Preliminary Results of FAA Fuel Tank Inerting Flight Testing on the NASA 747 SCA

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DTA - Grenoble, France
June 21-22, 2003

FAA-NASA 747 Inerting Flight Test

Outline

- Goals and Objectives
- OBIGGs
- Instrumentation / DAS
  - Fuel Tanks
  - System
  - Additional Parameters
  - OBOAS / FAS
- Preliminary Data
- Status

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Testing Goals and Objectives

- Study the simplified inerting concept and validate/expand upon existing system performance models
- Develop/validate system sizing data
- Validate previous in flight inert gas distribution modeling done by FAA
- Measure the progression of flammability in the CWT and a single wing tank for a typical commercial transport airplane

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OBIGGS - System Architecture

- Uses Air Separation Modules based on HFM technology
  - Excepts 350 degree F air from aircraft bleed system
  - Cools, filters, and conditions air
  - Air is separated in 3 ASMs and NEA is plumbed to output valves to control flow
  - OEA is dumped overboard with H/X cooling air
  - System flow control is presently configured with low flow orifice and high flow control valve
- System controlled by control box in cabin that is connected to system with cable
- System installed in empty pack bay area of 747 SCA

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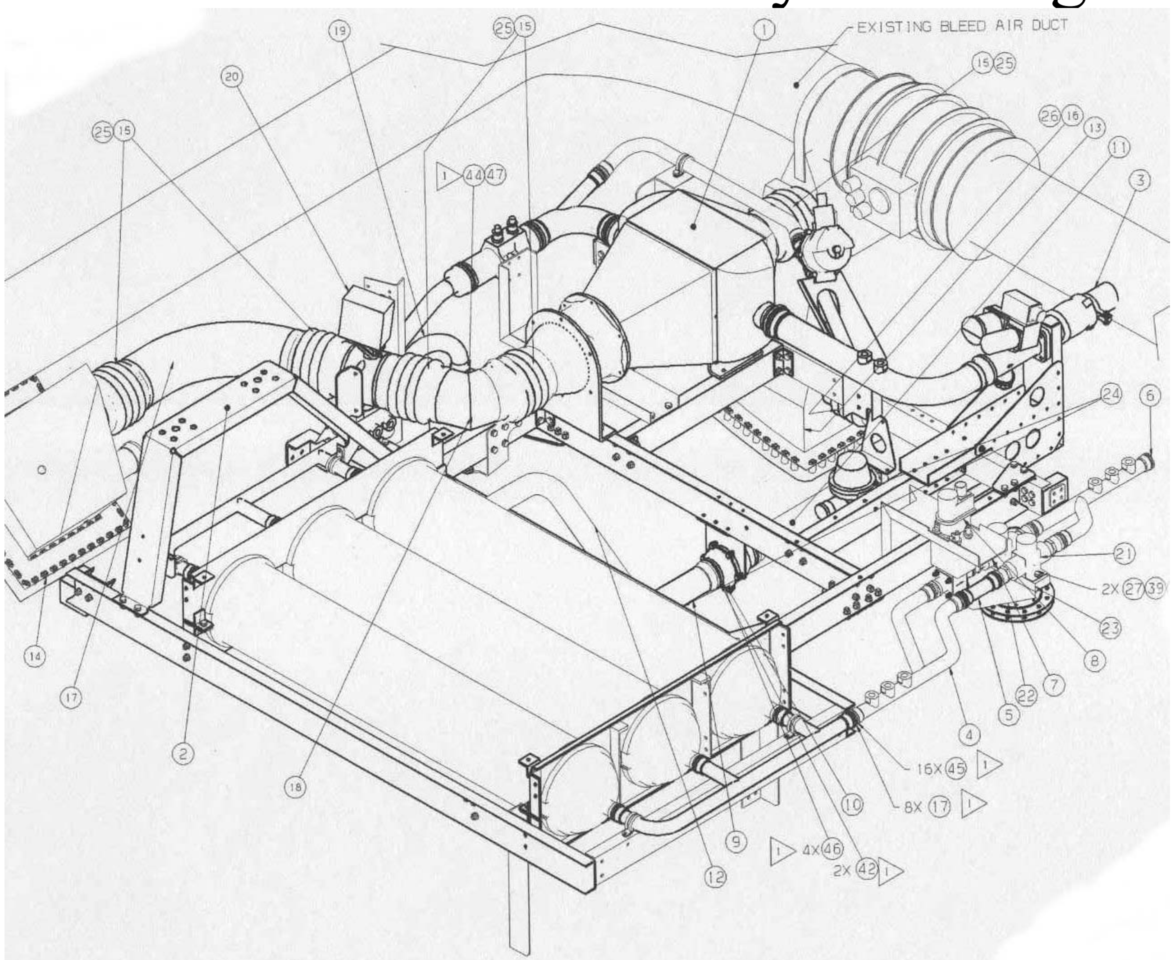
FAA OBIGGs Assembly Drawing



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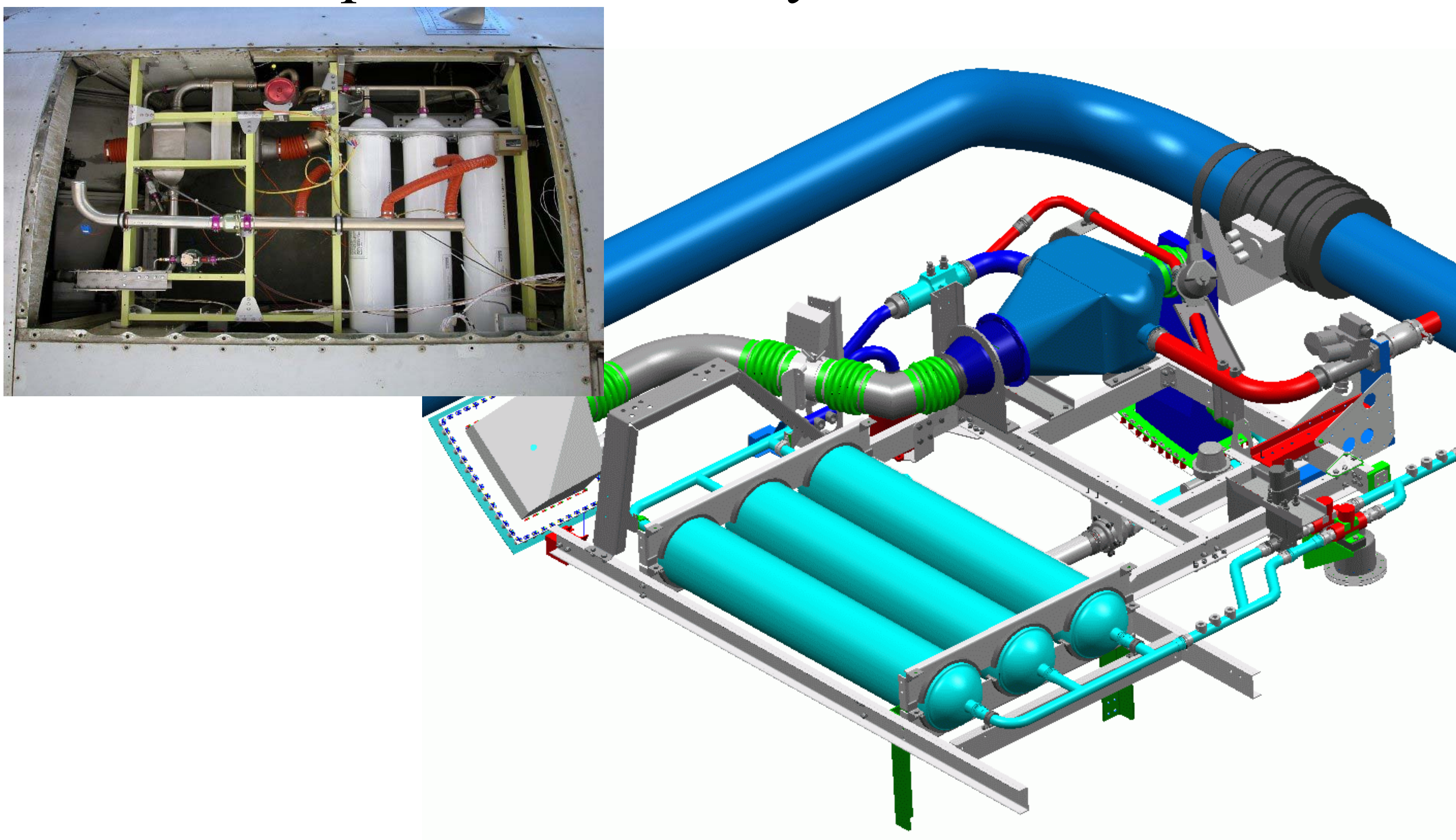
Simplified OBIGG System Installation



