broken cotter pin on any Orbiter installation
- Special inspections of OV-105 castellated nuts show proper cotter pin installation

WHITE RESIDUE ISSUE

Presenter:
Karrie Hinkle
Organization/Date:
Orbiter/04-05-01

Observation:

- White residue was seen on OV-104's chin panel and some leading edge RCC panels prior to ferry flight from Dryden following STS-98
- Subsequently white residue was found on OV-102's nose cap and leading edge panels and OV-105's leading edge panels

Concern:

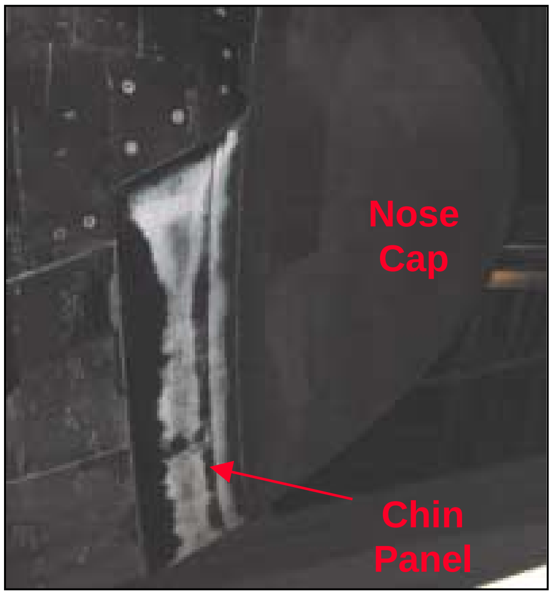
- Residue may be a contaminant that will adversely affect the RCC, Structure, and TPS

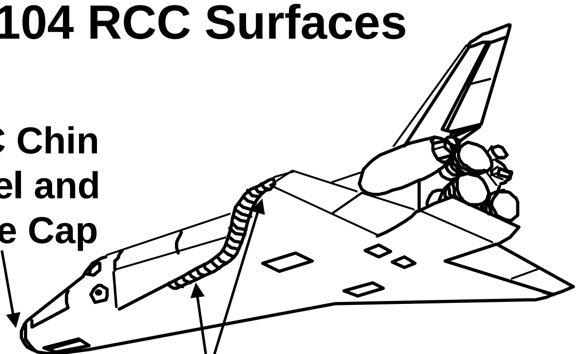
WHITE RESIDUE ISSUE

Presenter:
Karrie Hinkle

Organization/Date:
Orbiter/04-05-01

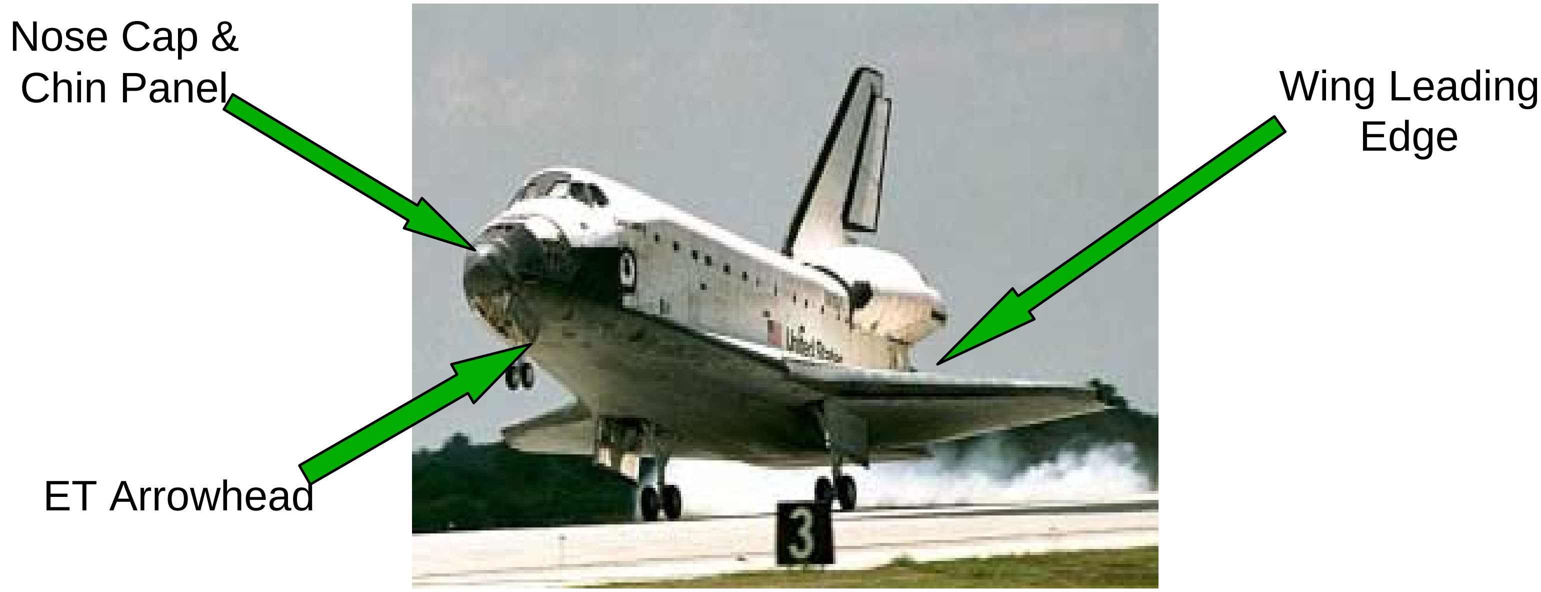
White Residue on OV-104 RCC Surfaces



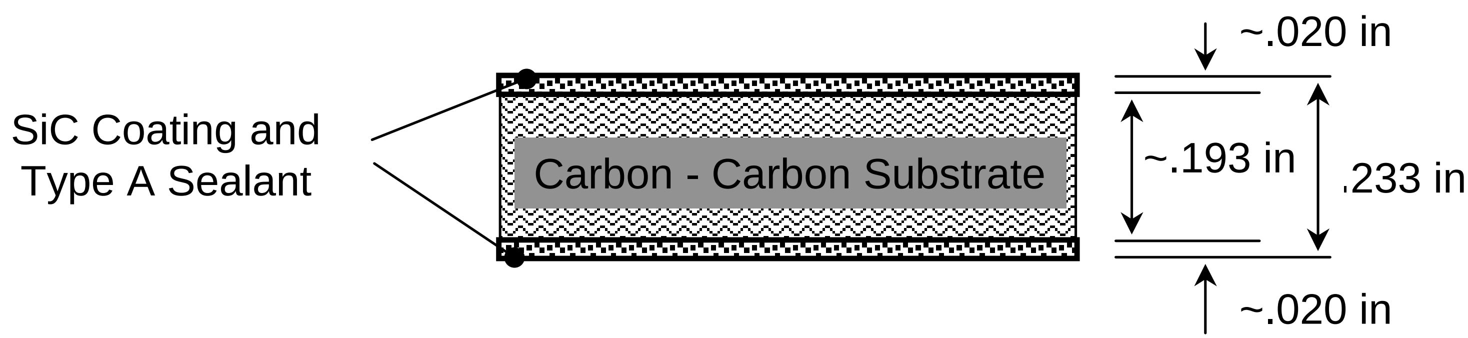


WHITE RESIDUE ISSUE

Presenter:
Karrie Hinkle
Organization/Date:
Orbiter/04-05-01



Orbiter LESS Locations



Typical Cross Section Through RCC

WHITE RESIDUE ISSUE

Presenter:
Karrie Hinkle
Organization/Date:
Orbiter/04-05-01

Background:

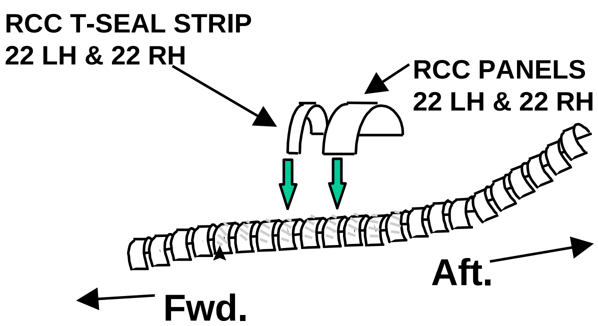
- RCC is composed of three layers
- Carbon carbon is the structural load bearing layer
- Silicon Carbide coating provides primary oxidation protection for Carbon Carbon
- Type A sealant which contains a sodium silicate binder, provides the secondary oxidation protection layer on top of the silicon carbide
  - Panels may have one application of Type A sealant (single Type A) or two applications (double Type A)

