A Test Program to Address Gas Entrainment in Side-branching Pipes from a Common Header at Arizona State University

Preliminary Testing Data to Demonstrate the Conservatisms Associated with WCAP 11916

Steve Swantner for An Utility

A Test Program to Address Gas Entrainment in Side-branching Pipes from a Common Header

- Test Program Objective
  - A test program was initiated at Arizona State University to assess the effect of gas transport in common suction headers with multiple branch lines.
  - The primary objective was to determine the amount of gas that would accumulate (hide out) along the top of the suction header and not be entrained into the respective HPSI, CS, or LPSI pump branch suction lines
  - The initial evaluation assumed hide out volumes based on the correlations established in WCAP 11916
  - The ASU tests were conducted to demonstrate that these correlations (for static conditions) were conservative for dynamic flow conditions in the common suction header (flow past the branch line)
  - Program results may be used to assess OPERABILITY only

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- Test Overview
  - A scaled flow loop (3:1) was constructed
  - Testing and selection of flow conditions based on Froude Number scaling
  - Flow rates for the respective branch lines were established by valve throttling in each line – total flow provided by a single centrifugal pump with variable speed controller
  - Test ranges based on plant operating conditions
  - Void fraction limited to 2% and was determined by time averaged impedance measurements
  - Critical submergence depth calculated based on measured arc length of void one pipe diameter upstream of the branch nozzle
  - Estimated uncertainty for critical submergence depth is approximately 0.5 inches – estimated uncertainty for flow is approximately 5%

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- Test Overview
  - Additional tests performed
    - Three branch line orientations (0^o, 45^o, 90^o from horizontal)
    - Three aspect ratios (0.250, 0.4375, 0.750)

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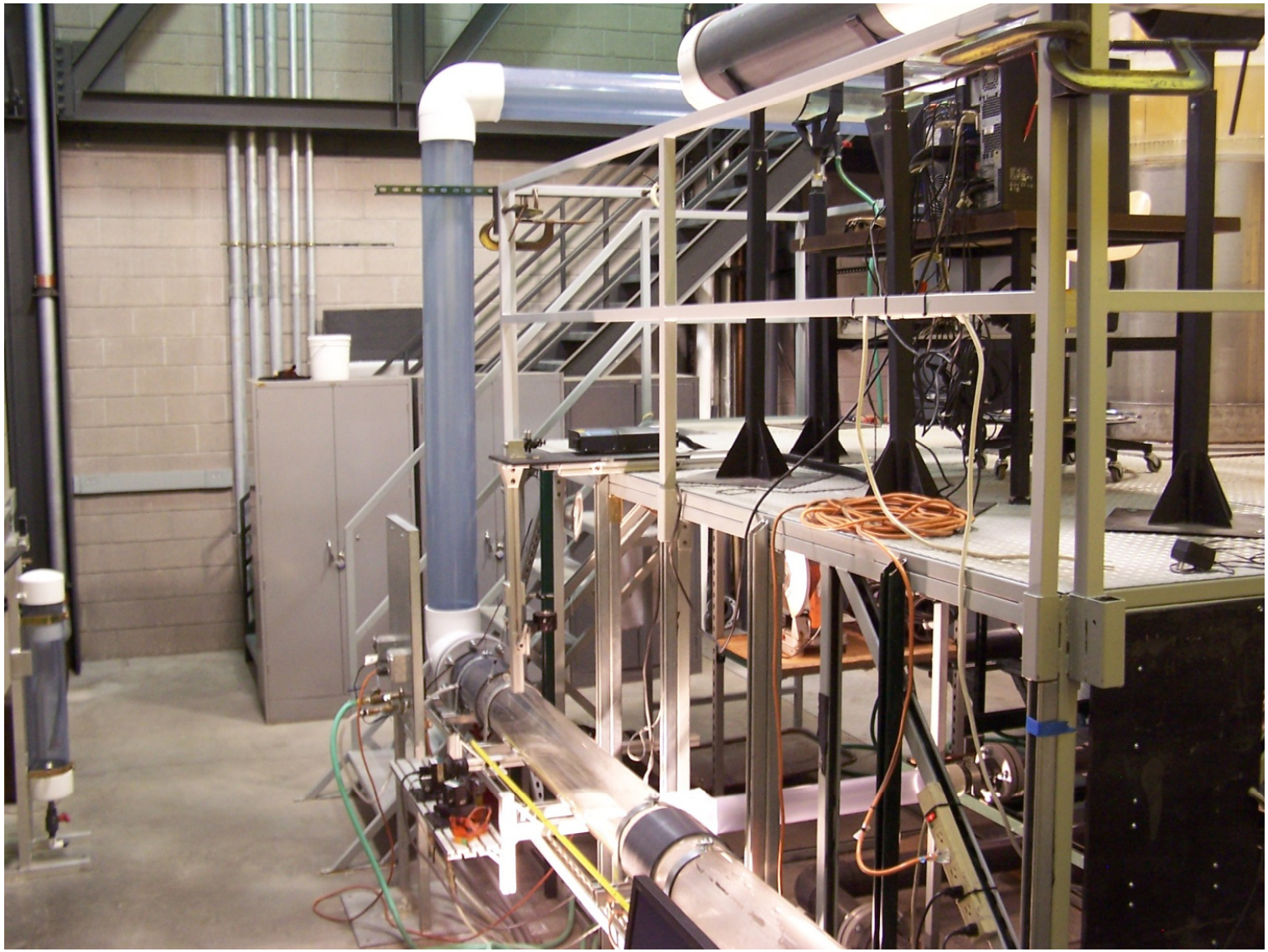