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Simplified OBIGG System Installation

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Instrumentation and Data Acquisition

- Various thermocouples and pressure transducers used
  - Evaluate system performance
  - Measure tank flammability parameters
  - Measure ancillary parameters
- OBIGGS system flow meter and 2-channel oxygen analyzer for NEA and OEA analysis
- Onboard Oxygen Analysis System (OBOAS) measurements
  - 8-channel system analyzes 8 locations in tank
- Flammability Analysis System (FAS) will measure progression of CWT and #2 wing tank flammability in flight
  - 1 location in forward section of center tank

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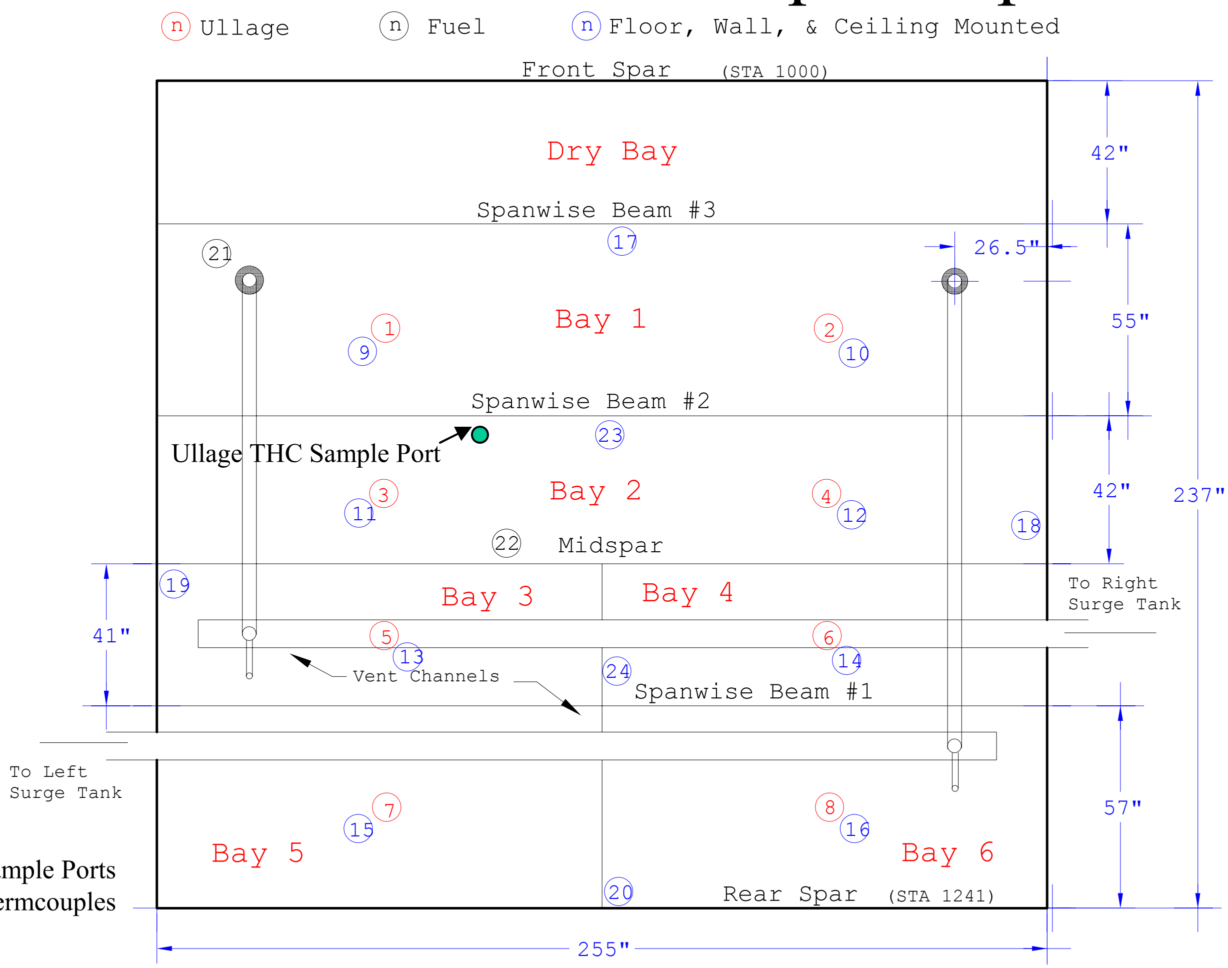
CWT Thermocouple Map