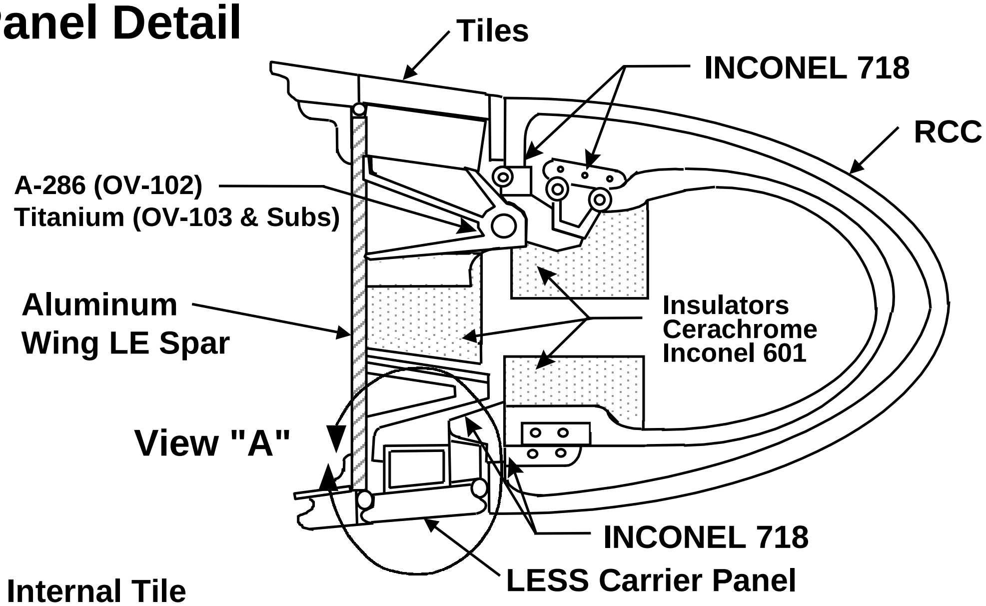
WHITE RESIDUE ISSUE

Presenter:
Karrie Hinkle

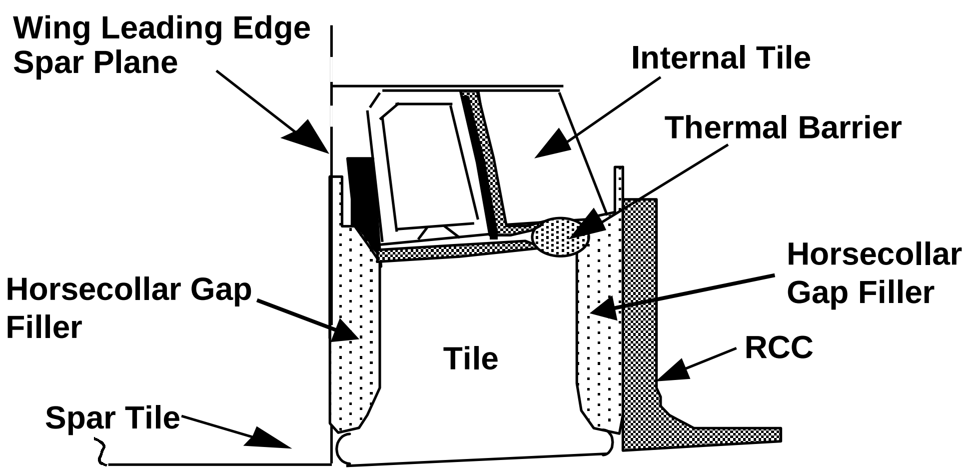
Organization/Date:
Orbiter/04-05-01

RCC Panel Detail





Internal View of RCC Hardware
Cutaway Looking Outboard



View "A"

WHITE RESIDUE ISSUE

Presenter:
Karrie Hinkle
Organization/Date:
Orbiter/04-05-01

Background: (Cont)

- White residue was found and mapped on the external surfaces of OV-104, OV-102 and OV-105
  - Lab analysis of samples determined the material was sodium carbonate
  - Subsequently, residue was detected both visually and using pH checks
    - pH reading of 8-11 was used to indicate the presence of sodium carbonate in other locations
  - OV-104 had residue on 32 LE panels and the chin panel
    - Residue was found on this vehicle in the highest quantity
  - OV-105 had residue on 24 LE panels
  - OV-102 had residue on 23 LE panels and the nose cap
- On OV-104 residue was found on the internal surfaces of RCC Panel #14 and on the accompanying internal fittings and insulators but not on the LE spar
- The internal leading edge tiles at Panel #14 had several spots of contamination material
- No residue was found on any external TPS components

WHITE RESIDUE ISSUE

Presenter:
Karrie Hinkle
Organization/Date:
Orbiter/04-05-01

Background: (Cont)

- Residue is seen on RCC hardware of all ages and processing types
  - Recently refurbished flown panels
  - Unrefurbished flown panels
  - Coated with single or double Type A sealant
  - A newly fabricated unflown panel and the newly fabricated arc jet test specimens used in our current testing
    - Vendor technicians have noted white residue on RCC hardware in the past but not analyzed it for composition
- All three vehicles were exposed to post flight rain after their last flight

WHITE RESIDUE ISSUE

Presenter:
Karrie Hinkle
Organization/Date:
Orbiter/04-05-01

Actions Taken:

- Composition of the residue was analyzed and compared to possible environmental contaminants
  - Samples taken from the WLE hardware on all three vehicles were confirmed by analysis to be sodium carbonate with no other trace elements
  - One sample taken from the OV-104 chin panel was found by analysis to be sodium carbonate and boric acid
    - Presence of boric acid in this single sample is unexplained however not an adverse contaminant to RCC
  - Samples taken from Dryden contain sodium carbonate and boric acid but also silica and calcite
  - Based on the localization to the RCC only, the purity of the residue, the existence on unflown hardware, and the existence of elements within RCC to form sodium carbonate the most likely source is the RCC system itself

WHITE RESIDUE ISSUE

Presenter:
Karrie Hinkle
Organization/Date:
Orbiter/04-05-01

Actions Taken: (Cont)

- Residue was collected from OV-104 and locally applied to arc jet test samples to simulate concentrated material on the external RCC surface
  - 3 arc jet samples were tested once at 2800F/100psf
    - One sample was newly fabricated and two had been previously exposed to arc jet testing
    - Previously exposed arc jet samples showed no visual reaction
    - The new sample showed reaction, in the contaminated region only, affecting the surface of the Type A sealant, evidenced by increased surface temperature and visual observation

WHITE RESIDUE ISSUE

Presenter:
Karrie Hinkle
Organization/Date:
Orbiter/04-05-01

Actions Taken: (Cont)

- An additional 5 cycles were then run on the new sample
  - The surface temperature decreased in the affected region indicating no further reaction was taking place
- The new sample used in this testing had a small amount of preexisting sodium carbonate across the entire surface
  - No visual reaction outside of the concentrated contamination area indicates that sodium carbonate on the surface is only detrimental when concentrated
- Surface chemistry of the samples is under evaluation
  - Shows no interaction with the carbon carbon substrate

WHITE RESIDUE ISSUE

Presenter:
Karrie Hinkle
Organization/Date:
Orbiter/04-05-01

Actions Taken: (Cont)

- Residue collected from OV-104, in addition to off the shelf sodium carbonate, was locally applied to radiant heat test samples to simulate concentrated material on the internal RCC surface
  - 4 radiant heat samples were tested three times each at 2300°F in vacuum
    - Two samples consisted of previously flown RCC, the third sample had the Type A sealant removed exposing the SiC and the fourth sample was newly fabricated with double Type A sealant
    - Visual interaction with Type A sealant was noted on the previously flown and new samples after the first run
    - No additional degradation was noted on subsequent runs
    - Cross sections of the samples show no degradation of the SiC coating even on the sample with Type A removed
- Sodium carbonate removal in the reacted area was possible showing that panels can be refurbished even with the presence of heat exposed residue

WHITE RESIDUE ISSUE

Presenter:
Karrie Hinkle
Organization/Date:
Orbiter/04-05-01

Action Taken: (Cont)

- Residue on previously flown RCC hardware was exposed to DI water overnight and then dried
  - Residue became visibly concentrated around the edge of the water exposed area
    - Indicates ability to migrate material upon water exposure
- Based on arc jet results showing reaction with Type A sealant when concentrated on the surface, OV-105 exterior RCC surfaces were cleaned to remove concentrated residue
- Internal residue has been determined to be acceptable for at least three flights based on radiant heat test results
  - Testing shows that reaction is visually detectable
  - No reaction of Type A has been seen in the past
  - Continued long term testing will determine mission capability beyond three flights
  - Worst case potential is that all panels with internal residue will require refurbishment prior to OMM

