Fuel Tank Ignition Experiments at Reduced Oxygen Concentrations

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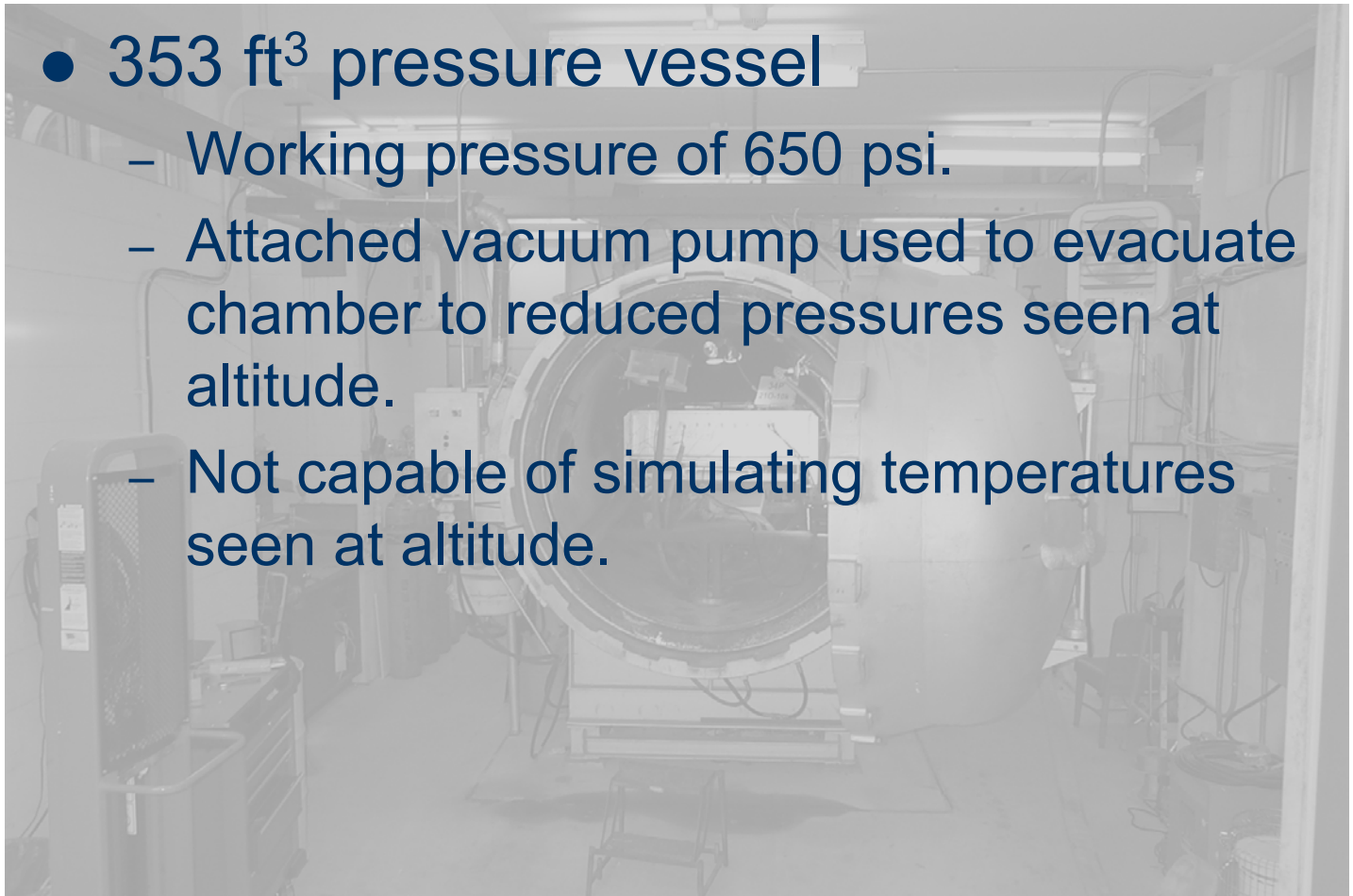
Objectives

- Determine the Lower Oxygen Concentration (LOC) at altitudes varying from 0 - 40 kft.
  - What is the O_2 concentration, below which ignition of the ullage fuel vapors will not occur?
  - How does this effect fuel tank inerting requirements?