Note: Ullage Oxygen Sample Ports Located Adjacent to Thermocouples 1-8

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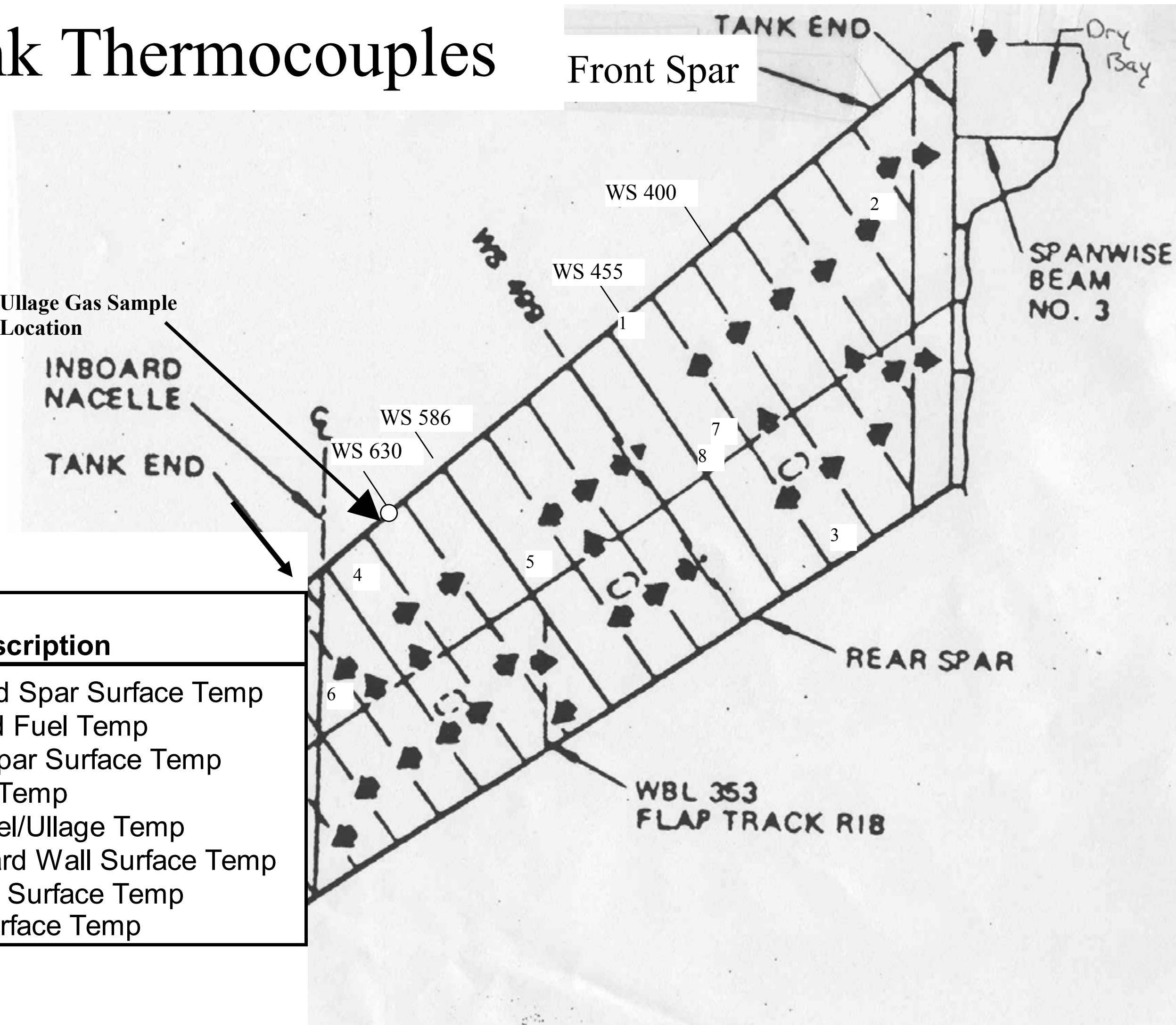
#2 Wing Tank Thermocouples



T'couple #	Description
1	Wing Tank Forward Spar Surface Temp
2	Wing Tank Inboard Fuel Temp
3	Wing Tank Rear Spar Surface Temp
4	Wing Tank Ullage Temp
5	Wing Tank Mid Fuel/Ullage Temp
6	Wing Tank Outboard Wall Surface Temp
7	Wing Tank Bottom Surface Temp
8	Wing Tank Top Surface Temp

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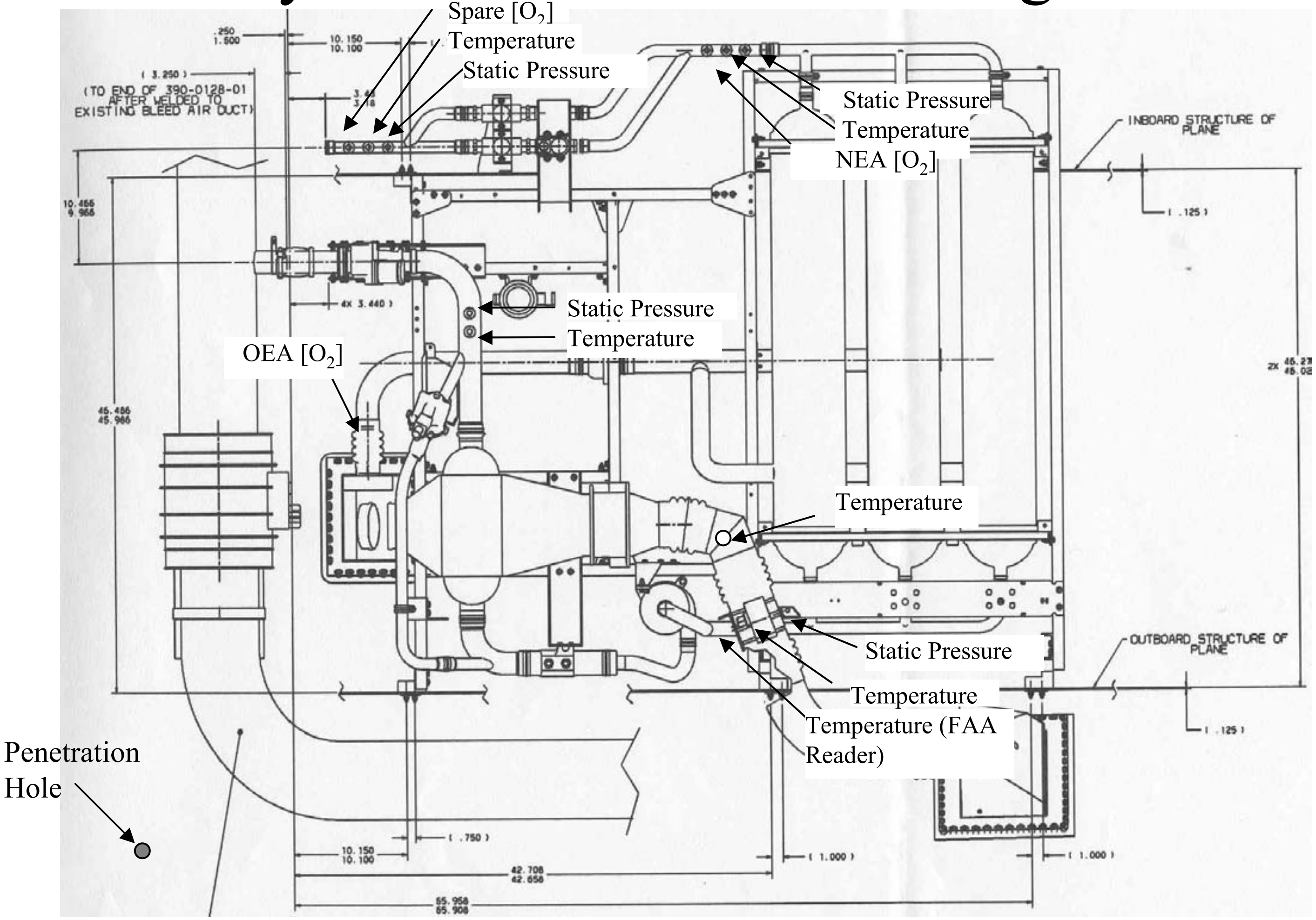
System Instrumentation Diagram



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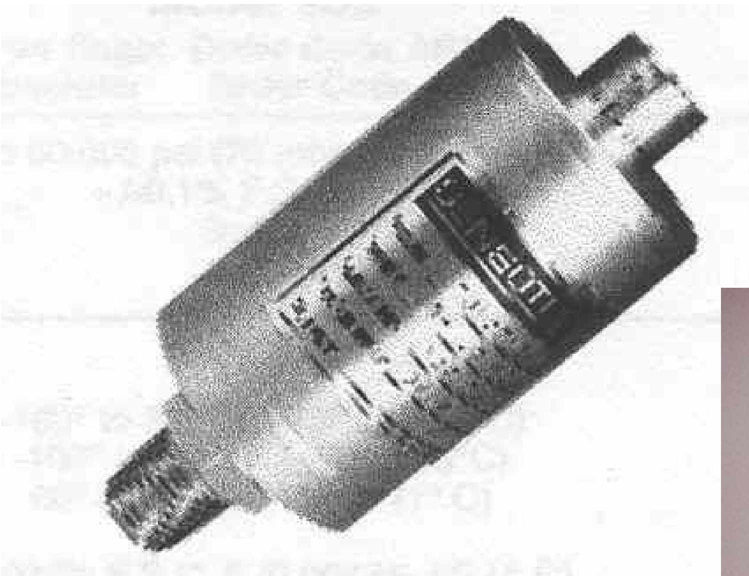
Thermocouple Probe and Pressure Transducer