WHITE RESIDUE ISSUE

Presenter:
Karrie Hinkle
Organization/Date:
Orbiter/04-05-01

Actions Taken: (Cont)

- Boeing quality and engineering personnel visited Lockheed Martin Dallas to review the RCC fabrication process and specifications
- Review of the Type A coating process, build records, and specifications did not reveal any changes
- Raw material components used in the fabrication of Type A were tested and did not reveal the presence of sodium carbonate

WHITE RESIDUE ISSUE

Presenter:
Karrie Hinkle
Organization/Date:
Orbiter/04-05-01

Actions Taken: (Cont)

- Effect of residue on metal hardware was evaluated
  - Sodium carbonate, as a salt, could contribute to corrosion of exposed metal parts
- LE fittings and insulators are made of titanium, inconel and stainless steel
  - These materials are very resistant to corrosion
  - Corrosion has not been seen on these parts in the past
- LE spar and LE access carrier panels are made of aluminum
  - Corrosion of the LE aluminum components has occurred throughout the life of the program and has been tied to galvanic corrosion
  - Effective corrosion protective measures have been implemented in these areas
- Hardware is inspected for corrosion at each OMM and whenever panels are removed from the vehicle
  - No corrosion was seen on these parts during OV-102 OMM
- The only risk to the metallic hardware is the possibility of a higher incidence of corrosion, which would be corrected at OMM

WHITE RESIDUE ISSUE

Presenter:
Karrie Hinkle
Organization/Date:
Orbiter/04-05-01

Actions Taken: (Cont)

- Effect of residue on TPS hardware was evaluated
  - Sodium carbonate in large quantities promotes localized melting of the tile coating and weakening of the TPS components
- External TPS components had no evidence of sodium carbonate
- The internal leading edge tiles had several spots of the residue on the coating surface
  - No evidence of degradation has been seen on these tiles in the past
  - Internal tiles are not affected by aerodynamic loading and their thermal performance will not be degraded by exposure to sodium carbonate
  - Any damage would be detected at OMM

WHITE RESIDUE ISSUE

Presenter:
Karrie Hinkle
Organization/Date:
Orbiter/04-05-01

Actions Planned:

- Further testing is needed to completely understand the formation/reaction mechanism and long term life issues of the sodium carbonate within the carbon, SiC, and Type A sealant materials
  - Additional arc jet coupons will be prepared and tested in the coming months in order to characterize and quantify any long term effect the residue may have to the age life of the RCC
  - NASA Glenn is working to determine the sodium carbonate formation mechanism

WHITE RESIDUE ISSUE

Presenter:
Karrie Hinkle
Organization/Date:
Orbiter/04-05-01

Acceptable for STS-100 Flight:

- Residue will not affect the short term performance of the RCC hardware
  - No safety of flight issue
- All external surfaces of the RCC panels on OV-105 with visual deposits have been cleaned
- 30x visual inspection after cleaning verified Type A sealant was intact and appeared normal
- Residue has not been found on external TPS and aluminum structure parts
- Residue is believed to be a product of the RCC components themselves and not an external contaminant

ET Separation Camera Flight Readiness

Background

- ET Separation Camera (16 mm) configuration has been updated after previous anomalies
  - STS-101 IFA - Orbiter fuse blown due to internal short
  - STS-106 IFA - Orbiter fuse blown due to film jam

Rationale for Flight

- Workmanship and design issues have been corrected
  - Internal cable routing and clearances resolved to prevent short to case
  - Film loading processes improved to avoid repeat of film jamming
- Hazard analysis and safety reviews have been completed
  - Cameras are designed for safe operation in AFT compartment
    - Camera housing purged and backfilled with positive pressure N2
    - After servicing, seals are verified by He leak test prior to shipping
    - Cover screws are torque striped to allow verification of case integrity

ET Separation Cameras are ready for flight

	Presenter:
	Organization/Date: Orbiter/04-05-01

FLIGHT READINESS STATEMENT

ORB-RRS 2

SPACE SHUTTLE VEHICLE ENGINEERING OFFICE

STS-100 (OV-105) ☐ ORR ☒ FRR ☐ Prelaunch MMT

Pending completion of scheduled open work, the Orbiter vehicle, support hardware, flight crew equipment, and software are certified and ready to support. For United Space Alliance accountable functions, insight, audit, and surveillance activities have been reviewed, and there are no constraints to flight.

ORBITER / FLIGHT SOFTWARE / FLIGHT CREW EQUIPMENT

P. E. Shack, Manager, Shuttle Engineering Office

4/2/01
D. S. Rasco, Manager, Flight Crew Equipment Management Office

3/30/2001
D. E. Stamper, TMR, Software

J. P. Mulholland, TMR, Orbiter and Flight Crew Equipment

REMOTE MANIPULATOR SYSTEM

S. Higson, Program Director, SRMS
McDonald Dettwiler and Advanced Robotics Limited

20 Mar 01
R. Allison, RMS Project Manager

SPACE VISION SYSTEM

L. Beach, Program Manager, SVS
NEPTEC
for Tarun Beach.

3/22/01
D.S. Moyer, SVS Integration Office

FERRY FLIGHT PLANNING

3/30/01
D. L. McCormack, Ferry Flight Manager

Ralph R. Roe, Manager
Space Shuttle Vehicle Engineering

ORB-RRS 3

USA SSVEO Functions

STS-100 (OV-105) FLIGHT READINESS STATEMENT

☐ ORR ☒ FRR ☐ Prelaunch MMT

PENDING COMPLETION OF SCHEDULED OPEN WORK, THE ORBITER VEHICLE, SUPPORT HARDWARE, FLIGHT CREW EQUIPMENT, AND SOFTWARE ARE CERTIFIED AND READY TO SUPPORT.

ORBITER / FLIGHT SOFTWARE

G. A. Ray, Program Director, Orbiter
Reusable Space Systems
The Boeing Company

03/30/01
F. C. Littleton, Associate Program Manager
Orbiter Element
United Space Alliance

03/30/2001
T. F. Peterson, Associate Program Manager
Flight Software Element
United Space Alliance