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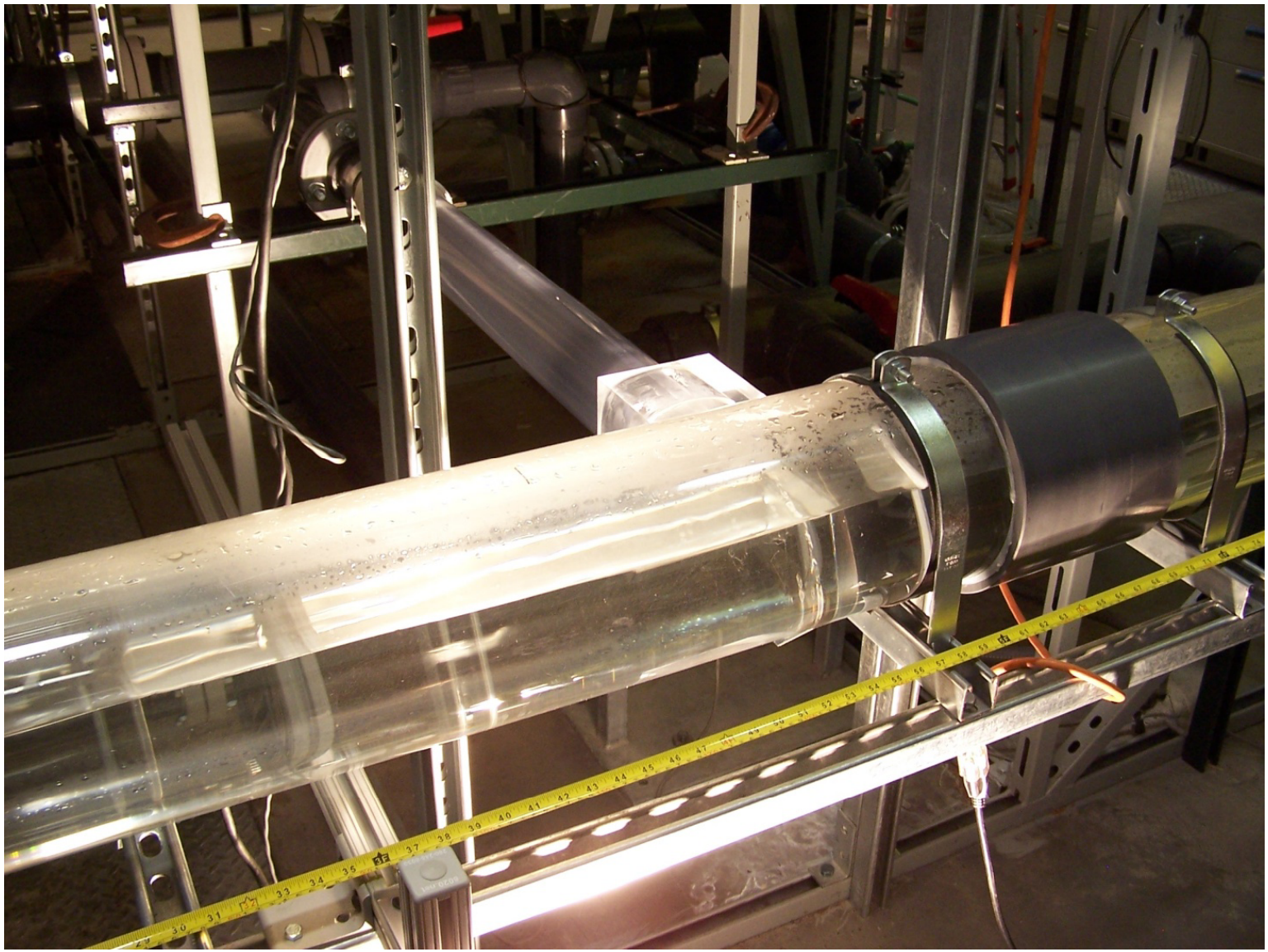