Test Facility

Test Facility

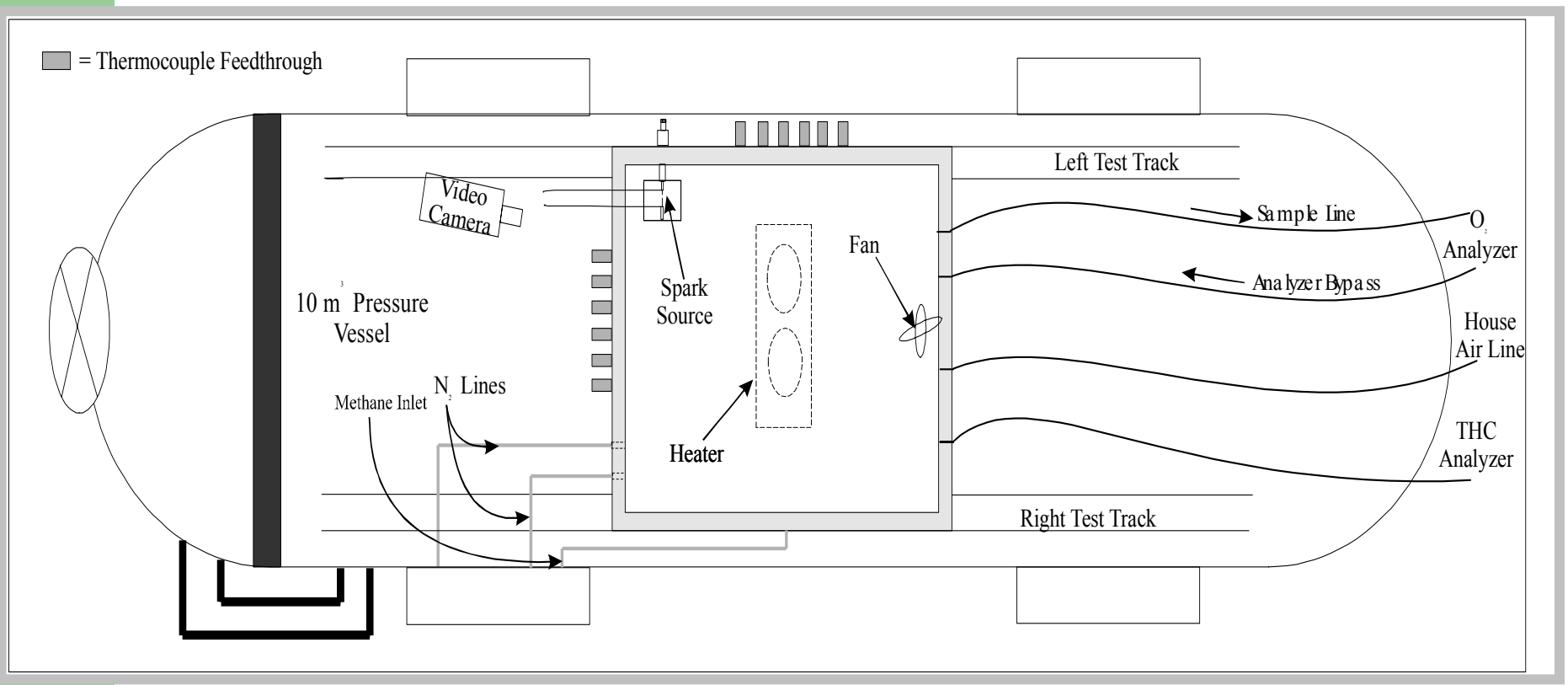


- 353 ft^3 pressure vessel
  - Working pressure of 650 psi.
  - Attached vacuum pump used to evacuate chamber to reduced pressures seen at altitude.
  - Not capable of simulating temperatures seen at altitude.

