INL/RPT-22-66478-Revision-0

February 2022 Monthly Status Report for the Versatile Test Reactor

March 2022

Thomas Fanning

Changing the World's Energy Future

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

FY 2022 February Status

SOLVING ENERGY CHALLENGES THROUGH SCIENCE

Versatile Test Reactor

Project Highlights

Thomas Fanning, Program Overview

An archive of all data on the Confluence server has been created as the final step in the Hold and Restart process. The archival process, and an index of all available reports, was documented in a February 4 project memo and distributed to Department of Energy-Idaho (DOE-ID) and DOE-Office of Nuclear Energy (DOE-NE) staff as well as the VTR Project Technical Advisory Committee. A special thanks is extended to AnnMarie Marshall for her leadership and guidance through the entire Hold and Restart process.

The House proposed a bill to extend the current Fiscal Year (FY) Continuing Resolution until March 11. A budget change proposal (BCP) was completed to define an updated schedule for the remainder of FY2022 under the assumption of a flat budget. Level 2 milestones include completing a report on fuel fabrication siting studies, holding the annual VTR Experiment Development Integration Meeting, documenting studies on the potential effects of gallium of metallic fuel performance, completing and documenting full-length assembly testing in the Pressure Drop Experimental Loop for Investigations of Core Assemblies in Advanced Nuclear Reactors (PELICAN) loop, and documenting the status of geotechnical investigation field work.

Progress continued with Bechtel National Inc. (BNI) toward finalizing internal agreements with General Electric-Hitachi (GEH) and TerraPower to support the engineering, procurement, and construction (EPC) contract for the VTR. Scope and budget are reserved under the PICS BCP to support initiation of work under the EPC contract. Additional updates are expected mid-March.

The Fuel Design and Fabrication Strategy and Technical Review meeting was held February 22–23. The two-day meeting provided a detailed overview of the fuel manufacturing process, priorities, and major focus areas to support site selection and schedule planning. Challenges were identified in terms of space requirements to accommodate fuel pin fabrication, fuel assembly construction, and scrap waste processing within existing facilities, particularly at the Materials and Fuels Complex (MFC).

Nuclear Design

Established a baseline for the full-length prototypic assembly in the PELICAN facility. Completed partial flow measurements at 30°C, 60°C, and 110°C. Continued computational fluid dynamics (CFD) efforts to support processing of the measurements previously obtained with the PELICAN loop. Some discrepancy was observed, which was identified to come from the advanced CFD solver used that was unable to properly converge. Use of a slightly simpler solver showed good agreement due to proper convergence.

VTR Plant Engineering

Existing preliminary civil/structural calculations and designs are being reviewed against the draft geotechnical specification to verify consistency. This work scope supports the geotechnical investigation field work scheduled for spring/summer 2022. Design and engineering for temporary power for the geotechnical field work (electrical power for the field trailers) is complete. Preparations for clearing and grubbing of the VTR site near the southeast

corner of MFC continues and is scheduled to be performed prior to March 31, 2022. Continued development of Rev. 1 of the geotechnical investigation specification with input from the preferred supplier, Wood Engineering.

VTR Experiments

University students are continuing to complete their work. Documented qualification of a computer program that analyzes the heat transfer efficacy of natural circulation in a Gas Fast Reactor (GFR) cartridge loop under loss of cooling conditions.

Upcoming Events:

NURETH-19, 19th International Meeting on Nuclear Reactor Thermal Hydraulics, March 6-11, 2022, Brussels, Belgium (Virtual conference)

Atlantic Council Workshop, March 14, 2022, Washington, DC

IAEA International Conference on Fast Reactors and Related Fuel Cycles (FR22), April 19-22, 2022, Vienna, Austria

Social Media

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Technical Highlights

Sal Mascareñas, Reactor Technical Integration

Design Engineering Support

The Dounreay In-Vessel Transfer Machine (IVTM) information exchange effort is moving through DOE and United States approval channels. Detailed plans for the information exchange will follow export control approval.