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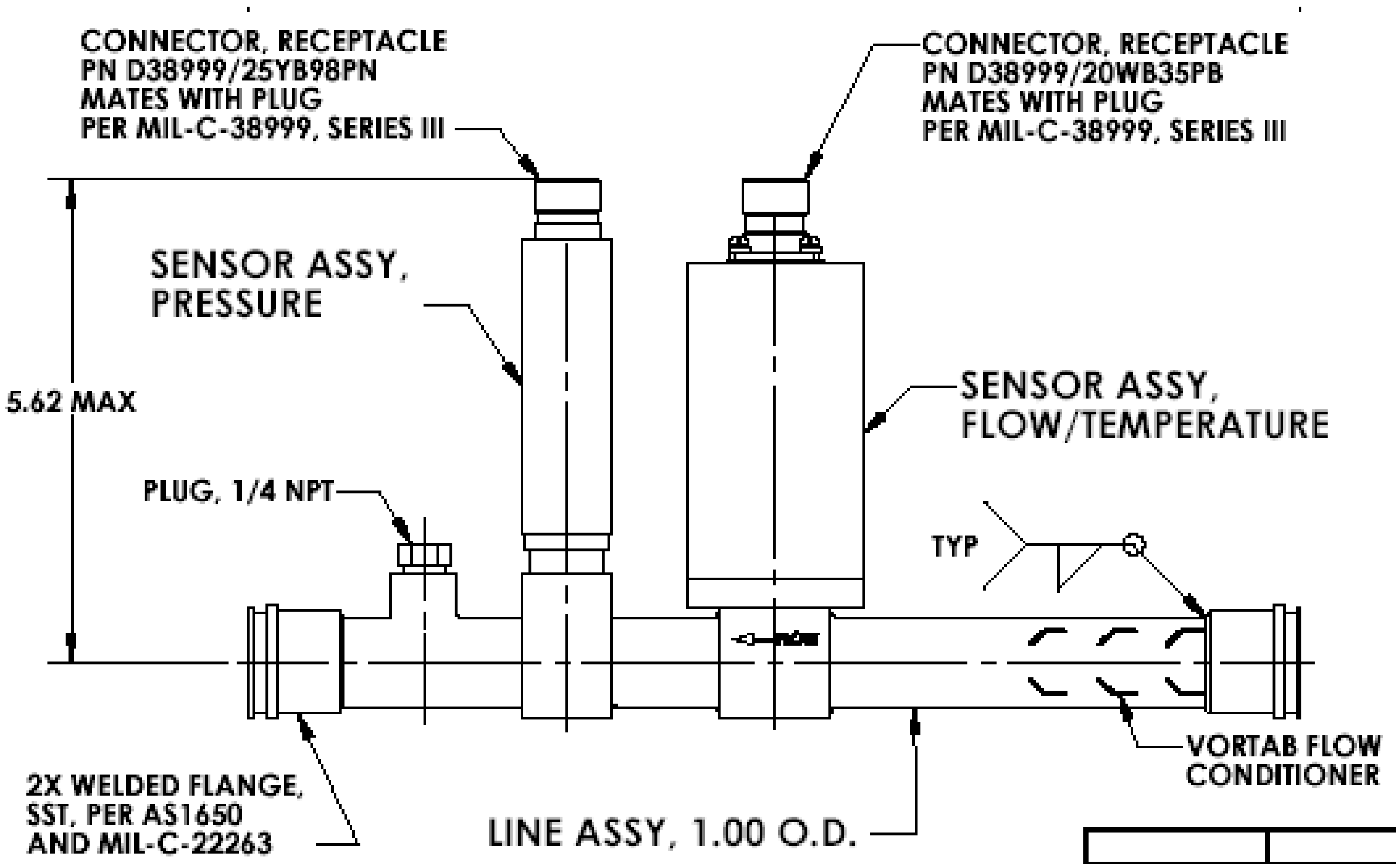
Flow Meter



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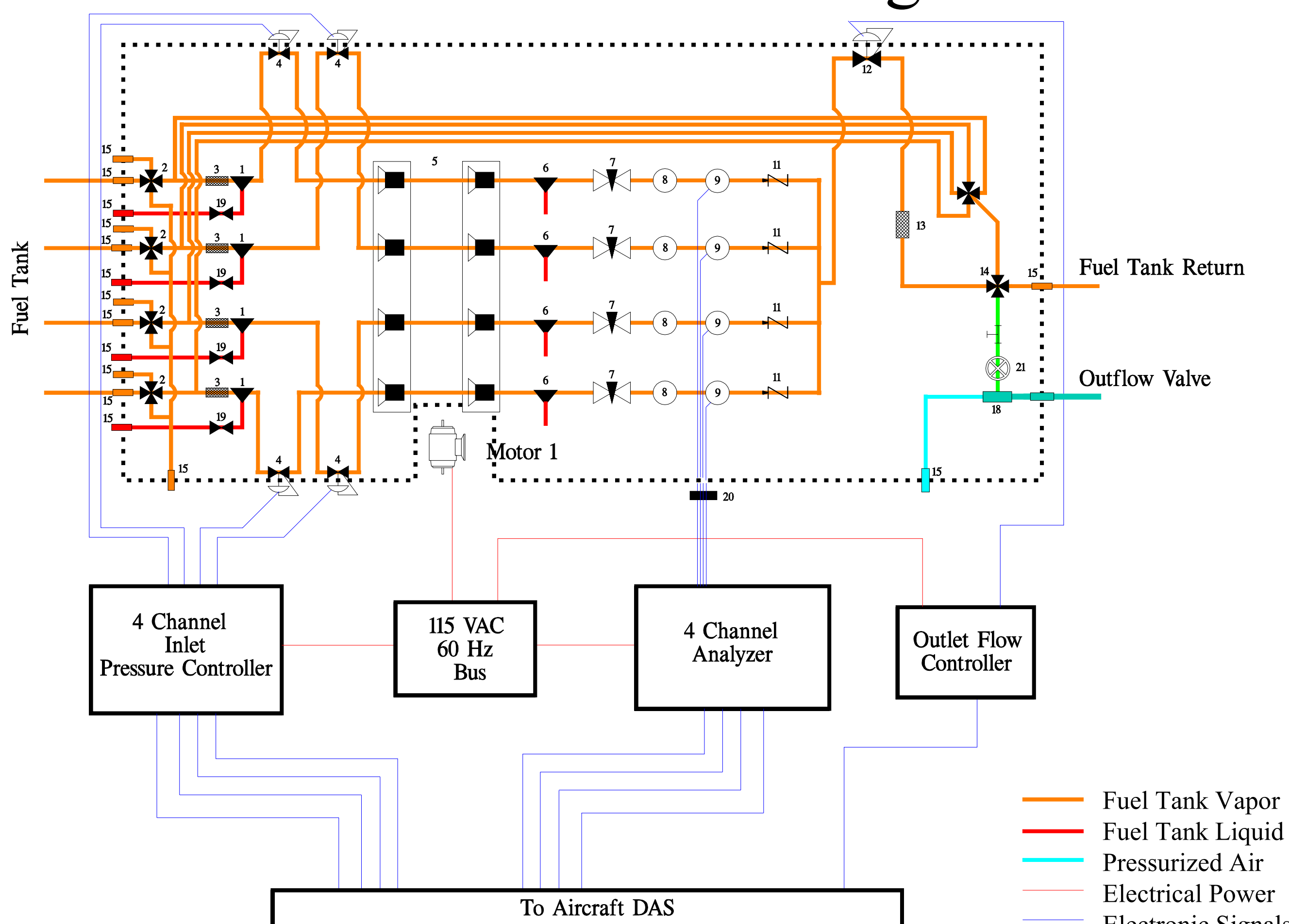
OBOAS Block Diagram