Test Facility

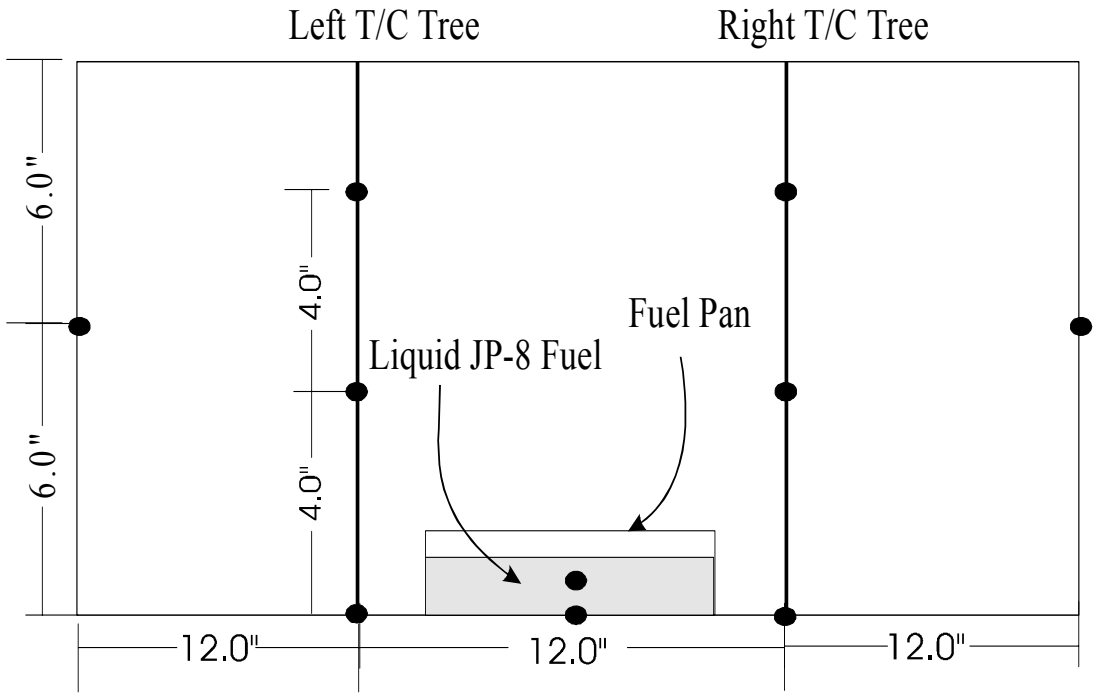
- 9 ft^3 simulated fuel tank placed inside of vessel equipped with:
  - Bottom surface heaters.
  - 12 thermocouples.
  - 2 piezoresistive pressure transducers mounted behind sintered porous metal discs.
  - Interchangeable pressure relief mechanism.
    - ¼-in. aluminum plate.
    - Foil diaphragm.
  - Ignition source.
    - 2 tungsten electrodes powered by 10 kV transformer.