Located but did not retrieve the design documents and operating procedures for the Fast Flux Test Facility (FFTF) Ex-Vessel Transfer Machine (EVTM). The FFTF EVTM was a rail mounted machine for seismic reasons and was capable of transporting fuel assemblies generating up to 10 kwt. The design and operation of an operating EVTM could be used to inform the design of the VTR EVTM with respect to seismic qualification and heat transfer capability.

Thomas Fanning, Nuclear Technical Integration

Fuel Design and Analysis

Drafted a report on analysis of the high-burnup fuel performance of VTR driver fuel. This assessment provides insight on possibly reducing Pu feedstock requirements for VTR through increased fuel utilization to higher burnup. Continued U-Pu-Zr-Ga characterization work with retrieval of Experimental Breeder Reactor-II (EBR-II) experiment X521 archive samples (as-cast, unirradiated) for high-resolution microstructural and micro-chemical characterization of Ga behavior in the as-cast fuel alloy. Established work scope for the remainder of FY2022 as contingency for further FY2022 appropriation to the VTR project.

Fuel Manufacturing

Issued a scrap processing report examining alternative equipment options for an MFC-based manufacturing facility layout. Completed the technical review of the fresh fuel waste form and disposal options report. Completed a new model scenario focused on the Savannah River National Laboratory (SRNL) fuel manufacturing siting option, collected initial results, and started a descriptive report with planned completion in March.

Core Design

Collected quotes for procuring the test section (a modified pressure vessel) for the REDuced Scale Hydraulic Inlet Plenum (REDSHIP) facility. Controllers for the pumps are expected to be delivered in the future.

Reviewed documents discussing the start of operations and approach to criticality for previous sodium fast reactors (SFRs). The information was concentrated to extract tradeoffs and eventually apply it to VTR. This will serve to identify what type of checks, measurement, and characteristics performance would be expected for VTR.

Completed uncertainty quantification of fuel slug manufacturing tolerances and issued a draft report. Developed and documented example cases for the OTERR code to illustrate basic code capabilities.

Safety Analysis

Completed an assessment of the impact of using a more detailed modeling approach for the VTR sodium-to-air heat exchangers (SAHX). For the updated models, peak temperatures and safety margins were not significantly impacted primarily because secondary heat rejection impacts transient performance in the long-term, after peak temperatures and minimum margins have been predicted. Several modeling assumptions were necessary because the design performance of the SAHX is currently unknown. Refinement of these assumptions based on actual SAHX design performance will be necessary before these results can be integrated into the VTR safety analyses.

Completed and released a report on coupled SAS/CFD verification. This report captures the results of testing performed on the SAS/CFD coupling interface and compares the results of the testing to defined acceptance criteria.

Finalizing a report documenting review of the SAS gap assessment. This report summarizes the progress of the Verification and Validation (V&V) task for SAS by capturing the results of the verification effort and noting gaps identified in model capabilities or code documentation.

Safety Basis

Continued improvements to the SPCA-ANL software for sodium fire analyses. The code is being updated to include capabilities to handle British and International System of Units (SI) units in both the software input and outputs.

Began efforts to establish a closer interface with the VTR Experiment Team. This will ensure that safety evaluations performed by the experiment team members for cartridge loops and the rabbit are consistent with each other and will provide relevant information needed for safety classification of Structures, Systems, and Components (SSCs).

Continued validation efforts of the Simplified Radionuclide Transport (SRT) mechanistic source term code with improvements to the bubble transport and uncertainty functions based on the latest comparisons to DOE-funded experimental results from the University of Wisconsin.

Kevan Weaver, Experiments Technical Integration

Documented qualification of a computer program that analyzes the heat transfer efficacy of natural circulation in a Gas Fast Reactor (GFR) cartridge loop under loss of cooling conditions.