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OBOAS Mounted in FAA AMCO Racks

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DAS Rack with OBIGGS Analyzer

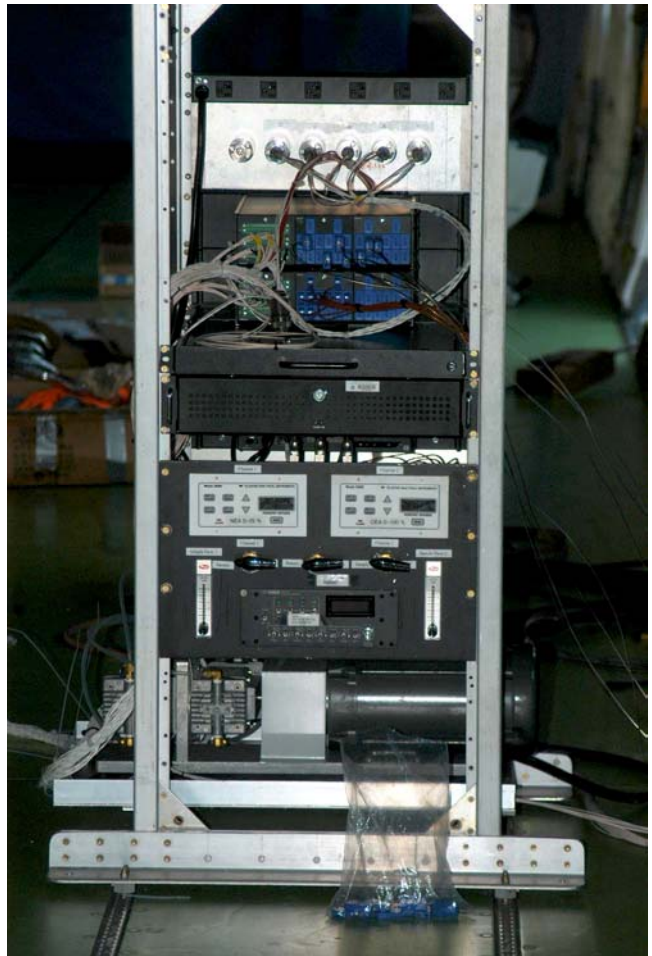

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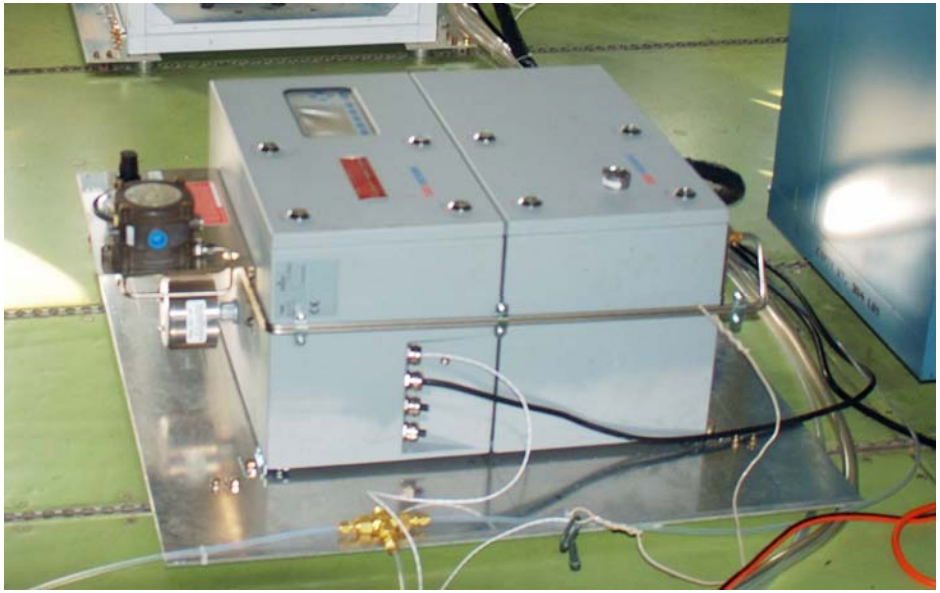
Photo of FAS Sample System and Analyzer



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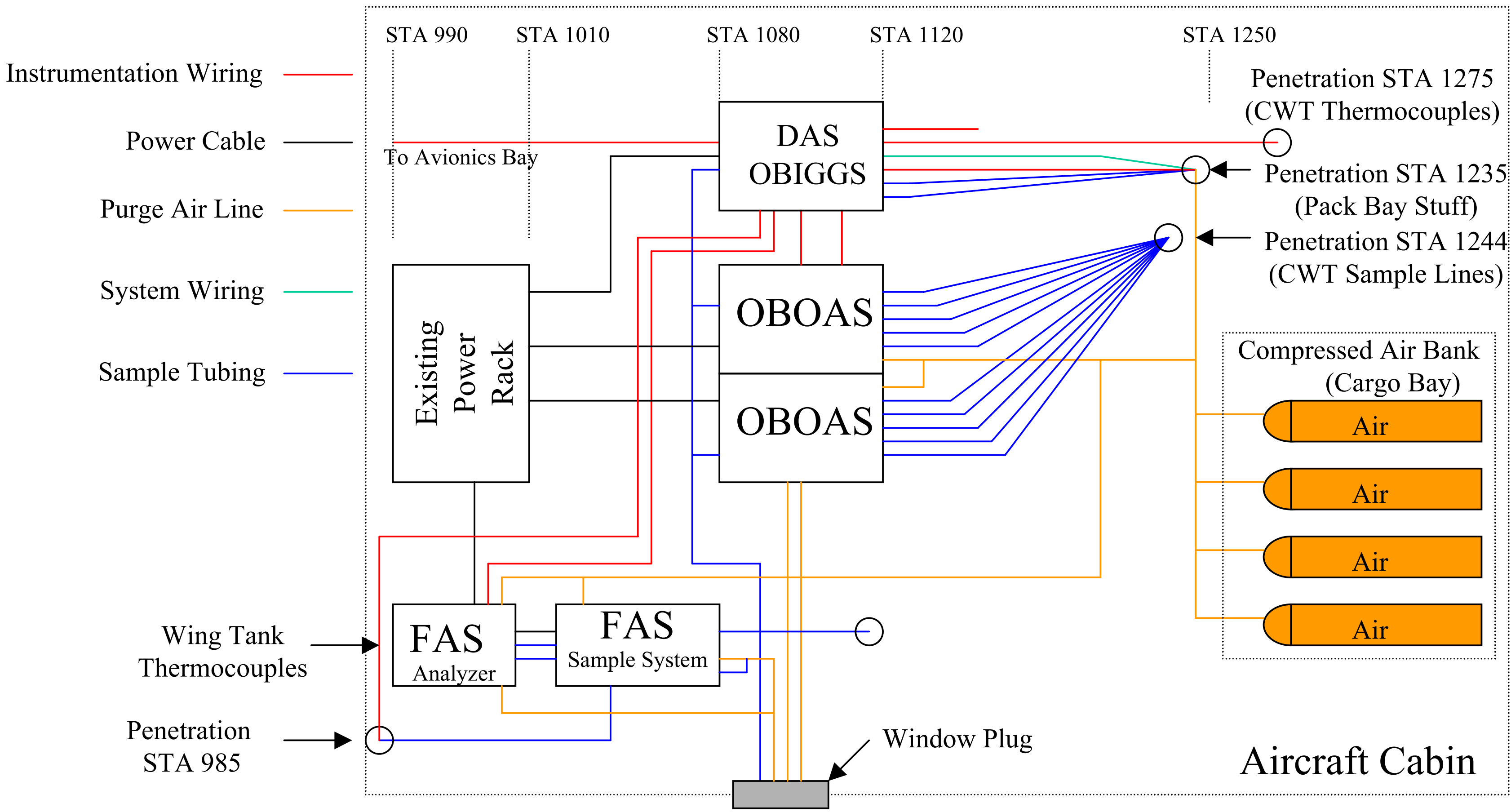
Cabin Instrumentation/Rack Diagram