Apparatus

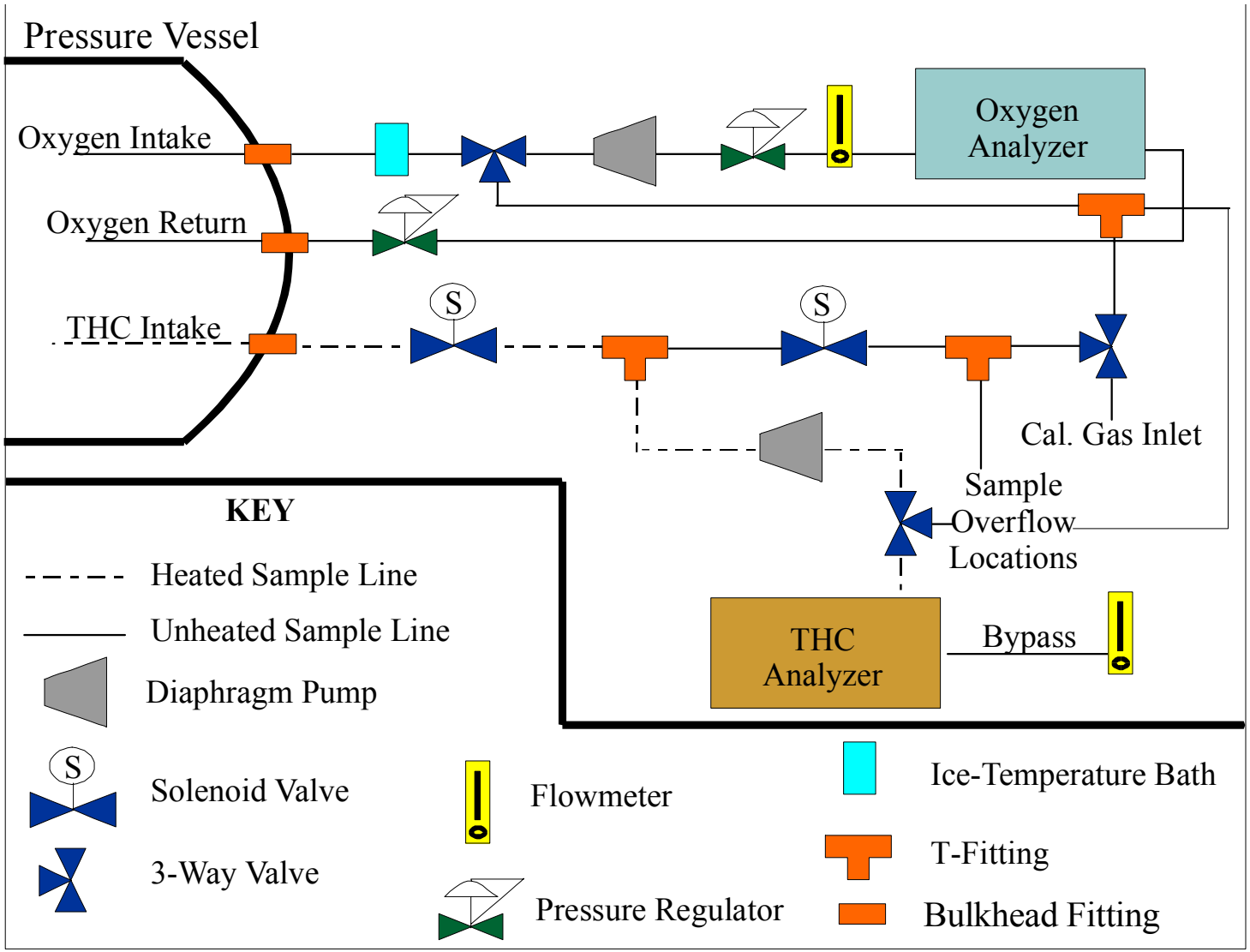

= Thermocouple Feedthrough
Video Camera
Left Test Track
Sample Line
O2 Analyzer
Analyzer Bypass
Fan
Spark Source
10 m3 Pressure Vessel
House Air Line
N2 Lines
Methane Inlet
Heater
THC Analyzer
Right Test Track