FLIGHT CREW EQUIPMENT

03/30/01
E. L. Young, FCE/EVA Associate Program Manager
United Space Alliance

	Presenter:
	Organization/Date: Orbiter/04-05-01

BACKUP INFORMATION

	Presenter:
	Organization/Date: Orbiter/04-05-01

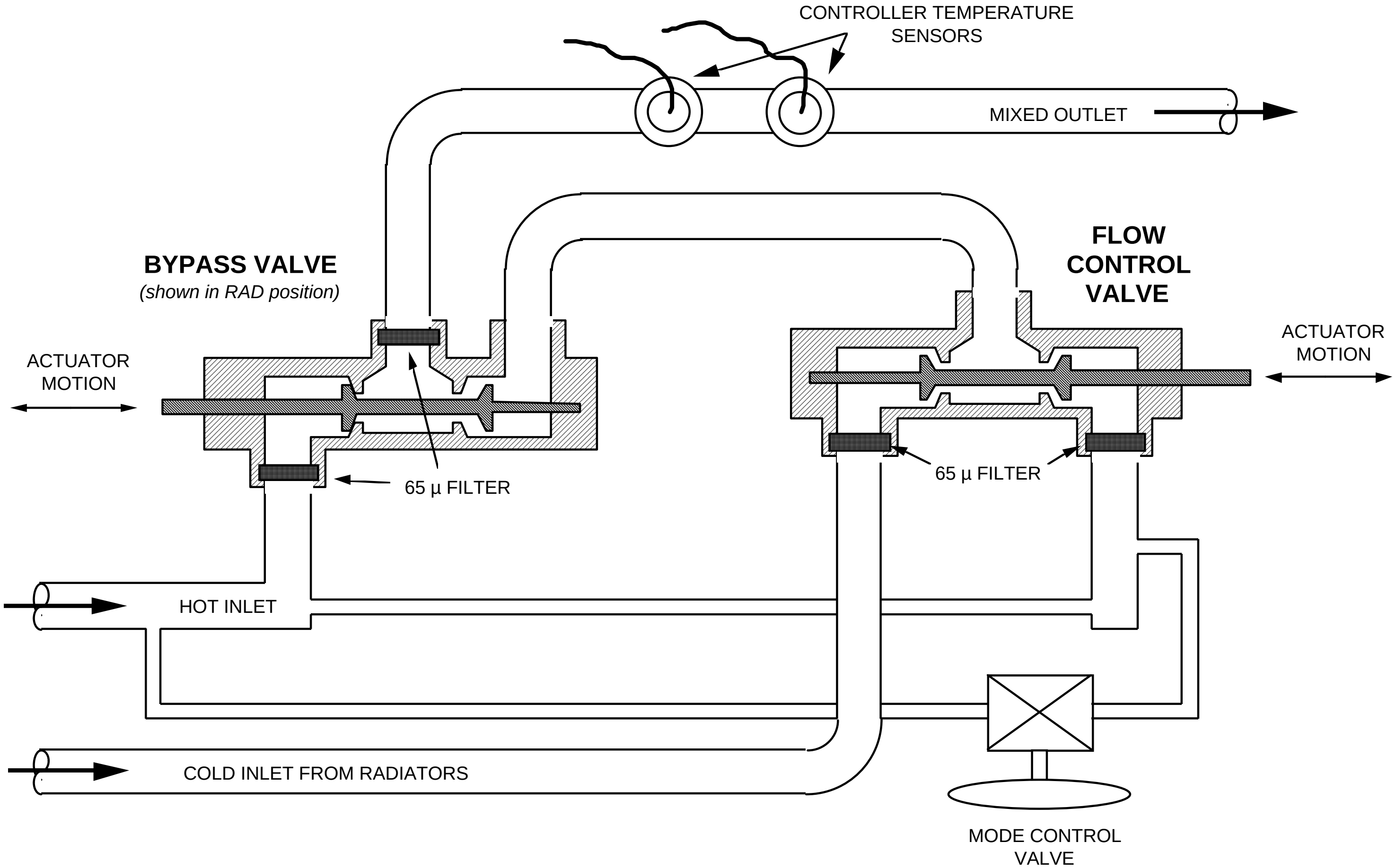
PREVIOUS FLIGHT ANOMALIES BACKUP

	Presenter:
	Organization/Date: Orbiter/04-05-01

STS-102
IN-FLIGHT ANOMALIES
BACKUP

STS-102 RADIATOR FREEZING ISSUE	Presenter:
	Organization/Date: Orbiter/04-05-01

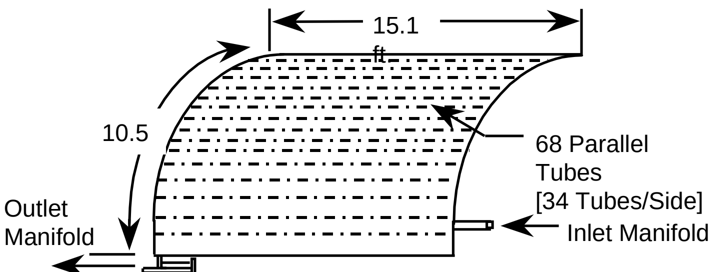
RFCA SCHEMATIC



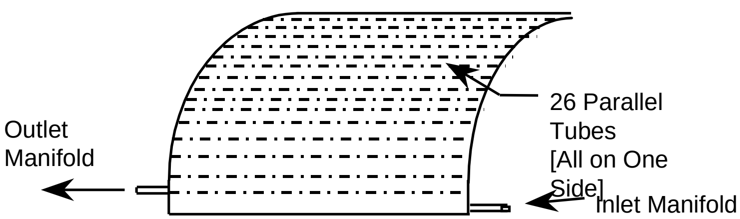
STS-102 RADIATOR FREEZING ISSUE	Presenter:
	Organization/Date: Orbiter/04-05-01

The Orbiter Radiator System

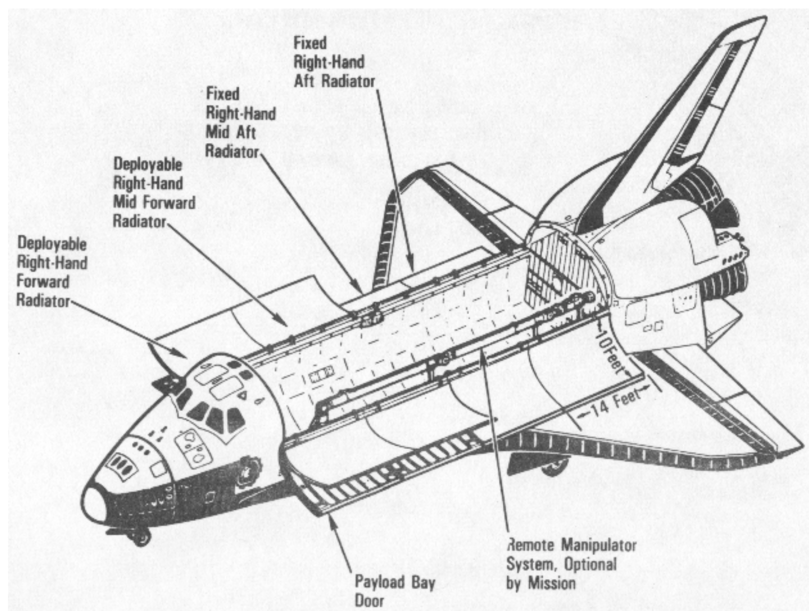
- 4 Panels and A Flow Control Assembly Per Loop
- ~1200 Ft2 of Area (Stowed) For Radiation Cooling



2 Fwd Radiator Panels



Aft Radiator Panel

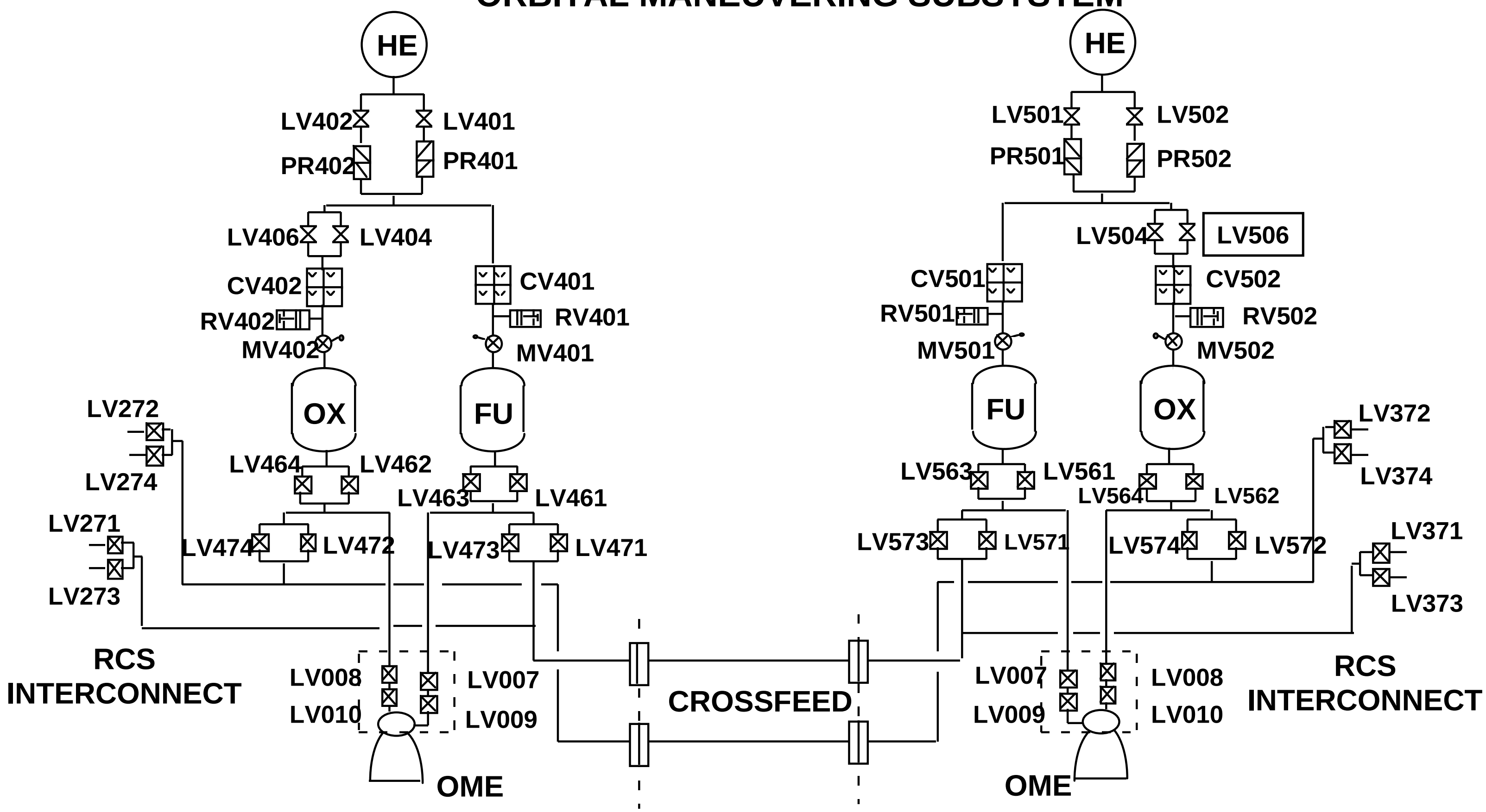


OMS VAPOR ISOLATION VALVE FAILED CLOSED INDICATION

Presenter:

Organization/Date:
Orbiter/04-05-01

ORBITAL MANEUVERING SUBSYSTEM



	Presenter:
	Organization/Date: Orbiter/04-05-01

STS-97
IN-FLIGHT ANOMALIES
BACKUP

ERRONEOUS VERNIER THRUSTER F5R FUEL INJECTOR TEMPERATURE READINGS	Presenter:
	Organization/Date: Orbiter/04-05-01

Observation:

- RCS vernier thruster F5R (S/N 106) fuel injector temperature sensor was off-scale high intermittently during STS-97

Concern:

- Potential loss of vernier RM leak detection

Discussion:

- Vernier thruster F5R fuel injector temperatures diverged from oxidizer temperature periodically during the flight
  - The fuel side temperature measurement increased at a higher rate during firings and lagged behind during periods of inactivity
- This behavior was determined to be indicative of a temperature sensor problem and had no effect on RM leak detection or vernier thruster operation
  - The companion oxidizer temperature measurement was used for monitoring

ERRONEOUS VERNIER THRUSTER F5R FUEL INJECTOR TEMPERATURE READINGS	Presenter:
	Organization/Date: Orbiter/04-05-01

Discussion: (Cont)

- Following undocking, the F5R fuel injector temperature measurement failed off scale high and remained failed for the duration of the flight
- Earlier in the flight, vernier thruster L5D experienced an erratic oxidizer injector temperature measurement (repeat of an anomaly seen on previous OV-105 flights)
  - RM deselected this thruster when the erroneous temperature measurement fell below the leak detection limit
  - A GMEM was implemented to deselect the oxidizer temperature measurement, utilizing only the fuel measurement for RM leak detection, restoring use of the affected vernier thruster
  - Implementation of this GMEM deselects oxidizer temperature measurement RM leak detection on all vernier thrusters

ERRONEOUS VERNIER THRUSTER F5R FUEL INJECTOR TEMPERATURE READINGS

Presenter:

Organization/Date:
Orbiter/04-05-01

Discussion: (Cont)

- Because of the GMEM implemented for the L5D anomaly, thruster F5R was left without RM leak detection when it failed off-scale high following undocking
- With the loss of both fuel and oxidizer injector RM leak detection, vernier usage is limited to periods of ground coverage which allows monitoring of injector temperatures
  - Mission impact was minimal in this case because the docked portion of the mission was completed and vernier thruster use was no longer required

Actions Taken:

- Troubleshooting isolated the cause of the anomaly to the thruster which was removed, replaced and successfully retested

ERRONEOUS VERNIER THRUSTER F5R FUEL INJECTOR TEMPERATURE READINGS	Presenter:
	Organization/Date: Orbiter/04-05-01

Actions Taken: (Cont)

- The anomalous thruster was sent to WSTF for failure analysis
  - This was the second flight of this thruster (S/N 106) since refurbishment which included removal and reinstallation of its temp sensors
  - Electrical checkout results at WSTF were within specification
  - Temp sensor was R&R'd and sent to Boeing HB for detail failure analysis
    - X-rays of sensor were inconclusive
    - Electrical checks verified the failure
    - Destructive analysis in work
- Additional corrective action was taken to address two remaining possible causes the L5D oxidizer temperature anomaly
  - The LH OMS pod was removed to replace dedicated signal conditioner (DSC) OL1 and to add replacement instrumentation wiring from DSC OL1 to thruster L5D
  - This will mitigate the risk of future occurrences of loss of insight into both vernier fuel and oxidizer temperature measurements

ERRONEOUS VERNIER THRUSTER F5R FUEL INJECTOR TEMPERATURE READINGS	Presenter:
	Organization/Date: Orbiter/04-05-01

Risk Assessment:

- Workarounds exists to deal with loss of or erratic behavior of vernier oxidizer or fuel temperature measurement
  - Loss of visibility into injector temperature if failed or erratic off-scale high
    - Companion injector temperature measurement can be used for insight
  - Loss of RM leak detection and deselection of vernier thruster for off-scale low failure
    - A GMEM can be used to deselect the discrepant side temperature measurement and use the other side only for RM leak detection to restore use of vernier thruster
  - Loss of thruster leak detection redundancy for a situation involving a combination of both a fuel and oxidizer RM leak detection
    - Vernier usage limited to periods of ground coverage

ERRONEOUS VERNIER THRUSTER F5R FUEL INJECTOR TEMPERATURE READINGS	Presenter:
	Organization/Date: Orbiter/04-05-01

Acceptable for STS-100 Flight:

- The cause of the anomaly was isolated to the F5R thruster which was removed, replaced and successfully retested
- Loss of fuel temperature indication alone does not impact mission operations
  - Oxidizer temperature sensor can provide leak detection for both valves
- Additional corrective action was initiated to correct the L5D oxidizer temperature anomaly to mitigate the risk of future occurrences of loss of insight into both vernier fuel and oxidizer temperature measurements
- Vernier thruster valves have demonstrated high reliability
  - Only one in-flight leak (STS-28)

	Presenter:
	Organization/Date: Orbiter/04-05-01

ENGINEERING REQUIREMENTS CHANGES BACKUP

ENGINEERING REQUIREMENTS WAIVERS/DEVIATIONS

Presenter:

Organization/Date:
Orbiter/04-05-01

- **All Approved Engineering Requirements Changes, Waivers or Exceptions Have Been Authorized By The Appropriate Program Board:**
  - OMRSD:
    - 6 Exceptions and 2 Waivers processed - all approved
  - IDMRD:
    - 13 Changes and 0 Waivers Approved (11/25/00 – 1/25/01)
  - LCC:
    - No new Orbiter LCC for STS-100 – MEL approved 3/15/01
  - OVEI
    - 3 Waivers processed for STS-100
  - SODB
    - 1 Deviation processed for STS-100
  - Level III ICDs:
    - There are no outstanding technical issues for STS-100
  - Flight Rules:
    - No issues or concerns for changes to the “all flights” flight rules for STS-100

	Presenter:
	Organization/Date: Orbiter/04-05-01

CONFIGURATION CHANGES AND CERTIFICATION STATUS BACKUP

CONFIGURATION CHANGES AND CERTIFICATION STATUS

Presenter:

Organization/Date:
Orbiter/04-05-01

OV-105 STS-100 Modifications and Certification

Current Mission Requirements

MCR/Modification	Certification Method			Certification Approval Request No.	Approval Date	Remarks
	Test	Analysis	Similarity			

MCR 19477
Ducting Mod to Improve Orbiter Supply Air to ISS - Below the Floor Mod
 	
Mission Kit MVO828A
		X
		
		X
				CAR 12-35-643500-002M
				
				CAR 05-22-613760-001F
					1/9/01A
					
					1/9/01A
						• Poor quality orbiter provided ISS air supply was determined to be caused by a recirculation problem because the air mixing venturi location was too close to the middeck airlock hatch, causing ISS return air to be pumped directly back to ISS before being able to properly mix with cabin air.
						• Middeck supply air venturi was relocated to an interface location 51” further forward of the original location (previously used for internal airlock applications)
						  • Location allows for a better mix of middeck air to be provided as supply air to the system.
						  • This arrangement allows the external airlock ducting to be attached at the original air supply port, eliminating the above the floor flex duct.

