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June 2021 Monthly Status Report for the Versatile Test Reactor Project

July 2021

Jordi Roglans Ribas

Changing the World's Energy Future

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FY2021 June Status

SOLVING ENERGY CHALLENGES THROUGH SCIENCE

Versatile Test Reactor

Project Highlights

Jordi Roglans-Ribas, Project Overview

VTR Executive Director Kemal Pasamehmetoglu participated in the Atlantic Council webinar "Fast Reactors, the Versatile Test Reactor, and Nuclear Safety and Nonproliferation." The webinar focused on the role of advanced nuclear energy systems for the purpose of reducing carbon from fossil fuels and supporting global clean energy growth, and the essential role of the Versatile Test Reactor (VTR) in supporting innovation in nuclear energy. It addressed issues related to safety and security by design, how the VTR can enhance those features in the next generation of nuclear technologies, and how advanced reactor systems can incorporate enhanced safety and safeguard features. The webinar opened with comments from Ambassador Thomas Graham, Jr., and panel participants included Ambassador Laura Holgate, Jackie Kempfer (Oklo), and Kenneth Luongo (Partnership for Global Security). The webinar was moderated by Dr. Jennifer Gordon (Atlantic Council Global Energy Center).

Additional outreach activities in June included George Malone presenting an overview of the VTR at the Exelon Lunch & Learn series, Kemal Pasamehmetoglu, Tom Fanning, and Kevan Weaver presenting at a Nuclear Regulatory Commission (NRC) Staff webinar, and a VTR panel held at the Annual American Nuclear Society (ANS) meeting highlighting the test mission of the reactor.

Department of Energy-Idaho (DOE-ID) Federal Project Director (FPD) Mark Arenaz retired after a 30-year career. Though Mark's expertise and leadership will be missed, VTR congratulates Mark on his retirement and welcomes the new acting FPD, Dave Herrin, to the team.

After extensive negotiations, Battelle Energy Alliance (BEA) and Bechtel National Incorporated (BNI) reached agreement on the terms and conditions for the blanket master contract for the design-build phase of the project. Next, BEA will prepare the full package and send it for approval to DOE. Full approval is anticipated by late August.

The Memorandum of Understanding (MOU) between VTR and NATRIUM was signed in late June. Discussions on how to implement potential synergies have started between the two projects. Initial focus will be in possible sharing of component/system testing needs and test plans.

The VTR team prepared multiple papers on the VTR project providing a description of the conceptual design, ranging from the core design to the plant and experiment designs, to safety basis, analysis and validation, and the use of digital engineering. The papers are intended for a dedicated volume in the Nuclear Science and Engineering (NS&E) journal. Over 20 papers have been submitted for review.

Finally, the Experiments Integration team held their annual Integration meeting, bringing together representatives from University partner organizations to provide a status update. Detailed information will be provided later in this report.

Nuclear Design

A milestone summarizing progress on probabilistic risk assessment (PRA) external hazard and all-modes analyses and necessary next steps for both activities is on schedule to be completed the end of July. The deliverable contains an overview of assessments performed by GE-Hitachi Nuclear Energy Americas, LLC (GEH) and Laboratory partners.

Preliminary analysis of previously irradiated U-20Pu-10Zr-0.2Ga metallic fuel show that gallium appears to segregate with zirconium into intermetallic particles. No evidence was found of gallium segregation near the cladding.

A prototype casting furnace and glovebox are being procured and design efforts are under way. Continued requirements and design activities for additional fuel fabrication components.

Completed design of the Reduced-Scale Hydraulic Inlet Plenum (REDSHIP), with current efforts focusing on generating for-build engineering drawings, procurement of equipment and instrumentation, and laboratory space preparations. REDSHIP is a separate effects test facility for generating experimental data on hydraulic behaviors within the VTR inlet plenum.

A new electromagnetic pump (EMP) model continues to be developed and has been extended to allow for dynamic time step control and restart functionality. Steady-state and zero transients have been successfully performed using the simple and detailed models.

VTR Plant Engineering

Completed two Plant Design milestones in June. The first milestone, *Update 005N1076: Overall VTR Plant Requirements*, will facilitate transition to a data-centric requirements management system prior to the start of preliminary design and will finalize the VTR Stakeholder Requirements. Successfully and fully transitioned from document-based requirements to a data-driven format in the DOORS Next Generation (DNG) requirements management tool. Future progress in requirements will not necessarily be reflected in a document revision but will be a living document digitally stored in DNG. A document may always be printed for review or objective evidence as needed.

