Microreactor AGile Non-nuclear Experimental Test bed / Helium Component Test Facility (**MAGNET / He-CTF**)

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Functional Requirements

- Provide a general-purpose, non-nuclear test bed for prototype microreactor design evaluation
- Collect thermal-hydraulic performance data for prototypical geometries and operating conditions
  - Test article and flow loop temperature, pressure, and flow data for steady state and transient operations
  - Displacement and temperature data for design performance verification and accompanying analytical model validation (V&V)
- Enhance the technical readiness level of novel microreactor components, e.g., heat pipes or other passive heat removal technologies
- Identify, develop, and test advanced sensors for potential autonomous operation
- Evaluate interfaces between simulated microreactor components
- Demonstrate the application of advanced techniques, e.g., additive manufacturing and diffusion bonding, for microreactor applications
- Address knowledge gaps to support high-temperature reactor components and systems

Design Bases

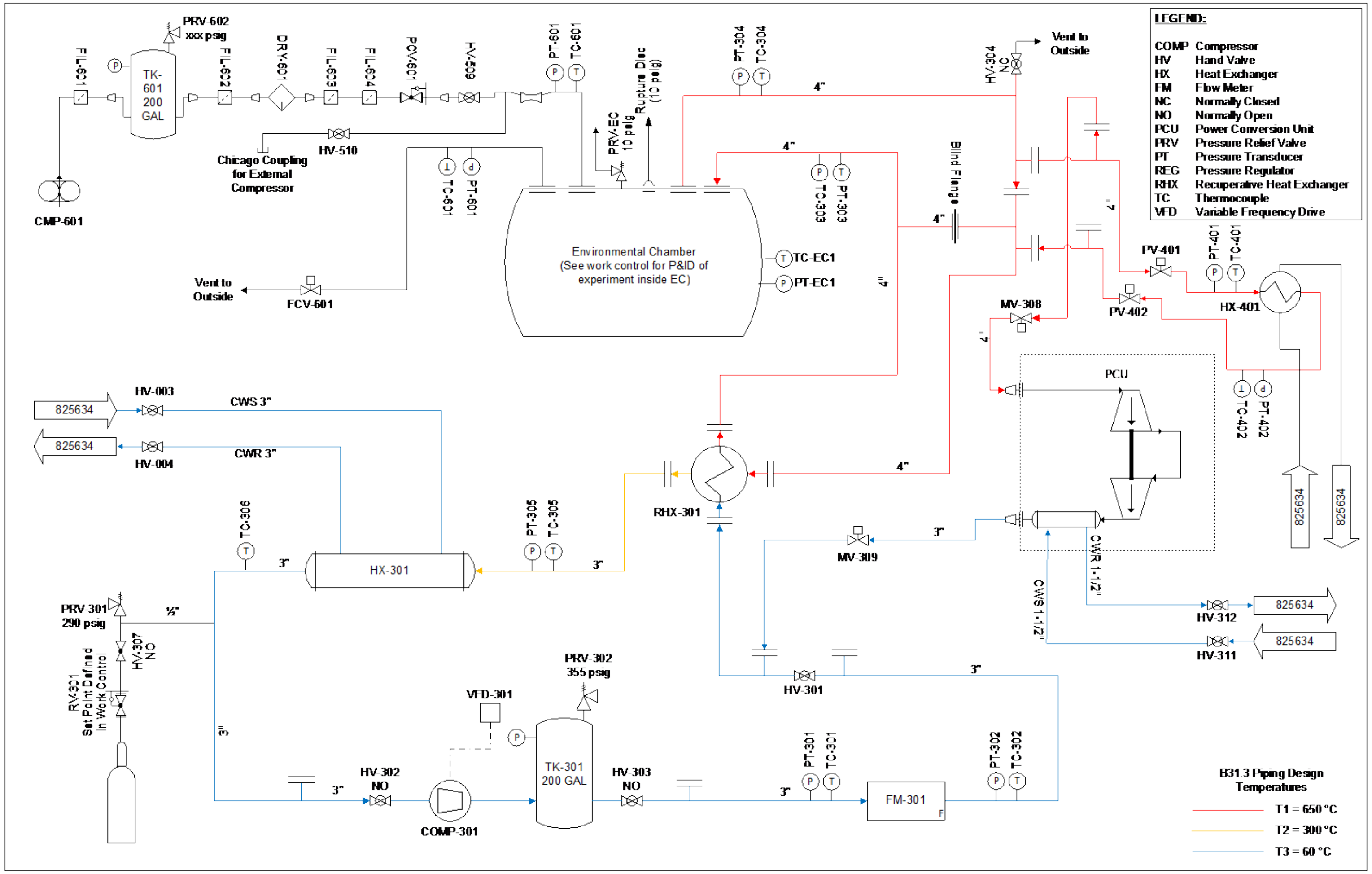
Typical Test Article Operating Parameters

- 600°C T_{OUT}
- 360°C T_{IN}
- 250 kW heat input
- 1.2 MPa
- 350°C air at 3 bar for shell side heat removal

General Design Bases

- Test article ≤ 750°C
- Piping designed to ASME B31.3 "Power Piping"
- Gases – He, N_2, compressed air
- 2.0 MPa maximum operating pressure
- Flexibility to integrate other systems or install additional compressor
- 2 x 80 kW process heaters

Flow Diagram



MAGNET / He-CTF Process Flow Diagram

MAGNET Control Station and Environmental Chamber

FY25 Milestones

- Complete construction to integrate Power Conversion Unit (PCU)
  - Carried over from FY24 (next slide discusses delays)
  - Currently scheduled to complete at the end of March
- Install and validate PCU Instrumentation and Control
  - Work awaiting some piping construction to complete
  - Scheduled to complete at the end of April
- Complete shakedown testing of PCU
  Scheduled to complete at the end of May
- Performance testing of LANL graphite core assembly
  Scheduled to complete at the end of August