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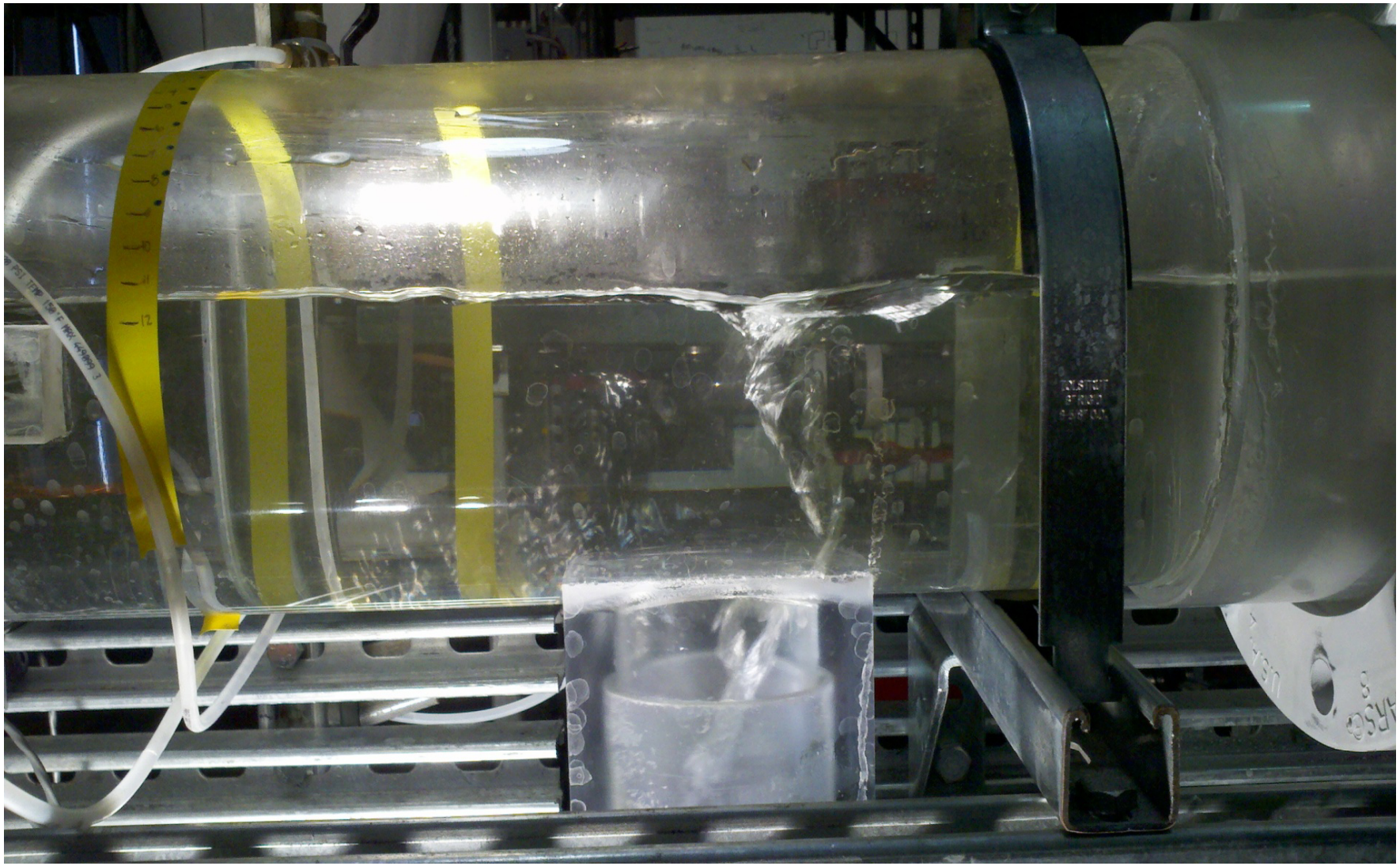