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Cabin Instrumentation/Rack Diagram

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Test Plan

- Operated system in two flow mode for first test and in variable flow for remainder of testing
- Did a series of 7 flight tests ranging from 2 to 5 hours totaling approximately 30 hours of flight time
  - Validated the two-flow mode methodology and studied maximizing system flow during top of descent
  - Studied effect of CWT fuel on inerting and demonstrated the ability of a system to reduce the flammability exposure of an aircraft
  - Examined existing fleet flammability with baseline flammability testing

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Preliminary Data Measured

- System performance similar to airbus (per ASM) but with notable differences
  - Needed full heat exchanger capability on the ground to keep Asm inlet below 185 degrees F in low flow mode
  - Bleed air flow considerable less on a per ASM basis due to low cruise bleed pressures
- Inert gas distribution similar to previous models
  - Air entered the tank in a less distributed manner leading to a greater inequity of inert gas distribution after landing
- Fuel tank temperature magnitudes similar to previous ground tests
  - Did not cool off in flight as much as predicted

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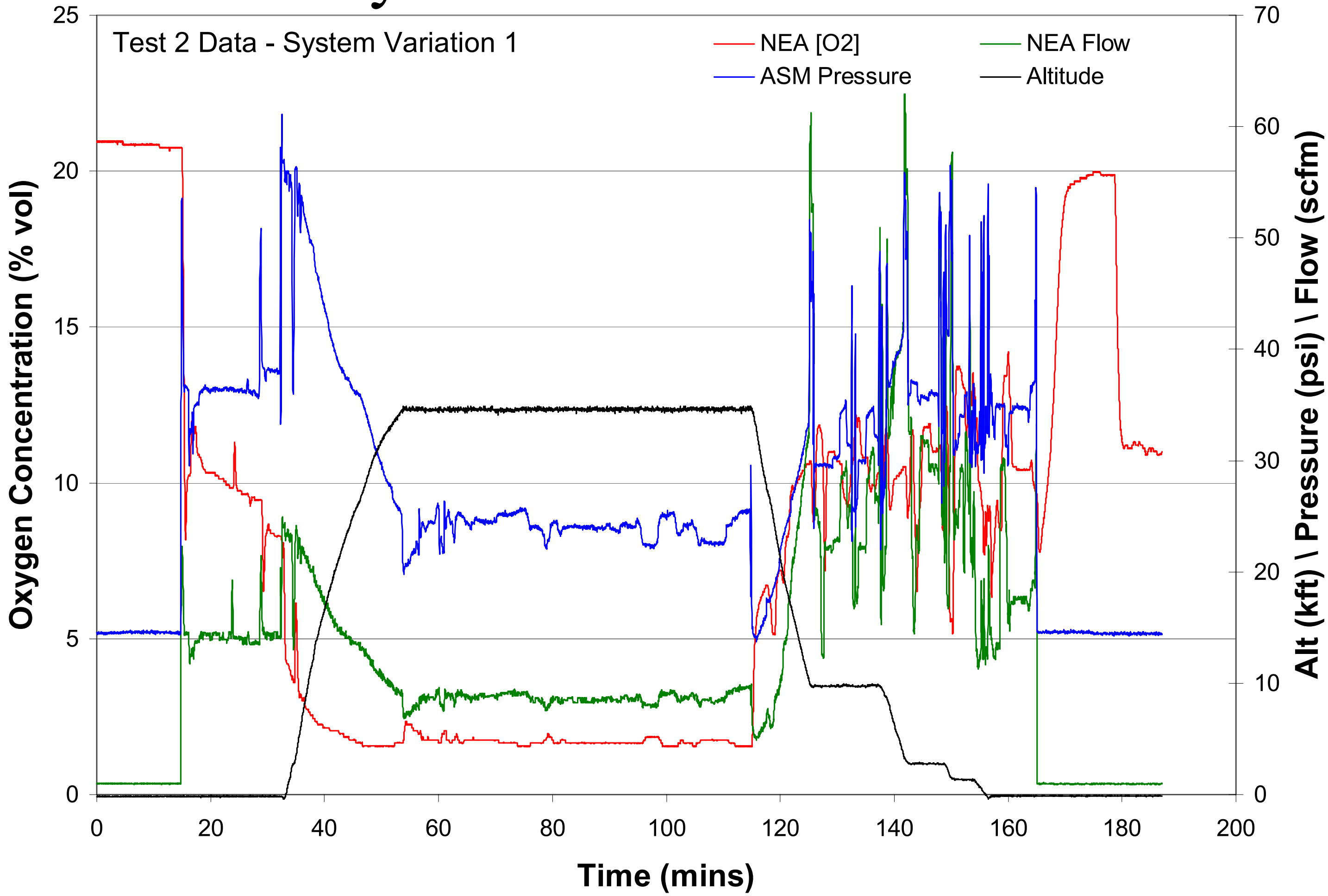
System Performance Data



