INL/EXT-22-65735-Revision-0

Structural Materials Characterization Test Rig Development

January 2022

Malwina A Wilding, Michael D McMurtrey, Anthony L Crawford, Kory Manning, Hollis Kristopher Woodbury, Wesley Jones, Troy Unruh, Brian Jaques

Changing the World's Energy Future

INL is a U.S. Department of Energy National Laboratory operated by Battelle Energy Alliance, LLC

INL/EXT-22-65735-Revision-0

Structural Materials Characterization Test Rig Development

Malwina A Wilding, Michael D McMurtrey, Anthony L Crawford, Kory Manning, Hollis Kristopher Woodbury, Wesley Jones, Troy Unruh, Brian Jaques

January 2022

Idaho National Laboratory
Idaho Falls, Idaho 83415

http://www.inl.gov

Prepared for the
U.S. Department of Energy
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517

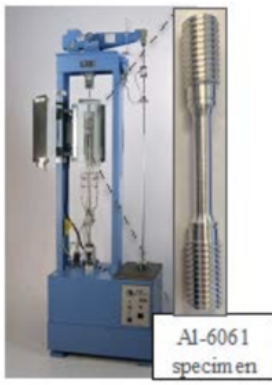
Development of a Test Rig for Structural Materials Characterization

PI: Malwina Wilding – Idaho National Laboratory
Collaborators: Michael McMurtrey, Anthony Crawford, Kory Manning, Hollis Woodbury, Wesley Jones, and Troy Unruh – Idaho National Laboratory
Brian Jaques – Boise State University

Project Description: The Structural Material Characterization work package focuses on research and development (R&D) activities to develop and deploy innovative sensors and sensor technologies in support of advanced reactors and fuel cycle development activities. Material and mechanical properties are critical for addressing safety concerns and the longevity of both current and future nuclear reactors. Real-time measurement of structural materials during irradiation is typically accomplished using a linear variable differential transformer (LVDT)-based creep test rig. This project will update and refine previously validated Halden-based technologies and methods for use in upcoming irradiation tests focused on creep under irradiation. Once the performance of the test rigs is characterized, these rigs will be ready for deployment in relevant irradiation tests that are of interest to stakeholders.

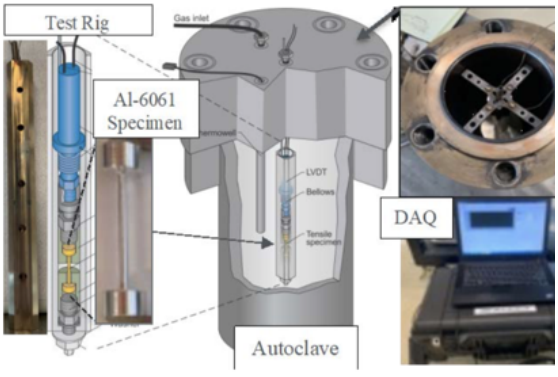
Impact and Value to Nuclear Applications: These strategies enable the U.S. Department of Energy (DOE) to establish core capabilities and respond to complex in-pile measurement objectives identified by different stakeholders and DOE Office of Nuclear Energy R&D programs, while also qualifying materials for both current and future nuclear energy systems.

Recent Results and Highlights: A better understanding of the capability to conduct in situ testing on irradiation creep will also improve our understanding of nuclear reactor structural materials. This will be achieved through comparative assessment of standard creep testing and out-of-pile creep testing, using aluminum samples. Additionally, an alternative method of measuring creep deformation will be investigated using a Double Delta testing device combined with high-temperature strain gauges. The Double Delta device employs two concentric opposing three-dimensional (3-D) motion delta platforms equipped with force/torque sensors to closely assimilate multi-physic (e.g., force, vibration, and thermal) 3-D reactor environments, while still remaining extremely controllable and accessible. Most measurement systems in this field (e.g., the Stewart platform configuration) are typically limited to one of these aspects, and lack the breadth to study interactive phenomena, especially when also being driven by representative 3-D motions/loadings.



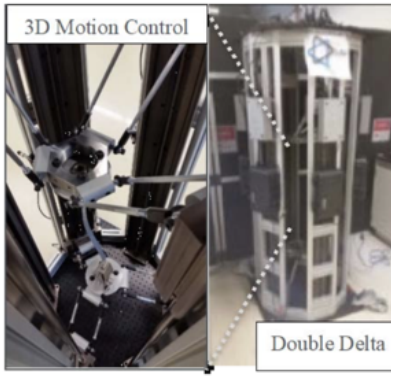
(a)

Standard Creep Testing.



(b)

Out-of-Pile Creep Testing Using Autoclave.



(c)

Double Delta.