Apparatus

● = Thermocouple Bead



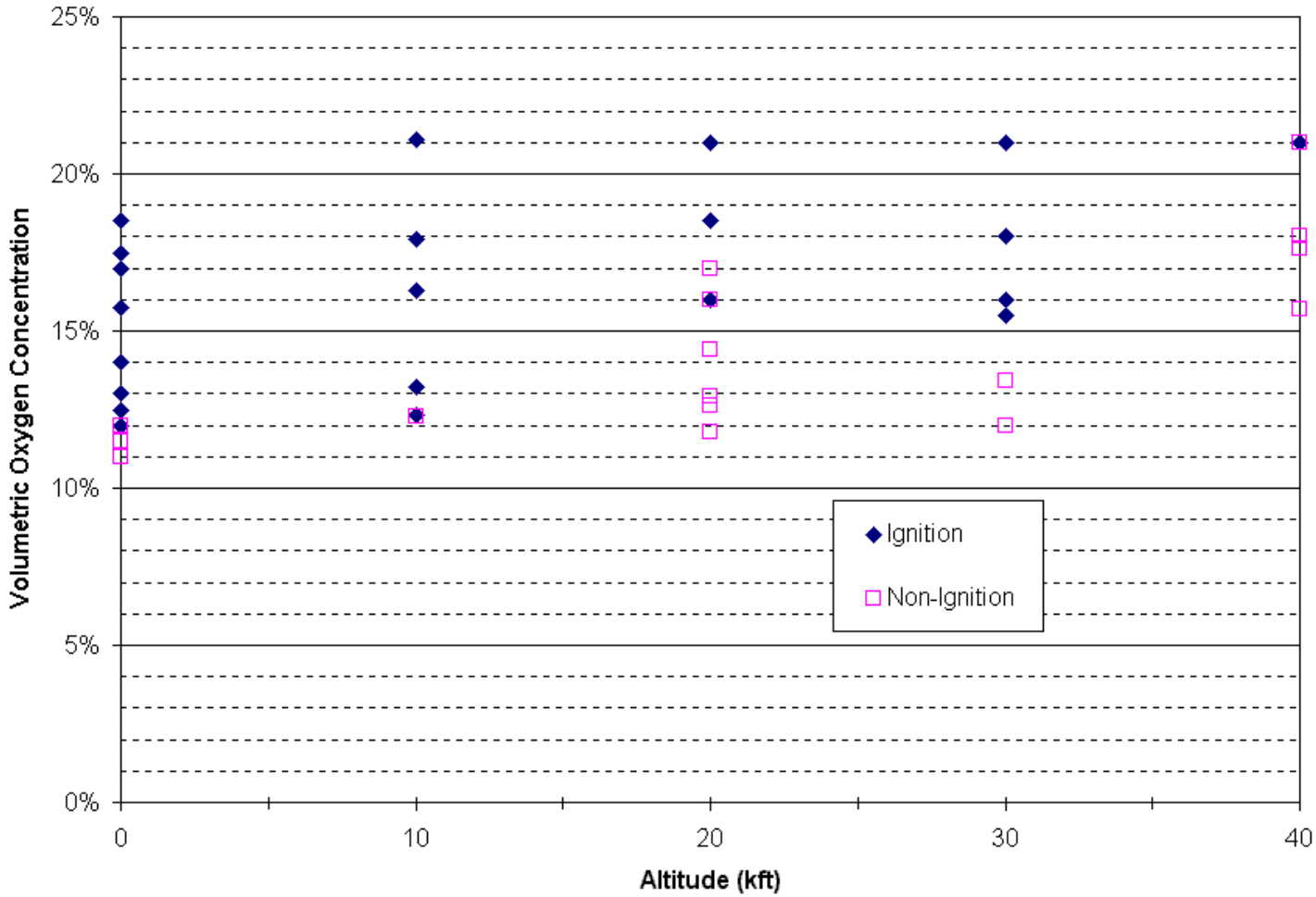
Ullage Vapor Sampling



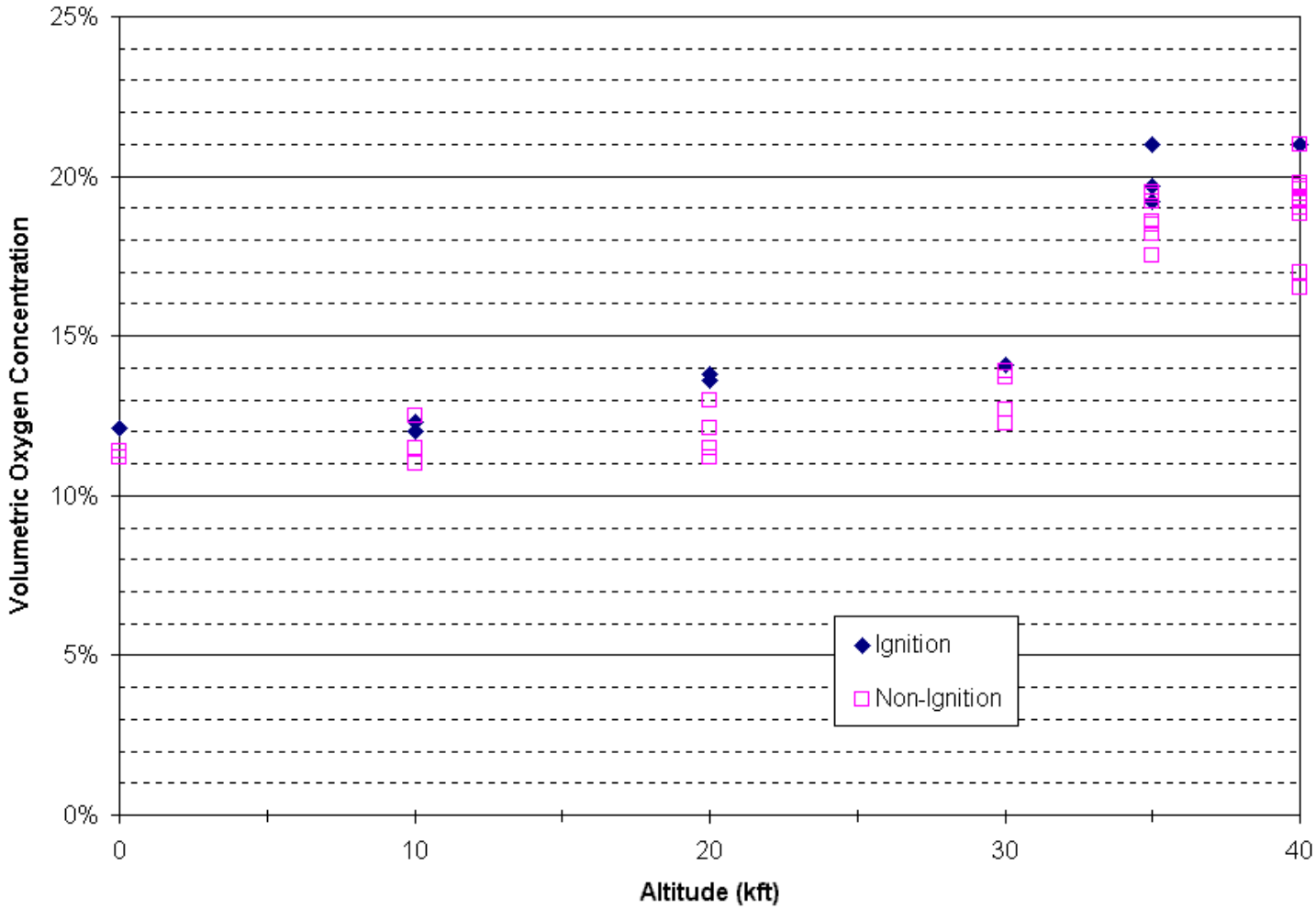
Test Program

- JP-8 LOC Tests
  - Determine ullage oxygen concentration needed to inert the fuel tank at altitudes of 0 - 40 kft.
  - Tests conducted with two different pressure relief mechanisms
    - ¼-in. aluminum plate
      - Ignition = movement of plate
    - Foil diaphragm
      - Ignition = rupture of foil
  - Piezoresistive pressure transducers used at O_2 values 1 – 1.5% above LOC.