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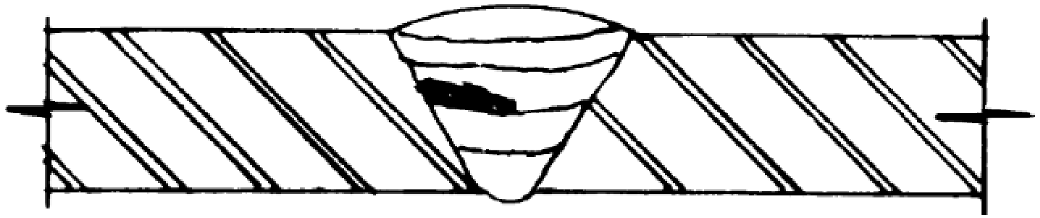
Power Conversion Unit (PCU) Integration

- All structural steel construction complete
- Electrical construction complete
- Piping construction beset by welding problems
  - Piping requires stainless steel alloys with ≥ 0.04% carbon content to meet B31.3 stress requirements for applications > 1000°F (538°C) (304H)
  - Elevated carbon content and potential impurities found in recycled stainless-steel alloys have the potential to cause welding issues
  - Piping material, subcontractor, and welder all common to initial MAGNET and He-CTF construction with no prior issues

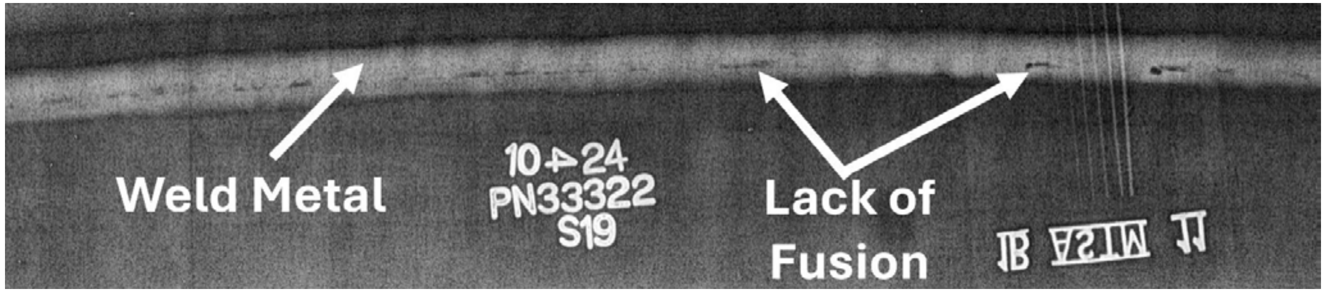
PCU Integration Welding Challenges

- Code of construction for PCU Integration (ASME B31.3) specifies that 5% of welds be volumetrically examined by either radiography (RT) or ultrasound (UT)
- A “progressive sampling” section in B31.3 drove us to examine 100% of welds in the job
- Original cost estimate was based on examining 5% of the welds
- Multiple INL resources were consulted to resolve weld issues
- Metallurgist destructively examined two failed welds to confirm UT and RT findings and attempt to discover a root cause—ultimately confirmed to be lack of fusion defects (next slide)
- INL welding Subject Matter Expert consulted with the subcontractor to identify weld parameter (cover gas flow, filler material specification, heat input) changes to correct the problem
- Lessons learned compiled to minimize impacts from potential recurrence of this issue in the future

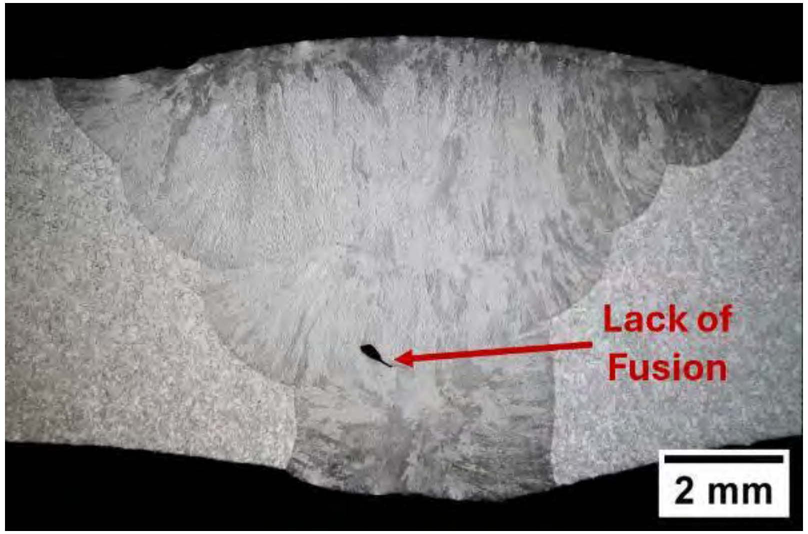
PCU Integration Welding Challenges



Example of Lack of Fusion Between Weld Passes (B31.3 §341.3.2)



X-Ray Image Showing Lack of Fusion Spanning the Length of a Weld Pass



Cross-Section Macrograph Showing Lack of Fusion in Early Weld Pass

Summary of Metallurgist and Weld SME Suggestions

- Increase heat input
- Feed filler metal more slowly
- Thoroughly clean welds between passes by grinding

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Conclusion

- PCU integration construction delayed but making progress (integrated effects testing capability supporting many microreactor developers planning on using Brayton cycles to generate electricity)
- Planning underway for testing LANL graphite core assembly

Questions?

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