A second milestone, *Complete VTR Time Motion Study*, was also completed. Conducted a time-motion study of the VTR refueling and experiment replacement processes to determine if the current conceptual design of the refueling systems supported conducting refueling outages within a 20-day window. The study evaluated replacement of 16-core assemblies (fuel), three Normal Test Assemblies holding material tests (NTA-M), five Dismountable Test Assembly inserts (DTA_i), and one Extended Length Test Assembly (ELTA). An additional goal of the study was to identify any necessary design changes that could pose a risk to the VTR Project schedule and cost.

The study concluded that if VTR outage staff worked 24 hours per day, 7 days per week, movement of the sixteen core assemblies and nominal experiment load would take 15.6 days. The sixteen core assemblies took just over eight days. Design recommendations were identified that could improve performance based on apparent bottlenecks in the refueling process. Recommendations include consideration of a spent fuel storage area,

installation of a second overhead crane, and increasing the number of wash vessels. The potential benefits in time were estimated and will be considered in future optioneering studies to be conducted in FY2022 to understand the cost-benefit relationship.

VTR Experiments

The annual VTR Experiments Integration meeting was held on June 8-9, fulfilling the Level 2 milestone. Over 100 participants registered, and the average engagement included more than 70-80 individuals. Each team presented their progress and future work, with discussions following each team's presentation. Particularly noteworthy was the design progress for each of the cartridge loops (ELTA-CL's), the rabbit (RTA), and the dismountable test assembly (DTA). In addition, each experiments team has begun close engagement with the engineering and plant design teams to development interface requirements, which will support the advancement of the VTR design.

Upcoming Events

NURETH-19, 19th International Meeting on Nuclear Reactor Thermal Hydraulics, March 2022, Brussels, Belgium.

IAEA International Conference on Fast Reactors and Related Fuel Cycles (FR22), April 2022, China

Social Media

Versatile Test Reactor @VTRnuclear @VersatileTestReactor Versatile Test Reactor

versatiletestreactor

Technical Highlights

George Malone, Reactor Technical Integration

GE-Hitachi Nuclear Energy Americas, LLC (GEH)/Bechtel National Incorporated (BNI) Design Engineering Support

Continued work on VTR risk reduction efforts. Notable work includes:

- Completed Plant Design Spec (005N1436) Revision H.
- Completed the Technology Maturation Plan (TMP) for B11 Reactor Module Revision C, addressing the Critical Technology Elements (CTE) related to stress analysis, specifically the effects of non-B11 components such as EMPs, Intermediate Heat Exchangers (IHXs), and core assemblies on the primary stresses of B11 components are considered in the preliminary analysis.
- Continued advancement of the EMP TMP by developing and issuing the VTR Electromagnetic Pump Insulation Test Plan, which provides a detailed test plan for characterizing the high-temperature electrical insulating properties of the Silicone Bonded Mica Hardboard (SBMHB) material. Initiated a strategy document for coupling EMP physics with the Ansys Software Suite. The goal of this work is to improve the simulation accuracy of the EMP performance and support the testing necessary to advance the EMP from low to higher Technology Readiness Level (TRL).
- Continued preparation of the Geotechnical Properties Summary report and Site Input Parameters for Conceptual Design Soil-Structure Interaction Analysis of VTR.

Argonne National Laboratory (ANL)

Continued to finalize driver fuel drawings, started initial review of core shield assembly drawings, and created a tool listing all dimensions and tolerances for each drawing. The list documents the design decision for each (i.e., Engineering Calculation/Analysis Report (ECAR)-4072 requirement, Technical Evaluation (TEV)-3727 requirement, reference drawing from a previous design, general engineering decision, etc.

Fast Flux Test Facility (FFTF) Documentation and Data Recovery

Completed recovery of the FFTF and Clinch River Breeder Reactor (CRBR) thermal striping documents and uploaded to the VTR Confluence Site. The document collection comprises 27 FFTF documents and 35 CRBR documents, which encompasses all knowledge about thermal striping during the design of the FFTF and the CRBR.

Completed retrieval of the FFTF Final Safety Analysis Report (FSAR) Appendices dealing with fuel removal, fuel cleaning, and washing, and the Engineering Change Notices (ECNs) containing these Appendices have been retrieved and placed onto the VTR Confluence Site. The Appendices are informative for the VTR fuel transfer activity and applicable to the corresponding fuel unloading and fuel washing activities.