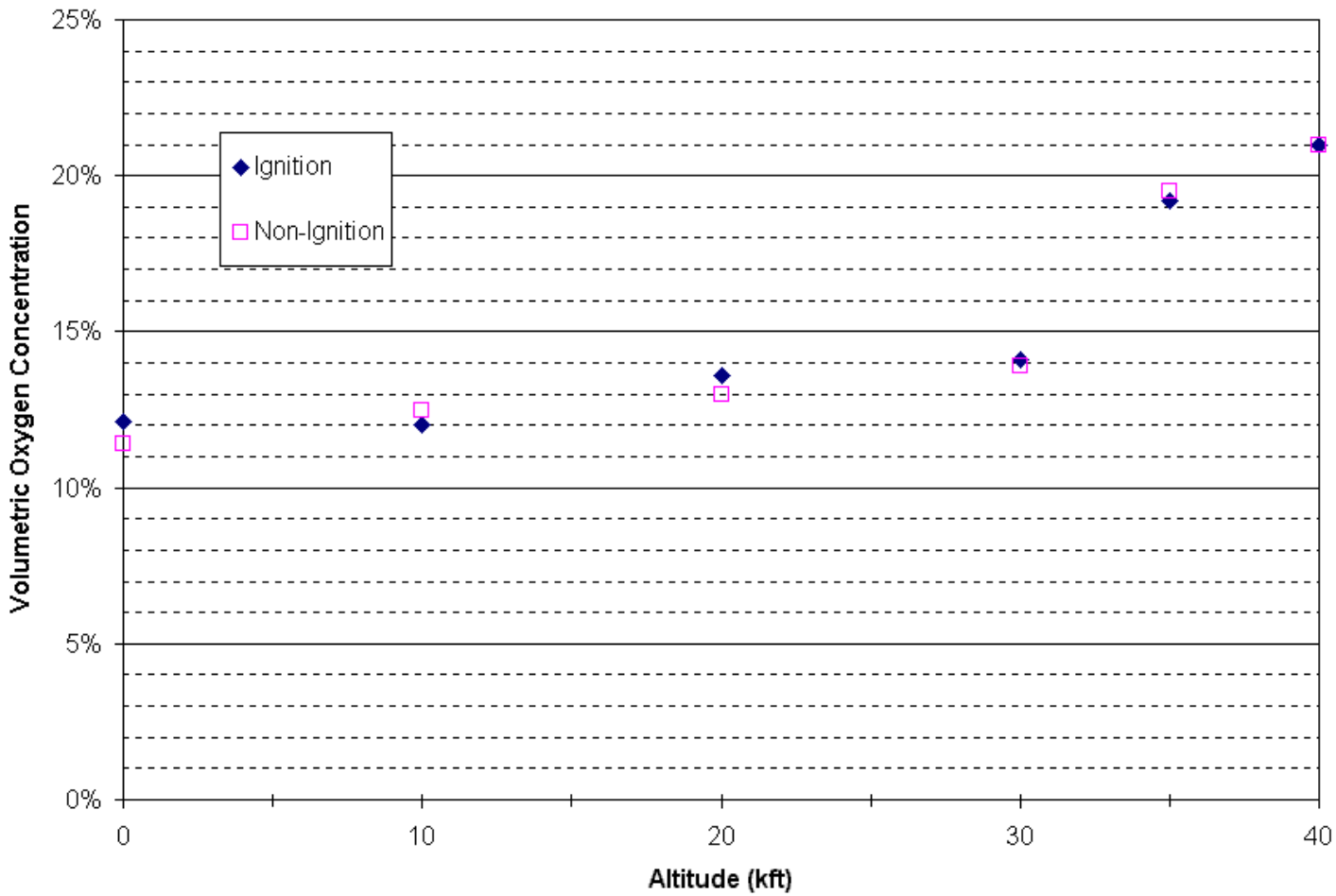
Results: *JP-8 LOC Tests (Al. Plate)*



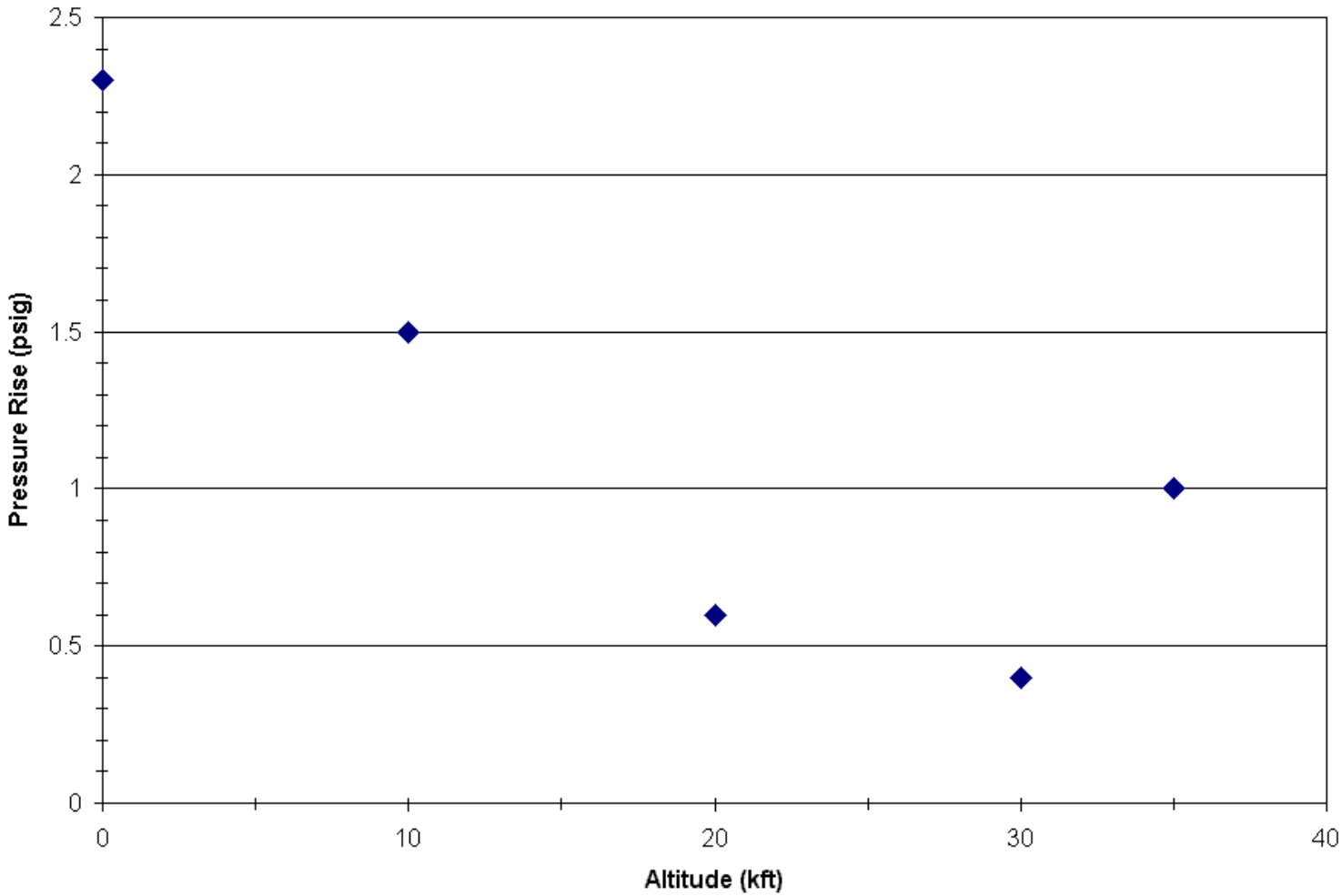
Results: *JP-8 LOC Tests (Foil Diaphragm)*