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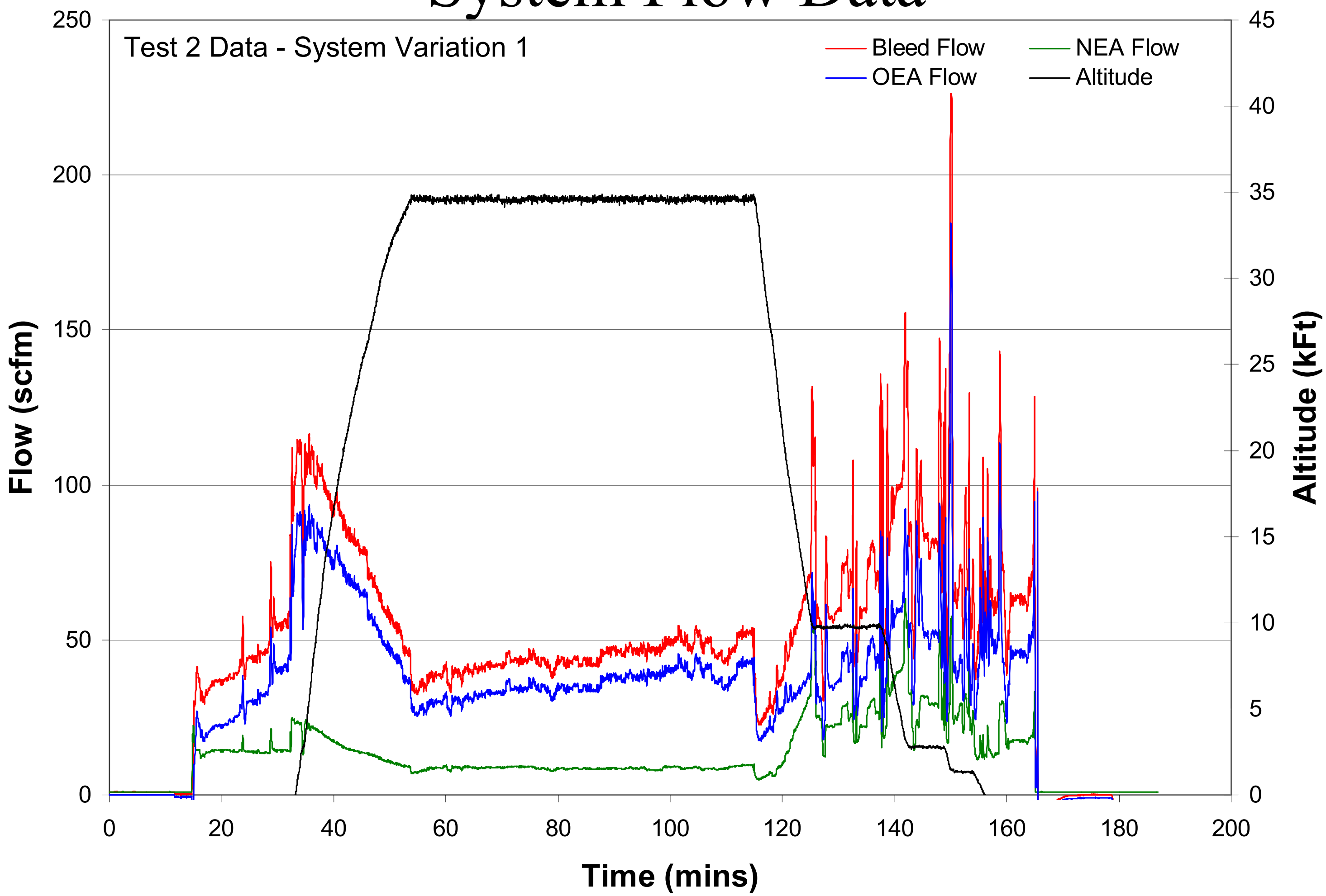
System Flow Data



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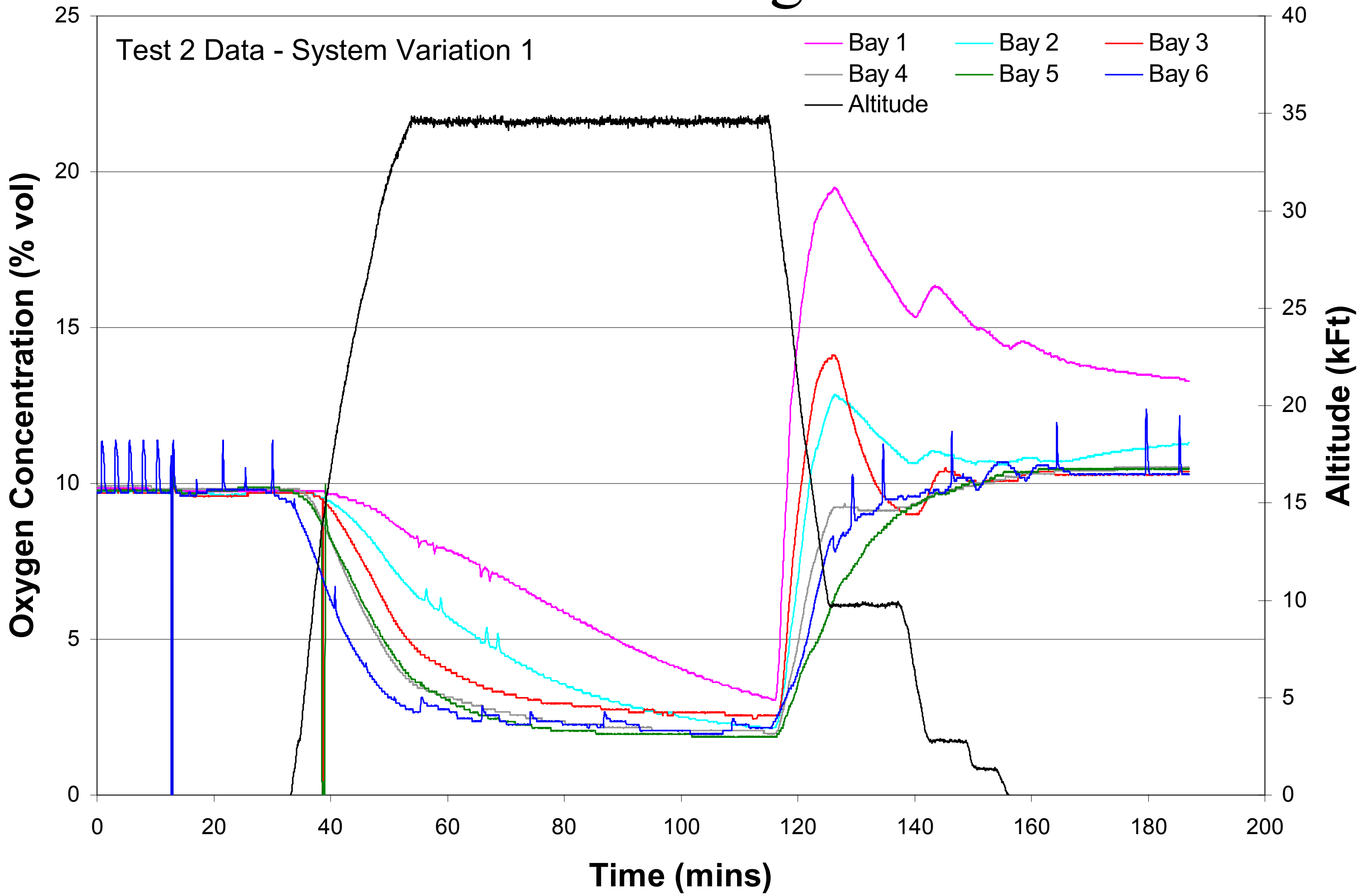
CWT Inerting Data



