The Innovation of I-Loop

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Andrew Kelsey Prince
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Idaho National Laboratory
Idaho Falls, Idaho 83415

http://www.inl.gov

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The Innovation of I-Loop
An Overview of Progress to Realize ATR’s Newest Test Facilities

Background
The closing and decommissioning of Halden Boiling Water Reactor in Norway resulted in the loss of many nuclear irradiation testing facilities, notably those providing boiling water reactor (BWR) environments. To lighten the loss of such an important asset, the Advanced Test Reactor (ATR) is being called upon. The recent overhaul of the ATR’s core and the installation of the new Top Head Closure Plate now makes it possible to utilize the ATR’s I-Loop locations for I-Loop Tube test facilities. Current efforts are underway to add new PWR and BWR I-Loop Tube facilities to the I-Loop positions.

I-Loop Tubes
I-Loop Tubes (ILTs) are pressure boundaries that can be inserted into the ATR’s outer ring of facility positions, its “I-loop”, allowing for radiation exposure while remaining separate of the core’s operating environment.

ILTs can operate at different:
• Pressures
• Temperatures
• Boron Concentrations
• Flow Rates
And more while reactor is operating

Coupled Flow
Boiling occurs along the path length of the test specimen. To ensure full exposure to the entire two-phase regime, the fluid flow in each test carriage is coupled together.

Ingenious Design
• Allows bending
• Upholds flow separation
• Small and integrated easily into flow path

Thermal Hydraulic Modeling
The expected boiling water environment within the ILT has never been operated in the ATR before. An in-depth thermal hydraulic analysis is being performed using RELAP5-3D to ensure safety, predict operating conditions along the fuel channel, and aid in design analysis.

RELAP5-3D can model:
• Two-Phase Flows
• Pressure Losses
• Heating Profiles
• Variable Flow Changes
And more!

Regulated Flow
As a means of “coarse gain” control, a flow regulator is attached to the end of the first carriage to create a pressure drop and slow coolant supply. This allows a curated environment similar to BWR operating conditions.

Conclusions
• Phasic changes and the new-to-ATR experiment demands encourage creative new ideas for facility design
• RELAP5-3D is heavily utilized to aid design and meet the requirements of the facility and safety
• Exciting expansion to the capabilities INL can provide to the nuclear community

Future Work
• Continue learning and developing a RELAP model for this test train
• Produce usable assessments of the I-Loop flow environment
• Complete my master’s thesis on this topic

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Andrew Prince
Oregon State University
Mentor: Nate Oldham
Org: C660

Oregon State University

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