Located information pertaining to the radionuclide content of the systems and components in the FFTF during deactivation. The information is included in radiological surveys and estimates performed at that time.

Information on the radionuclide content of the Cold Traps and Cesium Traps is part of this survey. This information has been retrieved and is proceeding through Export Control and Information Release. As soon as it clears, it will be placed onto the VTR Confluence Site. Operational information regarding the ease or difficulty of accessing the Cesium Traps during deactivation will also be provided in the summary management report.

Received a Design Information Request (DIR) related to information on the Control Rod Drive Mechanisms (CRDMs) used in the FFTF. The DIR requests drawings, Operating and Maintenance Manuals (OMMs), design specifications, and Environmental Life Testing Reports, nearly all of which have been converted into electronic format. Over 200 Royal Industries' drawings on the CRDMs have also been located. Royal Industries designed and manufactured the CRDMs used in the FFTF. It is not known if these drawings are electronic or hard copies; if they are hard copies, they will be converted into electronic format.

Received a second DIR requesting information on the FFTF Dump Heat Exchangers (DHXs). The DIR requests drawings, OMMs, design specifications, and design and test reports. Nearly all documents requested have been located and are being retrieved and converted into electronic format. To efficiently sort through more than 2,300 drawings, a hierarchical search process was developed starting with top drawings and proceeding toward lower tier drawings.

Retrieved and placed onto the VTR Confluence Site design drawings for the FFTF Materials Open Test Assembly (MOTA). These drawings are intended to be used as a starting point to design the Extended Length Test Assembly for the MOTA (ELTA-M). The drawings, consisting of 35 sheets, have been combined with a Test Design Description for the MOTA which will explain and facilitate their use.

VTR Control Rod Mechanical Design Analysis

ANL and Pacific Northwest National Laboratory (PNNL) discussed the possibility of using an analytical benchmark to resolve any uncertainties in the design of an absorber bundle for a control rod. PNNL will produce the first draft of the benchmark, ANL will review the draft and provide comments, then PNNL will reconcile and incorporate into a final benchmark. This benchmark will be used by ANL and PNNL to resolve any uncertainties in the absorber bundle design.

Thomas Fanning, Nuclear Technical Integration

Fuel Design and Analysis

Completed Scanning Electron Microscopy (SEM) examination of a sample from an Experimental Breeder Reactor-II (EBR-II) X521 fuel rod with U-20Pu-10Zr-0.2Ga composition. Preliminary results indicate that early in fuel lifetime, Ga appears to co-segregate with zirconium to form small particles evenly distributed through the fuel cross section, with no evident segregation of Ga near the cladding. This is a promising confirmation of expected behavior.

Completed heating of U-Pu-Zr-Ga/HT9 diffusion couples at 550°C and 600°C and sample preparation is underway for SEM examination. Continued evaluation of BISON for VTR fuel application, with focus on reporting benchmark status to date and issue of a report on VTR fuel analysis code requirements.

Fuel Manufacturing

Completed the prototype casting furnace and associated glovebox procurement and design efforts began. Visited the vendor's facility to coordinate kick-off efforts on the glovebox and to follow up on progress for the multi-mission Pu glovebox, also planned to be utilized for the VTR project. The multi-mission glovebox is ahead of the prototype, which will lead to efficiencies for the VTR prototype glovebox development.

The brusher and crusher are equipment pieces being developed to support the casting operations. Design packages for these pieces are nearing final drafting phases and have been submitted for export control reviews in preparation for prototype fabrication bidding. The development team met with fabrication specialists to determine the optimal path forward for fabrication.

The functional and operational requirements (F&OR) document for the pin/rod quality glovebox is 90% complete. Completed the rod loading equipment models and a report has been drafted to document the conceptual design. Completed a F&OR document for sodium bonding equipment which leverages TerraPower's experience to provide specific requirements that will need to be met to obtain proper settling of the pins into the sodium.

The University of Idaho completed a piece of equipment for mechanical bend testing which is now operational and ready for testing.

Continued maturing process models. Running scenarios to determine staffing requirements, space, critical movements, scrap generation, and facility requirements.