CONFIGURATION CHANGES AND CERTIFICATION STATUS

Presenter:

Organization/Date:
Orbiter/04-05-01

OV-105 STS-100 Modifications and Certification

Current Mission Requirements

MCR/Modification	Certification Method			Certification Approval Request No.	Approval Date	Remarks
	Test	Analysis	Similarity			
MCR 18755 Starboard Lightweight Tool Stowage Assembly (TSA) Cushion Assembly Mission Kit MVO849A			X	05-25-849-660516-001D	2/16/01A	• STS-100 flight unique cushion assembly configuration for starboard LWTSA
MCR 18755 Starboard Mid Deck Wall Air Diffuser Ducts Mission Kit MVO669A			X	01-25-669-660010-001	10/2/00A	• Installs flex ducts at starboard mid deck sidewall air diffusers to allow air flow to be directed around items stowed on-orbit in the sidewall stowage net

CONFIGURATION CHANGES AND CERTIFICATION STATUS

Presenter:

Organization/Date:
Orbiter/04-05-01

OV-105 STS-100 Modifications and Certification

Corrective Action Mandatory

MCR/Modification	Certification Method			Certification Approval Request No.	Approval Date	Remarks
	Test	Analysis	Similarity			

MCR 19381
Lightweight Mission Specialist Seat Lever Relocation
 	
Mission Kit MVO226A
		X	X	CAR 04-25-39126815-301D	1/22/01A	• Modified the lightweight mission specialist seats by relocating the seat back angle adjustment lever from the right hand side aft to the right hand side forward.
						  • Forward lever location is easier to reach, allowing more force to be applied
						  • Eliminates the difficulty some crew members had changing utilizing the adjustment lever to change the seat back angle from launch to entry position after main engine cut-off
						• To accommodate this change, the inertia reel adjustment lever was relocated from the right hand side forward position to the left ahnd side forward position
						• Makes the mission specialist seat lever configurations common to the pilot and commander seats

CONFIGURATION CHANGES AND CERTIFICATION STATUS

Presenter:

Organization/Date:
Orbiter/04-05-01

OV-105 STS-100 Modifications and Certification

Corrective Action Mandatory

MCR/Modification	Certification Method			Certification Approval Request No.	Approval Date	Remarks
	Test	Analysis	Similarity			
MCR 19470 Verification and Installation of Convoluted Tubing at Wire Tray Section Gaps				N/A *	N/A	• Additional wire protection was installed by specification allowable in the payload bay wire trays as part of the corrective actions from the fleet wiring investigation. • Engineering was subsequently released to ensure consistency across the fleet that all critical locations in the wire trays had proper wire protection. • Some midbody locations at starboard wire tray section gaps were initially missed. • Engineering was released to cover these locations • On-vehicle verification and installation as required was performed to the engineering. * Previously certified materials and processes.

CONFIGURATION CHANGES AND CERTIFICATION STATUS

Presenter:

Organization/Date:
Orbiter/04-05-01

OV-105 STS-100 Modifications and Certification

Corrective Action Mandatory

MCR/Modification	Certification Method			Certification Approval Request No.	Approval Date	Remarks
	Test	Analysis	Similarity			
MCR 19527 Verification and Installation of Aft Fuselage Convoluted Tubing Through Harness Support Clamps FIRST FLIGHT				N/A *	N/A	• During OMM inspection of OV-102 aft fuselage wiring, insulation damage and exposed conductors adjacent to clamps was found in cases where the convoluted tubing ended at the clamp point • The damage appeared to be a result of convoluted tubing being pressed into the harnesses due to personnel or equipment impact • Engineering was released to require all aft fuselage convoluted tubing harness protection to be installed continuously, through the harness clamps • Verification and installation was performed to the engineering in this processing flow. * Previously certified materials and processes.

CONFIGURATION CHANGES AND CERTIFICATION STATUS

Presenter:

Organization/Date:
Orbiter/04-05-01

OV-105 STS-100 Modifications and Certification

Corrective Action Optional / Process Improvement

MCR/Modification	Certification Method			Certification Approval Request No.	Approval Date	Remarks
	Test	Analysis	Similarity			

MCR 19535
Heat Shrink Tubing to Protect Separation Pyro Harnesses
				N/A *	N/A	• One of the findings from the fleet wiring investigation was that harnesses routed to various pyrotechnic devices in the orbiter are frequently handled and subject to excessive flexing, resulting in possible damage.
						• Corrective action identified to preclude damage is to add heat shrink tubing -
						  • Along the harness length to limit flexing and to protect the harness from damage
						  • An additional, localized overwrap sleeve, at the connector strain relief tang, to minimize local stress concentration
						• Harness inspection will be performed prior to application of the heat shrink tubing
						• During this processing flow, the two forward ET separation pyro harnesses were modified (hard effectivity) and one aft ET separation pyro harness was modified (by attrition)
						* Previously certified materials and processes

CONFIGURATION CHANGES AND CERTIFICATION STATUS

Presenter:

Organization/Date:
Orbiter/04-05-01

OV-105 STS-100 Modifications and Certification

Corrective Action Optional / Process Improvement

MCR/Modification	Certification Method			Certification Approval Request No.	Approval Date	Remarks
	Test	Analysis	Similarity			
MCR 19605 ODS Centerline Camera Harness Modification FIRST FLIGHT				N/A *	N/A	• STS-106 primary ODS centerline camera harness failure was found to be caused by a wire failure near one of three splice locations • The failure was attributed to the fact that the harness is flexed during handling, stowage and on-orbit installation, which causes stress at the splice locations • The failure was also partly attributed to splice over-crimp • Splices utilized to reduce voltage drop • Harness modification relocates the three harness splices to be contained within the backshells, protected from flexure induced damage * Previously certified materials and processes

CONFIGURATION CHANGES AND CERTIFICATION STATUS

Presenter:

Organization/Date:
Orbiter/04-05-01

OV-105 STS-100 Modifications and Certification

Corrective Action Optional

MCR/Modification	Certification Method			Certification Approval Request No.	Approval Date	Remarks
	Test	Analysis	Similarity			
MCR 19513 ET Aft Attach Fitting Modification	X	X		06-45-565201-001R 159-03-350013-001K (Submitted 2/19/01A)	9/18/00A 3/30/01A	• Prior to STS-84, elongated holes were found on the flange of the Orbiter ET aft attach fittings where the debris canister is attached • Hole elongation was found on all vehicles and was determined to be caused by ET separation event loads • An interim MR hardware fix installed utilizing three clamp-type fittings to share load with the two existing debris canister fasteners has been utilized since then • Heavy and difficult to install • A permanent solution has been designed and successfully tested • Modification established four new cannister attach hole points on the aft attach fitting with 'L-fittings' at each location to provide a stiffer load path between the cannister and the attach fittings • Eliminates material yielding at the aft fitting attach holes

CONFIGURATION CHANGES AND CERTIFICATION STATUS

Presenter:

Organization/Date:
Orbiter/04-05-01

OV-105 STS-100 Modifications and Certification

Corrective Action Optional

MCR/Modification	Certification Method			Certification Approval Request No.	Approval Date	Remarks
	Test	Analysis	Similarity			
MCR 11874 Replacement of OMS TVC Standby Controller - LH OMS Pod	X			CR 12-621-0009-0021H CAR 02C-12-621-0009-0021H	1/18/82A 1/18/82A	• Modified LH pod only - RH side will be performed at next pod removal

- Modified standby controllers have been upgraded to resolve a known control logic board capacitor problem that causes the controller dead-band to be greater than the specification requirement, which could cause degraded performance in the OMS thrust vector control (TVC) system
  - Originally authorized as an attrition mod (Ref. PRCBD S76425)
- During OV-103 STS-92 prelaunch testing of the OMS TVC system, the left pitch actuator failed the position accuracy test when using the standby controller.
  - The failure was isolated to the standby controller with the most likely cause being the control logic board capacitor in the dead-band circuit
- In light of the recent OV-103 anomaly, it was decided to implement the attrition mod on the OV-105 OMS pod standby controllers during the STS-100 flow
  - However, during the OV-103 controller changeout, it was determined that controller replacement is extremely difficult with the pod installed on the vehicle, with high risk of collateral damage,
- Since OV-105's RH OMS pod was not planned to be removed this flow, controller replacement was deferred until future pod removal
- Controller replacement is desirable, but not mandatory, from a technical standpoint
  - Previous performance of the OV-105 RH standby controller has been nominal
    - The OV-105 RH controller function was verified during this processing flow and will be for each subsequent flow until removal
  - TVC actuator control redundancy exists with the active controller (upgraded configuration)
  - Controller position accuracy anomaly observed on OV-103 was determined to be acceptable for flight operations
- As OV-105's LH OMS pod was removed this flow for another reason, the standby controller replacement was implemented

CONFIGURATION CHANGES AND CERTIFICATION STATUS

Presenter:

Organization/Date:
Orbiter/04-05-01

OV-105 STS-100 Modifications and Certification

Corrective Action Optional

MCR/Modification	Certification Method			Certification Approval Request No.	Approval Date	Remarks
	Test	Analysis	Similarity			
MCR 17990 Aft Payload bay Door Sealing Surface Mod		X		CAR 130A-02-370004-002G CAR 130-02-370004-002C	12/12/97A	