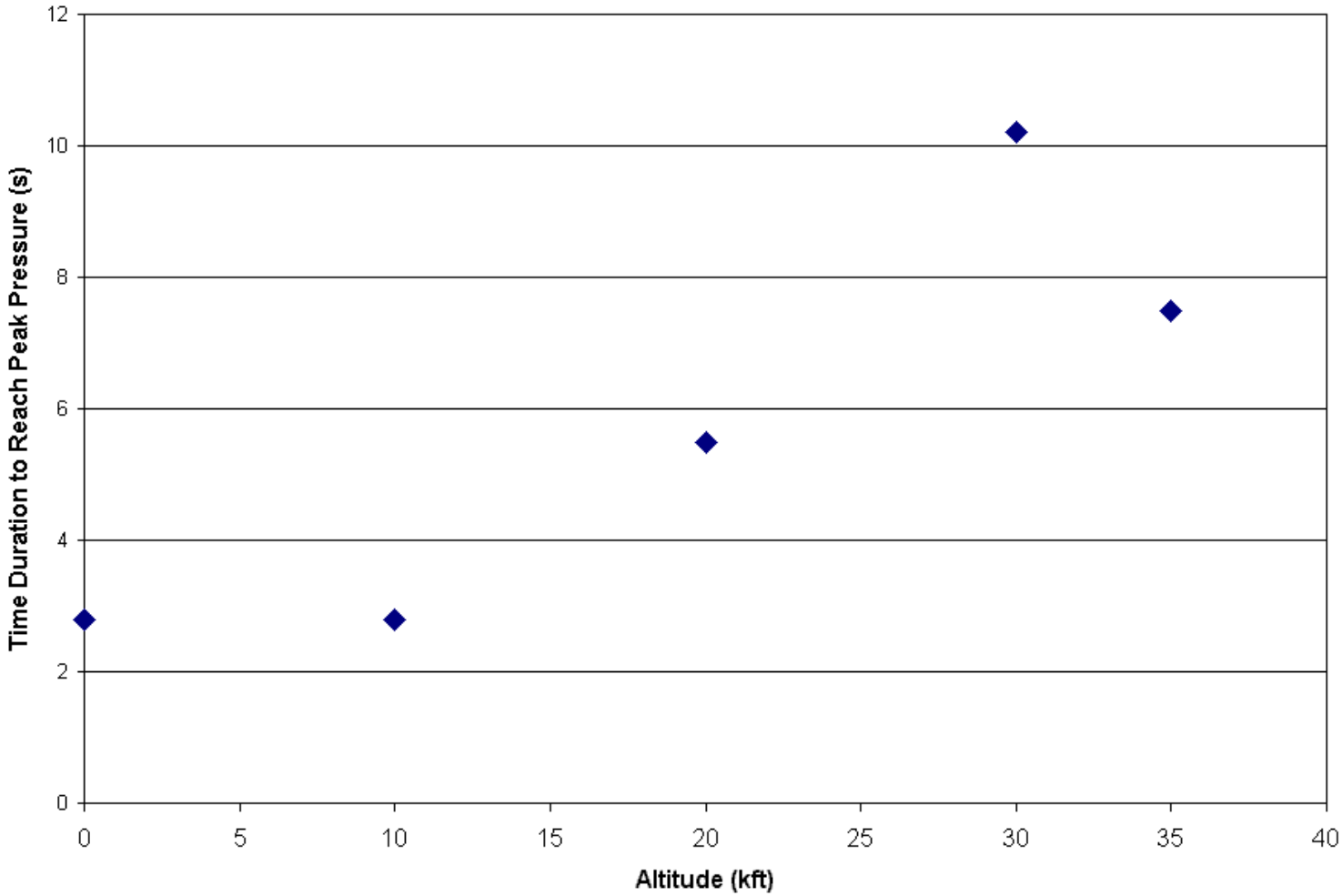
Results: *JP-8 LOC Tests (Foil Diaphragm)*



Results: *JP-8 LOC Tests (Pressure Data)*



Results: *JP-8 LOC Tests (Pressure Data)*



Summary

- LOC data ranges from 12% at 0 kft to 21% at 40 kft.
- LOC increases exponentially with increasing altitude.
- Peak pressure rise decreases exponentially with increasing altitude.
- Time duration of ignition increases. exponentially with increasing altitude.
- Final report to be published shortly.