Core Design

The Reduced-Scale Hydraulic Inlet Plenum (REDSHIP) experiment is the latest thermal hydraulic (TH) experiment designed at ANL. REDSHIP is a separate effects test facility for generating experimental data about hydraulic behaviors within the VTR inlet plenum, including fuel receptacles and restrictive flow orificing schemes, that will drive cooling capability throughout the primary heat transport system of VTR. The inlet plenum of REDSHIP represents a 60° wedge of the full VTR inlet plenum (62 assembly channels) with a single inlet stream at a 1:4 reduced length scale, shown in Figure 1.

Within the inlet plenum are a set of 62 fuel receptacles at that same 1:4 scale. These receptacles are designed such that they can be exchanged as the VTR receptacle design evolves. Likewise, the flow into any given channel can be restricted, as to mimic the prototypic flow distribution across the VTR core and various core assemblies.

Designed REDSHIP to match the Reynolds numbers of sodium flows expected in the full-scale inlet plenum and in the assembly channels using water as surrogate fluid. Performed scaling analyses using computational fluid dynamics (CFD) to confirm the validity of this approach (described in the April 2021 Monthly Report). To achieve representative flow conditions, two parallel 50 hp pumps drive flow rates of 80 kg/s total through the loop. Each channel is instrumented to provide data on temperature, pressure, and flow rate.

Also being measured are the pressure drops across each row of the inlet plenum receptacle bank. These data will be used in the validation of CFD assessments of plenum behavior. Completed the design of REDSHIP with current efforts focusing on generating for-build engineering drawings, procurement of equipment and instrumentation, and laboratory space preparations. Construction is expected to begin by early FY22, with preliminary data becoming available by mid-year.

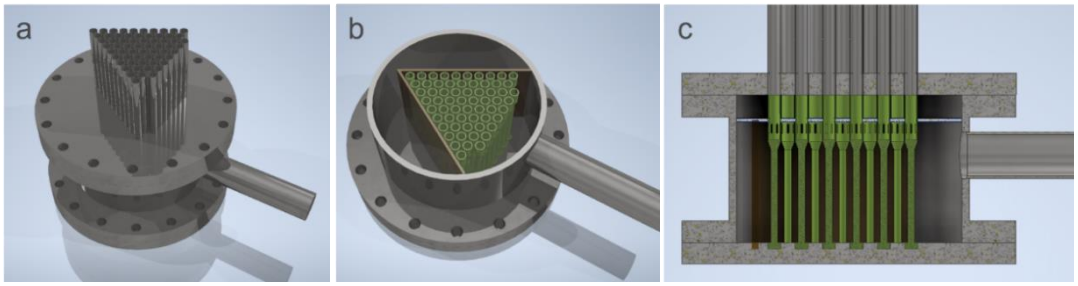

Figure 1: CAD schematics of the REDSHIP inlet plenum: a) exterior b) top-down cross section of test volume, c) side cross-section through wedge and inlet.

Transient Safety Analysis

Continued model development, confirmatory analysis, and software verification and validation activities as planned. A Level 3 milestone to document the EMP model is on track for completion in September.

Safety Analysis

The new EMP model continues to be developed and has been extended to allow for dynamic time step control and restart functionality. Successfully performed steady-state and zero transients using both the simple and detailed pump models. Submitted a conference paper documenting the development of the equivalent circuit model for EMP simulations to the NURETH-19 conference.

Pending availability of the new EMP model, an assessment is being performed to determine how long power needs to be provided to the primary pumps while they are coasting down. The assessment will inform the determination of total energy and coping time requirements for the backup power supply.

Performed confirmatory calculations with the TRACE code for comparison with the reference SAS results. Completed analysis of selected transients. Comparisons focused initially on the power and reactivity feedback predictions. Subsequent comparisons will target the protected transients, with specific attention on decay heat, natural circulation flow, and long-term temperature and heat rejection predictions.

Completed the initial SAS/CFD coupled simulations for a protected loss of flow transient. Results are going through post-processing and will be included in a NURETH-19 paper.

SAS Verification and Validation (V&V)

Submitted the Thermal Model V&V report for review. The report contains the verification work for the control rod drive line and the radial core expansion models. Continued verification of the SAS/CFD coupling interface. The files used to transfer the information between the two codes has been confirmed to be within the set tolerances. Time step synchronization is currently being verified.

MCTF validation continues. Review of the discrepancies of the thermal ramp up are being examined. Heat losses to the environment were modeled using the component-to-component heat transfer model. These calculations

confirmed that losses to the environment have little impact on the system heat-up rate. Additional sources of discrepancy are under review.