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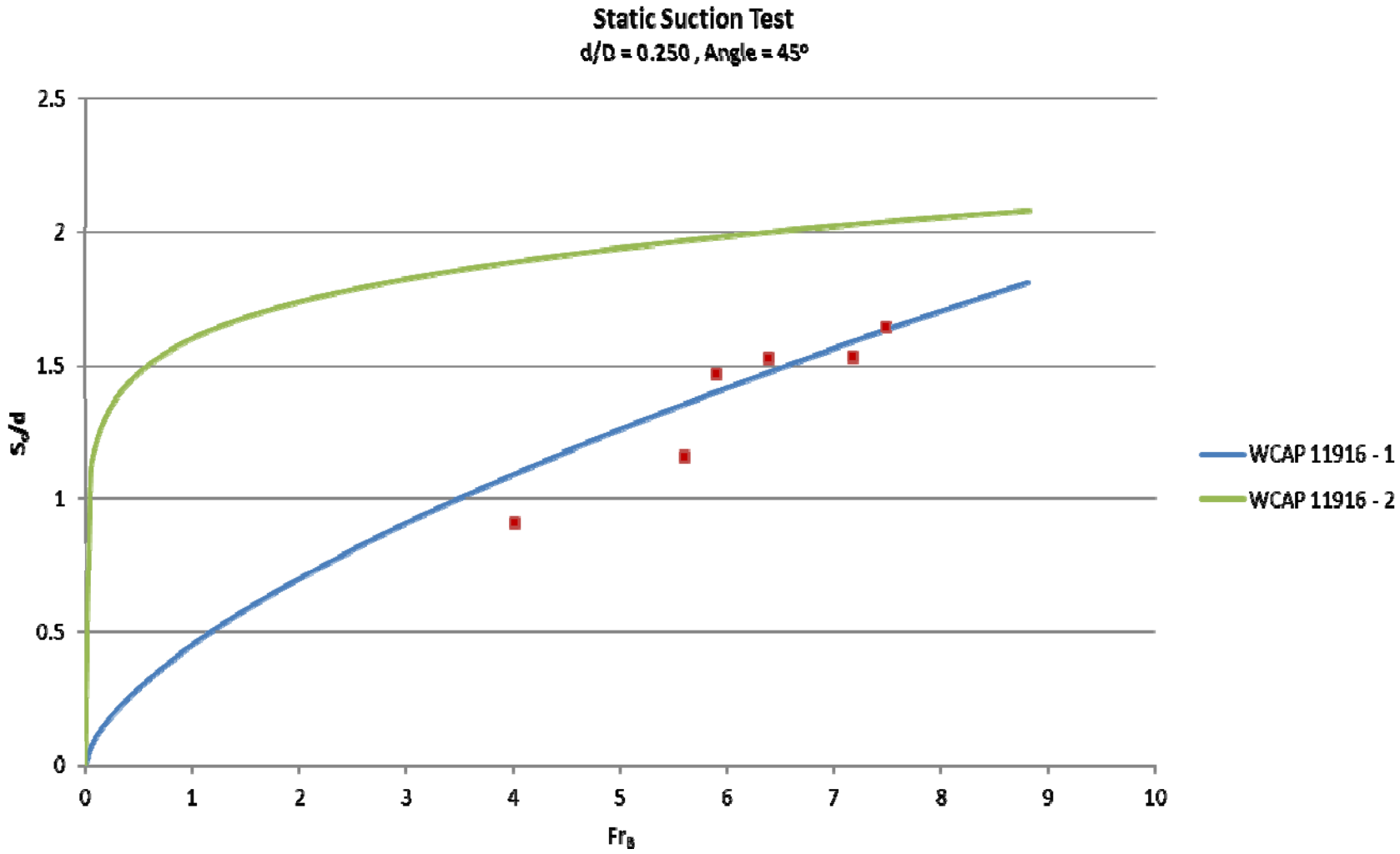

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- **Comments and Observations**
  - All results are preliminary and not verified
  - Allowing for differences in the aspect ratios established in WCAP 11916, these results suggest that the WCAP correlations are reasonable and conservative
  - Flow loop design resulted in various testing limitations
    - Few results for Fr less than 1.0
    - Aspect ratio 0.750 resulted in very small arc lengths and limited amounts of accumulated gas above branch – no data collected