- Aft payload bay door to Xo1307 bulkhead seal was not providing adequate sealing from the external environment
  - Delta pressure wave exists during ascent which deflects the aft portion of the payload bay doors was found to be forcing the aft sealing surface of the doors away from the bulkhead seal
    - Allowed air intrusion into the aft payload bay during ascent at the aft bulkhead causing potential of air impingement on and contamination of payloads, and TCS blanket and thermal barrier damage
- Measurements and analysis determined that the required 50% static seal compression to maintain proper bulkhead seal-to-payload bay door contact during ascent was not being met
- Flight by flight mission/payload unique analysis was required to clear any payload concern prior to implementation of corrective action
- Design change bonded 6 fiberglass spacers to each payload bay door aft sealing surface
  - Measurements of actual vehicle gaps were used to determine spacer thickness required to maintain proper static seal compression
- Note: During payload bay door verification closure, it was found that the LH outboard shim was slightly interfering with a payload bay door bulkhead latch hook.
  - It was determined that this shim was not built per print (incorrect taper direction) and since there was not enough time to fabricate a replacement, the shim was removed and RTV ramping installed in its place to provide a smooth transition for the environmental seal from the adjacent shim.
    - The RTV ramped shim will fly as a one flight restricted MR.
    - The replacement shim will be fabricated and installed next flow

CONFIGURATION CHANGES AND CERTIFICATION STATUS

Presenter:

Organization/Date:
Orbiter/04-05-01

OV-105 STS-100 Modifications and Certification

Corrective Action Optional

MCR/Modification	Certification Method			Certification Approval Request No.	Approval Date	Remarks
	Test	Analysis	Similarity			
MCR 18923 Water Spray Boiler PGME/Water Core Load	X			CAR 14-30-250-0019-001U	3/07/01A	• Cert deviation for 3 WSBs with PGME core load

- Purpose of the PGME additive is to prevent WSB core spray bar freeze-up during ascent which prevents proper temperature control (causes under-cooling) of APU lube oil
  - Historically, typical WSB core load was water only
- All three water spray boiler (WSB) cores were loaded with a Propylene Glycol Monomethyl Ether (PGME)/water mixture for STS-100
- WSB 2 core was loaded with PGME for STS-97, the last flight of OV-105
  - OV-105 WSB 2 had been one of a number of WSB's that had not consistently maintained the APU lube oil return temperature at the desired 250°F steady state temperature
  - WSB 2 performance during ascent was nominal
- There have been five successful flight demonstration tests (FDTs)of the PGME additive
  - OV-104, STS-101 and STS-106; OV-103, STS-92; OV-105, STS-97 and OV-104, STS-98
  - Successful completion of these FDTs has provided the remaining rationale for certification of utilizing PGME in all WSBs for flight
- OV-103, STS-102 is the first flight where all three WSBs were loaded and flown with PGME

CONFIGURATION CHANGES AND CERTIFICATION STATUS

Presenter:

Organization/Date:
Orbiter/04-05-01

OV-105 STS-100 Modifications and Certification

Corrective Action Optional

MCR/Modification	Certification Method			Certification Approval Request No.	Approval Date	Remarks
	Test	Analysis	Similarity			

MCR 18755
Window 9 Flight Cover Modification for MEDS MDU
 	
Mission Kit MVO611A
			X	03-25-661611-001I	1/25/01A	• Eliminates interference between window 9 flight shade and MEDS MDU support bracket
						  • Condition found during implementation on OV-104
						  • Outboard edge of shade trimmed to eliminate interference
						• Early implementation on OV-105 to provide fleet commonality

MCR 12999 Harness Reference Designator Update				N/A	N/A	• Due to lack of access to a harness associated with the previous flow verification of main engine controller bus separation, re-identification of mid fuselage wire harness was deferred to this flow
MCR 18755 Portable Foot Restraint (PFR) Mod Mission Kit MVO072P				Boeing Cert N/A	N/A	• Updated installation tech order to reflect modified GFE PFR's • Process change adding dry lube to the PFR gimbal assembly that rolls the configuration dash number.

CONFIGURATION CHANGES AND CERTIFICATION STATUS

Presenter:

Organization/Date:
Orbiter/04-05-01

OV-105 STS-100 Modifications and Certification

Corrective Action Optional

MCR/Modification	Certification Method			Certification Approval Request No.	Approval Date	Remarks
	Test	Analysis	Similarity			
MCR 19112 Wireless Video System (WVS) Follow-On Mods				N/A	N/A	• Secondary structure

- Two ‘paper’ mods for work previously accomplished on OV-105 by MR and now directed as a design change for the fleet:
- Cold bond of Xo 1307 bulkhead Wireless Video System brackets -
  - Hot bonding brackets could not be accomplished because local deflections in the bulkhead during heat application and subsequent cooling caused preload and weakness in the bond line
  - Brackets were installed utilizing a cold adhesive bond with a post-installation verification pull test
  - Since this was already done by MR on OV-105 during the flight 15 flow, this is design engineering coverage only for work already performed.
- Revision To Xo 1307 Bulkhead Antenna Installation -
  - During the OV-105 STS-97 payload installation at the pad, the WVS Xo 1307 bulkhead antenna bracket interfered with the Cargo Access Platform (CAP)
  - Removal of the antenna and bracket was required to allow ground processing to occur
  - The installation of the aft bulkhead antenna bracket was altered (via MR) by reversing the hi-lok fasteners to put the tails on the

    payload bay side (as opposed to the aft fuselage side) to facilitate removal of the bracket should it be required in the future
  - Since this was already done by MR on OV-105 during the flight 15 flow, this is design engineering coverage only for work already performed.

	Presenter:
	Organization/Date: Orbiter/04-05-01

MISSION KITS BACKUP

STS-100 MISSION KIT MODIFICATION SUMMARY

Presenter:

Organization/Date: Orbiter/04-05-01

53 Orbiter Mission Kits Are Manifested (MECSLSI & CCCD) For STS-100:

- 1 STS-100 Flight Unique Mission Kit Modification
  - MV0849A STS-100 Mission Unique Lightweight Starboard TSA Cushion
- 6 Mission Kit Related Modifications for STS-100 Previously Flown on Other Vehicles
  - MV0072P Modified GFE Portable Foot Restraint (PFR)
  - MV0226A Mission Specialist Lightweight Seats - Relocated inertia reel & seat back adjustment control levers
  - MV0465A 7 GN2 Tanks - 2 installed this flow
  - MV0611A Modified Window 9 Flight Shade
  - MV0669A Starboard Mid Deck Wall Air Diffuser Bypass Ducts
  - MV0828A Below the Mid Deck Floor Ducting Mod to Improve ISS Air Supply
- Detail listing of all manifested orbiter mission equipment kits and associated mission equipment modifications follows

STS-100 MISSION KITS

Presenter:

Organization/Date:
Orbiter/04-05-01

MISSION KIT	TITLE	COMMENTS
MV0072P	PAYLOAD / GFE INSTLS	- OSVS TARGET INSTL - MICRO WIS FOR FICS INSTL + MODIFIED PFR
MV0073A	PAYLOAD SUPPORT EQUIPMENT	
MV0074A	FERRY FLIGHT KIT	
MV0076A	ORBITER DOCKING SYSTEM MECHANISM	
MV0082A	REMOTE MANIPULATOR SYSTEM (RMS)	RMS INSTALLED THIS FLIGHT
MV0225A	CDR/PLT LW SEATS - COOLING UNIT MOUNTING BKTS (AFT/STBD) - FLT DATA FILE - EGRESS HANDHOLD	
MV0226A	M/S LW SEATS	+ RELOCATED INERTIA REEL & SEAT BACK ADJUSTMENT CONTROL LEVERS
MV0412A	S-BAND FM SYSTEM	
MV0418A	MCDS	
MV0424A	CIRCUIT BREAKER COLOR CODE KIT	
MV0439A	OV-105 MADS SYSTEM	
MV0456A	ET UMBILICAL CAMERAS	AWAITING DECISION ON WHETHER TWO LH UMBILICAL WELL 16MM CAMERAS WILL SUPPORT STS-100 DUE TO CAMERA ISSUES. THE RH UMBILICAL WELL 35 MM STILL CAMERA WILL BE FLOWN.
MV0458A	EDO PALLET MISSION KIT PROVISIONS	
MV0465A	GN2 SUPPLY (NITROGEN TANKS)	+ 7 GN2 TANKS - 2 INSTALLED THIS FLOW - BAY 4 RH AFT & BAY 2 RH AFT

+ INDICATES MISSION KIT MOD

STS-100 MISSION KITS

Presenter:

Organization/Date:
Orbiter/04-05-01

MISSION KIT	TITLE	COMMENTS
MV0485A	TACAN COOLING PROVISIONS	
MV0494A	GPS/INS DTO HARDWARE	SIGI/CRV INSTALLED WITH MAGR-S
MV0520A	PAYLOAD HEAT REJECTION (RADIATOR PANELS)	
MV0525A	PRSD SYSTEM TANK SET 4	
MV0529A	RENDEZVOUS AND DOCKING FLOODLIGHT	
MV0532A	PAYLOAD BAY LINER	PARTIAL INSTL UNDER BAYS 1 & 2 LONGERON BRIDGES
MV0544A	PRSD TANK SET 3	
MV0545A	COMSEC EQUIPMENT	
MV0546A	PRSD TANK SET 3 & 4 THERMAL CONTROL BLANKET KIT	
MV0548A	BULKHEAD CLOSED CIRCUIT TV	
MV0549A	PAYLOAD BAY FLOODLIGHTS	
MV0566A	PRSD TANK SET 5	
MV0568A	PROVISIONS STOWAGE ASSY (PSA) - HANDHOLDS & PFR	
MV0573A	AFT FUSELAGE BALLAST CONTAINERS	2050 LBS OF BALLAST
MV0602A	LW STOWAGE LOCKERS	42 OF 44 FOR STS-97
MV0603A	VOLUME A STOWAGE	
	VOLUME B STOWAGE & ATTACH FITTINGS	

+ INDICATES MISSION KIT MOD

STS-100 MISSION KITS

Presenter:

Organization/Date:
Orbiter/04-05-01

MISSION KIT	TITLE	COMMENTS
MV0606A	AIRLOCK STOWAGE KIT SERVICING & COOLING UMBILICAL	
MV0607A	SKY GENIE	
MV0610A	HAND CONTROLLER INSTLN	
	LWT SEAT FLOOR STUDS	
MV0611A	WINDOW SHADES	+ MODIFIED WINDOW 9 FLIGHT SHADE
MV0612A	MIDDECK STRUCTURAL CLOSEOUT KIT	
MV0617A	EVA SLIDEWIRE	
MV0622A	PAYLOAD BAY FLAG	
MV0627A	LIOH CONTAINER	
	MULT. HEADSET ADAPTER PLATE ASSY	
	CPU 2 & 3 ORIFICE SCREEN	
	ON-ORBIT STATION STOWAGE LOCKER	
MV0643A	MMU ORBITER PROVISIONS KIT	
MV0645A	LW MAR DEBRIS CLOSEOUT	
MV0647A	VOLUME D STOWAGE CONTAINER	
MV0651A	EMERGENCY EGRESS SLIDE	

+ INDICATES MISSION KIT MOD

STS-100 MISSION KITS

Presenter:

Organization/Date:
Orbiter/04-05-01

MISSION KIT	TITLE	COMMENTS
MV0653A	SORG	
MV0655A	AV BAY WIRE TRAY SCAMP ASSY	
MV0657A	CABLE TRAY	
MV0669A	SLEEPING BAGS	+ STARBOARD MID DECK WALL AIR DIFFUSER BYPASS DUCTS MANIFESTED THIS FLIGHT
	LADDER	
	EMERGENCY EGRESS PLATFORM CUE CARD SUPPORT	
	WMC STOWAGE AND TRASH BAG	
	VOLUME 3B STOWAGE	
	INTERDECK LIGHT SHIELDS	
MV0719A	PAYLOAD INTEGRATION AFT FLIGHT DECK AVIONICS KIT	
	INCLUDES GFE WIRELESS VIDEO SYSTEM CONTROL PANEL AS PART OF THE VIDEO PROCESSING UNIT (VPU)	
MV0827A	SPARE MCIU AND PDI	

+ INDICATES MISSION KIT MOD

STS-100 MISSION KITS

Presenter:

Organization/Date:
Orbiter/04-05-01

MISSION KIT	TITLE	COMMENTS
MV0828A	EXTERNAL AIRLOCK & PROVISIONS STOWAGE PALLETS & BAGS EMERGENCY EGRESS NET MIDDECK HANDHOLDS FIRE EXTINGUISHER 20G EMU COVER INSTL EMU ADAPTER PALLET ON-ORBIT BUNGEE ATTACH FITTINGS	+ BELOW THE MID DECK FLOOR DUCTING MOD TO IMPROVE ISS AIR SUPPLY - SMALL PORT FLOOR BAG - SMALL STBD FLOOR BAG - DOUBLE SMALL PORT CEILING BAGS - SHORT EMU STOWAGE STBD CEILING - EXTERNAL AIRLOCK STOWAGE BAG
MV0845A	ISS INTEGRATION HARDWARE	- APCU PROVISONS AND ODS INTERFACE PANEL

+ INDICATES MISSION KIT MOD

STS-100 MISSION KITS

Presenter:

Organization/Date:
Orbiter/04-05-01

MISSION KIT	TITLE	COMMENTS
MV0849A	LW TOOL STOWAGE ASSY (PORT)	+ STS-100 CONFIGURATION LWT STARBOARD TSA CUSHION
MVO859A	MAR & PROVISIONS INCLUDES LOCKERS & ATTACH FITTINGS	LIGHTWEIGHT MAR
MVO874A	WIRELESS VIDEO SYSTEM	MISSION KIT CONTAINS PAYLOAD BAY ANTENNAS & ASSOCIATED COAX CABLES

+ INDICATES MISSION KIT MOD

	Presenter:
	Organization/Date: Orbiter/04-05-01

SPECIAL TOPIC

BACKUP

PRSD CRACKED VALVE SEAT ISSUE

Presenter:

Organization/Date: Orbiter/04-05-01

- The H_2 manifold panel removed from OV-102 during OMM was returned to NSLD for cryo screening
- A H_2 T-0 valve from this panel failed internal leakage during ATP after successful cryo screening – 72 sccm
- Valve was originally delivered 10/1986 and was installed into the panel in 1987
  - Since that time, it has flown 19 missions (OV-104 & OV-102)
- S/N 74 T-0 valve leakage history (sccm)

10/86 OEM	11/88 KSC → 7/92 KSC	5/94 NSLD	6/94 NSLD	KSC	7/00 NSLD	3/21/01 NSLD
0**	all flights 0-6 sccm* OV-104 (flights 3-12)	4.8**	< 0.1**	see below OV-102	72** CAR NA1212	89.7** CAR NA1273

OV-102 (18-26) KSC OMI 1040				
9/95	10/95	11/97	3/98	6/99
23.6*	28*	51*	47*	51.1*

* 500 sccm max allowable leakage on-vehicle
** 18 sccm max allowable leakage at the component level

	Presenter:
	Organization/Date: Orbiter/04-05-01

RCS VERNIER ENGINE STATUS

BACKUP

OV-105 RCS VERNIER ENGINES THRUST CHAMBER ASSEMBLIES INSPECTED

Presenter:

Organization/Date:
Orbiter/04-05-01

STS-105 Flow Vernier Engines Thrust Chamber Inspection Results

Jet	S/N	Flights	Cycles	Burntime (sec)	Thermal Cycles	Chips
F5L	403	2	25,867	20,145	288	None
F5R	204 *	15	49,833	43,963	622	None
L5L	108	13	56,324	51,944	674	None
L5D	611	1	2,717	4,433	71	None
R5R	306	8	33,867	30,736	396	None
R5D	401	19	74,746	96,873	1718	2 small chips **

**Chips found following STS-99, OV-105 flight 14

F5R	106	1	5554	9606	292	None

*Replaced S/N 106 with S/N 204 due to off-scale high temp sensor failure

All OV-105 OME and Primary Thruster Engine Thrust Chambers Passed the Required Visual Inspection During the STS-100 Flow

	Presenter:
	Organization/Date: Orbiter/04-05-01

OMS/RCS MR SUMMARY

BACKUP

OMS/RCS MR SUMMARY

Presenter:

Organization/Date:
Orbiter/04-05-01

- **During the STS-100 processing flow time period of 12/11/00 to present there were no OMS/RCS MR's initiated**

	Presenter:
	Organization/Date: Orbiter/04-05-01

EMI CHANGE REQUEST SUMMARY BACKUP

EMI CHANGE REQUEST SUMMARY

Presenter:	
Organization/Date:	Orbiter/04-05-01

One EMI Change Request Was Reviewed and Approved During the STS-100 Processing Flow:

- S063038 Waiver of the RSRM Joint and Igniter Heater Requirement for Power Switching at the Null (Zero) Crossover
  - Note: This waiver is applicable only to RSRM
    No Orbiter impact