Work scope and schedule for FY22 SAS V&V activities are being developed. These will be incorporated into the estimates for the overall safety analysis schedule.

Safety Basis

Resolved comments for the Ex-vessel dose consequence ECAR that incorporates the VTR waste streams. Completed a draft of the Natural Phenomena Hazard (NPH) categorization for the VTR facility and started initial reviews of the document. Continued working with digital engineering to integrate the Safety Structure, System, and Component (SSC) classification list with DNG which supports the milestone deliverable. Reviewed the GEH document deliverables, specifically the mechanical document sets to help support reactor and facility design.

Sodium Fire Hazard Analysis and Software V&V

Continued making improvements in sodium fire modeling software to address inconsistencies and redundancies that were identified for constants, sodium properties, and other functions within source code. Developed reference cases and automated tests to identify differences in outputs from the updated version of the software compared to previous versions.

Participated in the Design and Analysis Integration Alignment Meeting II with GEH/BNI by providing an overview of the status of VTR sodium fire analysis efforts.

Probabilistic Risk Assessment (PRA)

The M3 deliverable summarizing progress on PRA external hazard and all-modes analyses and outlines necessary next steps for both activities is on schedule. The deliverable contains an overview of assessments performed by the GEH and lab teams.

Continued processing the VTR PRA model and associated files into the new PRA repository. The repository was modified to allow greater flexibility in approval chains to align with quality assurance (QA) requirements and reduce the scope and frequency of audits.

Continued validation of the Simplified Radionuclide Transport (SRT) source term analysis code, with a focus on validation of the aerosol transport model. Compared model results to a series of experiments investigating sodium aerosol behavior. The results will be formally documented in an upcoming SRT software quality assurance (SQA) report.

Kevan Weaver, Experiments Technical Integration

Selected key accomplishments within the four experiment vehicle types and support areas are included below. All partners provided input to and participated in the annual VTR Experiments Integration meeting held June 8 and 9.

ELTA – Sodium Cartridge Loop Development
Technical Lead: Mitch Farmer, ANL
Partners: University of Wisconsin (UW), Purdue, Framatome

Two major accomplishments in June were:

- Provided input to and participated in, the annual VTR Experiments Integration meeting. Feedback from efforts in the sodium fast reactor (SFR) cartridge loop development area were positive.
- All team members contributed to a draft article for the NS&E journal on development of a sodium cartridge loop testing capability for VTR. The paper was completed and is being reviewed by VTR management prior to submitting to the journal.
- University of Wisconsin
  - In collaboration with Framatome, completed development of a pre-conceptual design for an in-cartridge sodium purification system that will use a hot trapping method and a vanadium wire technique for monitoring average impurity levels in the cartridge sodium coolant.
  - Developing an experiment design to test the cartridge purification system prototype in existing sodium loop at UW.
- Purdue
  - Compared CFD results against scaling analyses focused on preserving hydrodynamic and thermal similitude between the SFR cartridge prototype and planned experiments, and the CFD results have confirmed the scaling. Completed papers for the NURETH-19 conference on scaling and CFD calculations.
  - Performed CFD simulation of steady state natural circulation condition under pump coast down. Planned simulations of other off-normal boundary conditions.
  - Completed assembly on the test loop and shakedown testing is underway for the hydrodynamic similarity experiments.
- Framatome:
  - Continued design evolution of the SFR cartridge, including integration of the sodium purification and monitoring system developed in collaboration with UW.
  - Worked to develop a CARLITA input file for the current cartridge design to support steady state and transient modeling of the cartridge performance under both normal and off-normal operating conditions.

- ANL:
  - Completed design of a reduced-size (i.e., 5 cm diameter) sodium cartridge coolant pump impeller to provide space for incorporation of the sodium cartridge coolant purification and monitoring system. Modified the pump test loop so it can be used to develop pump head curves for the reduced size impeller. Initiated testing to accomplish these measurements.
  - Successfully tested the SFR cartridge pump shaft magnetic coupler at room temperature. Test results showed a coupling efficiency close to that predicted by an analytical model that was also developed to predict the coupler performance. Reconfiguring the test rig to confirm high temperature (i.e., 550°C) performance in air. This information will provide the basis for developing a test plan for under-sodium testing to validate the performance of a prototype.
  - Completed additional validation of the CARLITA model for analysis of cartridge loop TH performance against the Oak Ridge National Laboratory (ORNL) thermal syphon test loop experiments and initiated additional validation against lead loop data.