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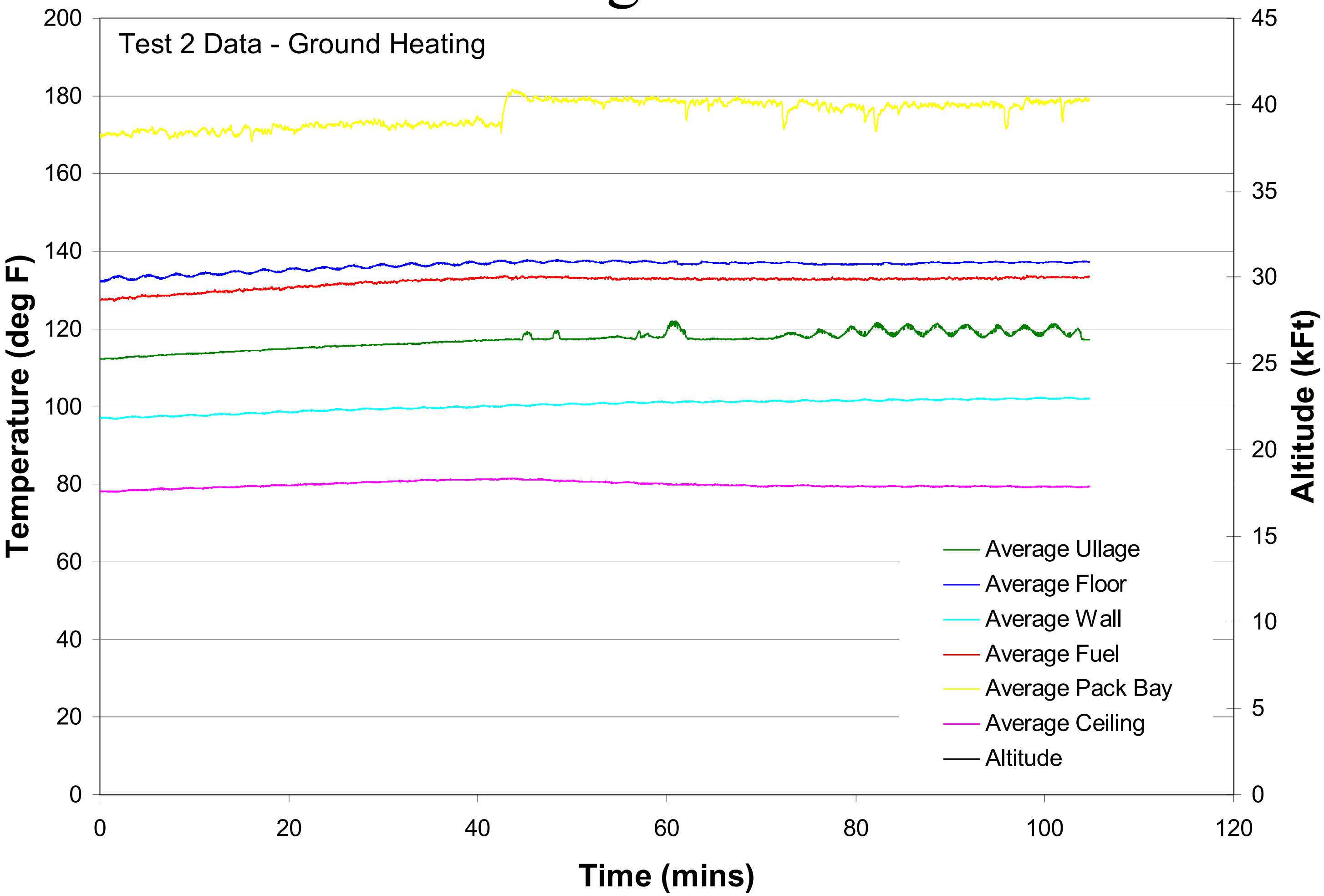
CWT Heating Data - Ground



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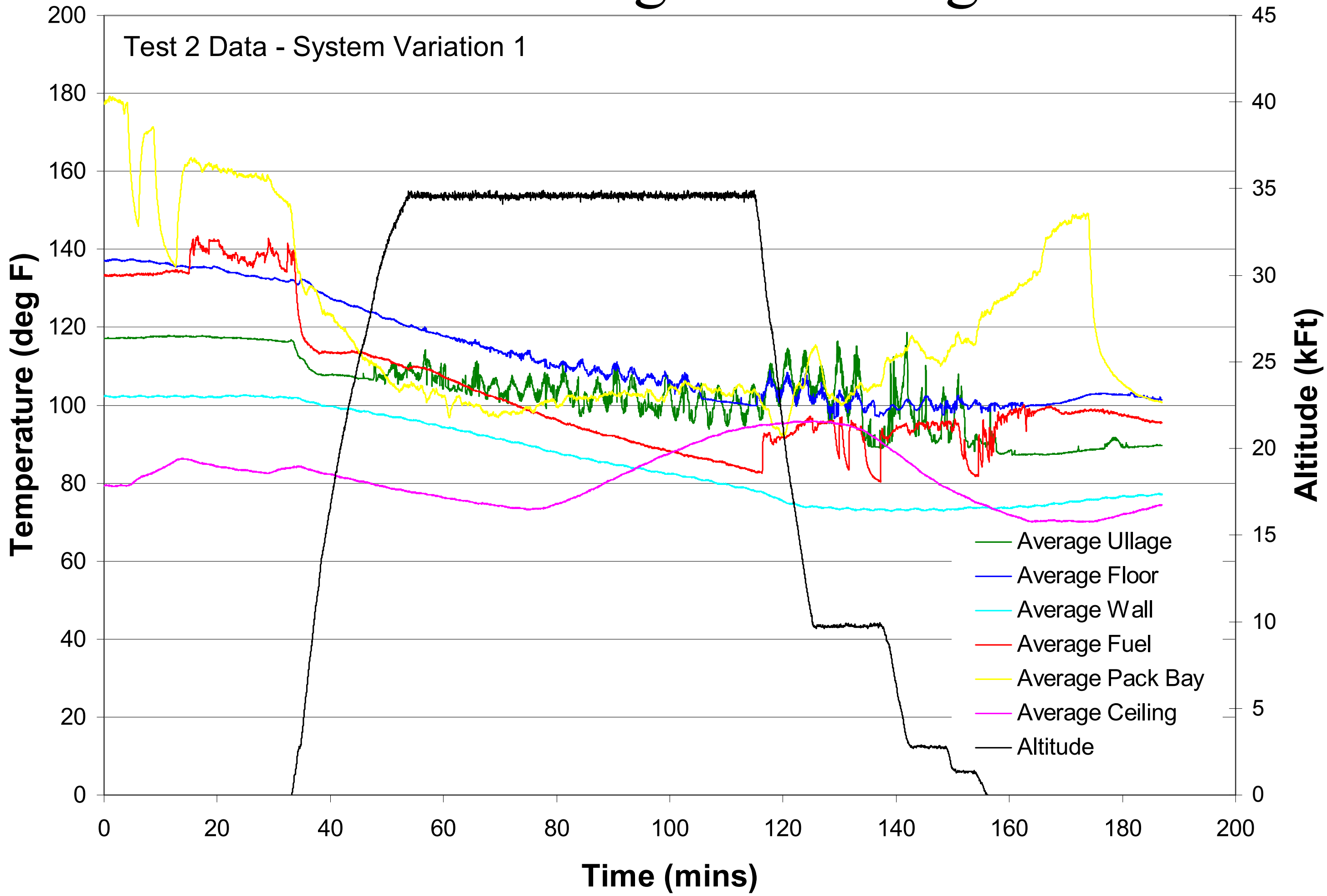
CWT Heating Data - Flight



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Status

- Completed testing of the FAA Simplified Inerting System and commercial transport fuel tank flammability study
  - Preliminary data reduction completed
  - Data analysis to continue
- Preliminary results illustrate validity of the FAA concept
  - Plan to use data to expand existing system performance models
  - Fuel tank heating trends very much as expected
- More work needed to study fuel tank flammability