



SPACE SHUTTLE PROGRAM
Space Shuttle Systems Integration Office
NASA Johnson Space Center, Houston, Texas



PRCB Action Response S060900ER3, Action 1-1

August 24, 2006



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◆ Action:

- Report to the PRCB why it is acceptable to have non-flight like boxes in the SAIL facility (reference Point Sensor Box).



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- **The purpose of SAIL is to provide a test facility for performing integrated testing of the Shuttle Avionics System (hardware and software) and its interfaces with other Shuttle elements.**
- **The Flight Software Office is responsible for the SAIL facility and Integrated Avionics Verification.**
- **The Orbiter Project Office is responsible for the Orbiter hardware that makes up the OV-095 vehicle in SAIL.**
- **The SAIL Configuration Control Panel controls the configuration of the SAIL facility and vehicle.**



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◆ Current Operations:

- **Percentage of flight qualified boxes actually in SAIL has always been a small portion of the total SAIL boxes**
 - Currently approximately 10% are flight boxes
- **SAIL has always had a mix of flight qualified boxes, flight like boxes, prototype boxes as well as engineering test only boxes**
 - All are similar with regard to form, fit and function



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◆ **Current Operations (cont):**

- **Differences between Orbiter boxes and SAIL boxes are defined for each flight by Boeing**
 - Tracked and documented in the SAIL Differences List (SDL)
 - Presented and approved by the SAIL CCP
 - Includes the rationale for why it is acceptable to use the boxes with identified differences in SAIL
- **Each SAIL test sponsor, with support from SAIL Engineering, must determine the acceptability of these differences with respect to specific test requirements/objectives**
 - If the differences are unacceptable, then an effort will be made to obtain a flight spare box for that specific test



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◆ **Conclusion**

- Entire community works together to assure a test facility that will accurately represent the Orbiter functional hardware/software configuration in order to produce valid Shuttle IAV test results.

◆ **Recommendation:**

- Close PRCB Action # S060900ER3 1-1



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Backup



Differences Between SAIL and Flight Point Sensor Electronics Box

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- SAIL Operations
 - Point sensors (100, 98, etc) not actively utilized by software during SAIL runs
 - External resistances applied to achieve all WET prior to liftoff, all DRY at liftoff
 - Low level cutoff simulated by application of external resistance equivalent to a DRY sensor on all four sensors simultaneously
 - Two of four sensors indicating DRY required by software for SSME cutoff



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- Older design PSB provided to SAIL was compatible with wiring interfaces and has no effect on PSB performance
 - SAIL PSB utilizes built-in time delay circuit cards with timers set to zero
 - After early shuttle flights, the PSB time delay circuit was set to zero since on-board flight software performed this function
 - Orbiter flights continued to use the original PSBs with the timer circuits set to zero
 - Current design of the PSB deletes the timer circuit card and replaced with a jumper card



Differences Between SAIL and Flight Point Sensor Electronics Box

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- SAIL PSB signal conditioning boards set to handle the Original design of the LO2 ECO transducers with Molybdenum / Rehenium Sensing Elements
 - Current PSB signal conditioning cards updated to incorporate platinum sensing elements in LO2 ECO transducers
 - Similar circuit design with slightly different resistance / WET / DRY trip levels
 - Current SAIL box configuration properly simulates the LO2 ECO sensor operations
 - Software only looks for a 28VDC ECO signal that is produced by the PSB
 - Differences in the LH2 sensors are compensated for through the application of external resistances to simulate WET / DRY sensors



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Configuration Differences SAIL vs Flt Point Sensor Box				
				Note: See assembly drawings for specific differences. The Schematic may not be up to date.
<u>Point Sensor Box P/N's</u>	<u>SAIL</u>	<u>Flight</u>	<u>Performance Delta</u>	<u>Description</u>
	MC432-0205-0009 (Vendor P/N 472698-002)	MC432-0205-0021 (Vendor P/N 472698-		
Power Supply Boards	1500080	1500080	No Change	Two power supply cards in the PSB. Each card provides the following voltages: 12 vdc and 14.5 vdc regulated
Optical Isolator Board	1500048	1500048	No Change	Provides the interface between the Orbiter command checkout functions and the point sensor signal conditioner SRU's. The signal represent either an Open, Wet or Dry condition.
ECO Timer Boards	1500052-001	None	None	The Engine cutoff timer boards were replaced with a spacer board. The spacer boards are mechanically connected in the PSB and perform electrical interconnections only. The original design utilized a built-in time delay circuit.
ECO Spacer Boards	None	1500052-004	None	
External Push Button Switches for timer boards	Yes	No	None	



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Signal Conditioning Boards for non ECO Depletion Sensors	1500050-001-1 Schematic 1500026-001	1500050-001-2 Schematic 1500026-002	None	The PSB uses nearly identical signal conditioners for the level sensors and ECO sensors. Each card consists of two channels; One is used for the LO2 and the other is used for LH2.
Signal Conditioning Boards for ECO Depletion Sensors	1500050-002-1 Schematic 1500062-001	1500050-002-5 Schematic 1500062-005	None	
Flex Circuit assembly	1500141	1500141	No Change	Flat flexible cable assemblies provides connection between the connector board and the external connectors. Its geometry provides repeatable electrical characteristics with good isolation between circuits.



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Differences noted on schematics for all signal conditioning cards		<p>Added C109 Cap on backup current controller</p> <p>Added C110 Cap on primary current controller</p> <p>Added C111 Cap on Sensor excitation</p> <p>Changed current detector diodes (D1) to 1D918 and resistor R4 to lower value.</p> <p>Ground Wire added to Flex circuit assembly board</p>	None	
Differences noted on schematics for ECO Depletion signal conditioning cards	Current controllers set to provide 120 MA to LO2 ECO sensors Wet/Dry trigger level is set to ~8.9VDC	Current controllers set to provide 110 MA to LO2 ECO sensors Wet/Dry trigger level is set to ~8.3VDC	LO2 Different trigger level. LH2 same trigger Level	



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Hybrid Micro circuits on all boards were slightly changed - - they are interchangeable with the latest units				
Resistors on sig cond boards		unit values changed to handle latest current and trigger values		