ELTA – Lead/Lead Bismuth Cartridge Loop Development
Technical Lead: Cetin Unal, Los Alamos National Laboratory (LANL)
Partners: University of New Mexico (UNM), Westinghouse

- Cartridge Heating System and Duct Heaters
  - Gauged heater sizing for the corrosion test loop, iterating with colleagues to arrive at required needs
- ELTA-CL Conceptual Design
  - Publications in NS&E and NURETH19 related to cartridge design work were submitted for review, and ANS presentation was given in June.
  - Began a Corrosion Test Stand (CTS) design study to scope the feasible heater size for lead corrosion testing, which will help mature the ELTA-CL design, shown in Figure 2.

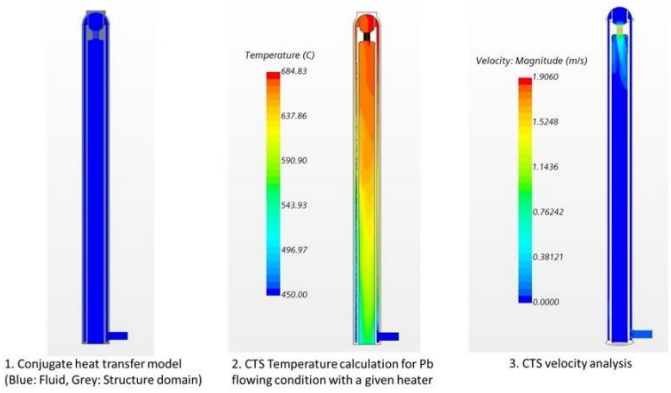

Figure 2. CTS model representation and preliminary TH results.

- Secured space within a high bay laboratory for the CTS and initiated the process of fencing the area. Work should be complete in July or early August.
- Design details for a modified venturi are in progress, with the intent of a water test of the concept to verify signal accuracy in reference to the calculated value. A commercial flow meter will confirm the measurement.

- UNM Pb-loop
  - Calculated the EM power requirement for 2 m/s flow velocity in the specimen holder channel based on pump curves. Loop operation started on June 26.
  - Finalized design of the Venturi flow meter and parts machining and purchasing will begin.
  - TIG welding of MA956-MA956, MA956-APMT, APMT-APMT, MA956-SS316, and APMT-SS316 have been completed using various post- and pre-heat treatment methods published by manufacturers and available literature, shown in Figure 3.

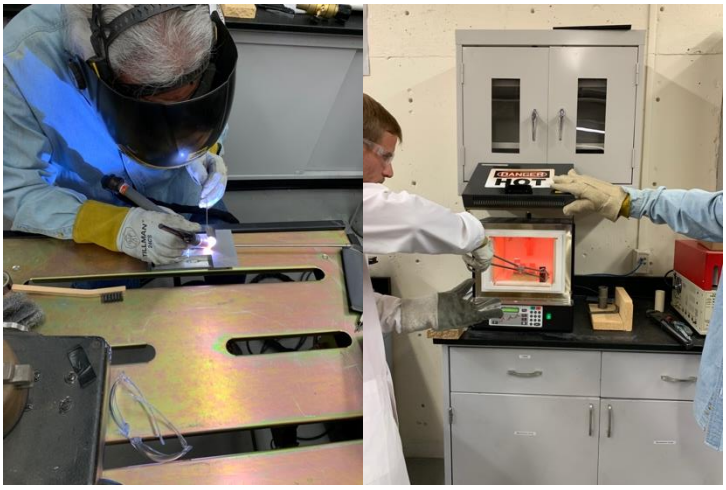

Figure 3. TIG welding of MA956-MA956, MA956-APMT, APMT-APMT, MA956-SS316, and APMT-SS316

ELTA – Molten Salt Cartridge Loop Development
Technical Lead: Joel McDuffee, ORNL
Partners: University of Utah, University of Idaho, MIT, TerraPower

- Annular Flow Characterization
  - Completed helium gap sensitivity study.
  - Documented the Modelica MSR-EV comparison along with the RELAP model.

- VTR Cartridge Loop Experiment
  - Fabrication of the new VTR vessel outer containment is complete and has been hydro tested, shown in Figure 4.

Figure 4. VTR Vessel Outer Containment

  - Working on assembly of the inner containment of the new VTR vessel so it can be hydro tested.
- Pressure and corrosion sensor development
  - Continued integrating the Hyperion system with the corrosion sensor design to stabilize the deflection measurements.
  - Inspected and are waiting on scheduling a formal leak test of the pressure control system to stabilize pressure measurements.
  - Received the miniaturized sensor components from the fabricator and will assemble the sensor once the remaining commerical off-the-shelf parts arrive.

ELTA – Gas Cartridge Loop Development
Technical Lead: Piyush Sabharwall, Idaho National Laboratory (INL)
Partners: Texas A&M (TAMU), University of Michigan, General Atomics (GA)

- Collaborated on the NS&E manuscript of VTR-GCL development.
- Performed thermal property measurements for SiC samples provided by GA using the University of Houston's thermal property measurement platform at 300℃, shown in Figure 5.

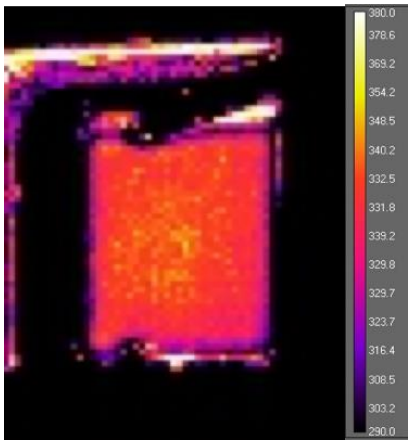

Figure 5. Thermal Property Measurements for SiC Samples

The IR image for SiC composite manufactured by GA at 300℃ hit by a laser beam.

- Continued to evaluate physical property evolution for irradiated Sapphire fibers.
- Initiated TAMU's emissivity measurements at higher temperatures (up to 550℃).
- Continued to perform emissivity measurements for SiC samples at UI.
- Continued constructing a high-temperature and high-pressure test chamber to investigate LIBS performance in a VTR-relevant environment.
- Completed GCL CFD simulations and drafted an INL report.
- Installed high-pressure high-temperature loop; relocating facility to be used with overhead crane.
- Numerical models using OpenFOAM – performing parametric study for velocity profiles and turbulence intensity.
- Performed low-Reynolds SiC simulations using ANSYS.

ELTA – Materials Capability Development
Technical Lead: Tarik Saleh, LANL
Partners: OSU, Purdue, EPRI

- Design drawings for the FFTF Materials Open Test Assembly (MOTA) have been retrieved and placed onto the VTR Confluence Site. These drawings are intended for use as a starting point for the design of the Extended Length Test Assembly for the MOTA (ELTA-M) for the VTR. The drawings, which consist of 35 sheets, have been combined with a Test Design Description for the MOTA which will explain and facilitate their use.

RTA – Rabbit Capability Development
Technical Lead: David Wootan, PNNL
Partners: Texas A&M

- Two papers on the VTR Rabbit are in the process of being developed: one will be presentated at the NURETH-19 conference and the other was submitted for publication in the special issue of NS&E.
- Discussed experiment requirements with GEH to ensure compatibility between Rabbit requirements and plant experiment support.

Support Area – Instrumentation and Controls
Technical Lead: Sacit Cetiner, ORNL
Partners: ACU, Georgia Tech, MIT, University of Pittsburgh, Cosylab

- Self-Powered Neutron Detector (SPND).
  - Presented a paper on SPND activities at the 7th International Conference on Advancements in Nuclear Instrumentation Measurement Methods and their Applications (ANIMMA 2021).
  - Presented a short talk to DOE sponsors on SPND status.

Support Area – Digital Engineering + Virtual Design and Construction + M&S
Technical Lead: Chris Ritter, INL
Partners: North Carolina State University (NCSU), Virginia Commonwealth University (VCU), TerraPower

- NCSU
  - Performed coupled analysis of building piping interaction using a demonstration building.
  - Drafted a journal paper for the VTR special issue with NS&E.
  - Working setting up virtual environment for the VTR model conversion.
- VCU
  - Repurposed the IBM Jazz authentication code to work with tokens (OAuth) instead of form-based login (username/password).
  - Tested and deployed pipeline code on INL side to verify what works and what needs further configuration.
  - Repurposed INL Deep Lynx authentication code to also be token-based (WIP).