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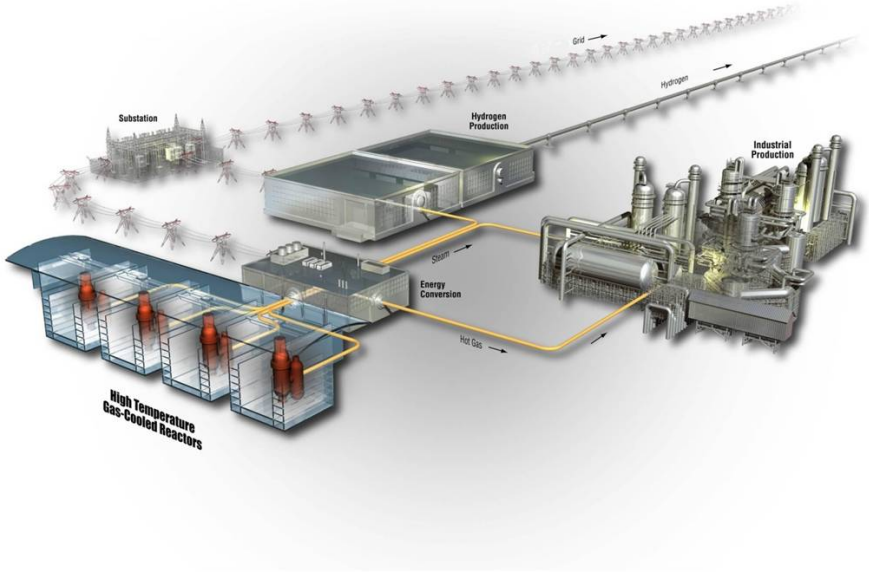
Statement of Work

Project No. 23841, 29412

Support for INL ART TDO Advanced Gas Reactor Fuel Fabrication and Characterization



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P For Preparer of the document.

A For Approval: This is for non-owner approvals that may be required as directed by a given program or project. This signature may not be applicable for all uses of this form.

C For documented review and concurrence.

Note Applicable QLD: MSA-000049, B60-000026, MFC-001316

REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0	09/28/2012	All	New document.
1	05/21/2013	Pages 7, 9, and 10	Revised to include additional scope and applicable Quality Assurance program changes.
2	10/01/2013	All	Revised to incorporate additional work scope and remove completed work scope.
3	12/20/2013	All	Revised to incorporate additional FY-14 work scope.
4	04/16/2014	All	Revised to incorporate plus-up funding work scope.
5	10/01/2014	All	Revised to incorporate planned FY-15 work scope.
6	07/20/2015	All	Revised to add coating of materials work scope.
7	10/01/2015	All	Revised to incorporate planned FY-2016 work scope.
8	11/28/2016	All	Revised to incorporate planned FY-2017 work scope.
9	06/16/2017	6-7	Added characterization support for AGR-5/6/7 compacts.

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1. INTRODUCTION

1.1 Background

Oak Ridge National Laboratory (ORNL) has participated in the Advanced Gas Reactor (AGR) program for the Next Generation Nuclear Plant (NGNP) and the transition to the Idaho National Laboratory (INL) Advanced Reactor Technologies (ART) Technology Development Office (TDO) since the inception of the program. In this effort, ORNL has fabricated tristructural isotropic (TRISO) fuel and fuel compacts for AGR-1, AGR-2, and AGR-3/4 experiments, provided matrix only components for AGC-2, AGC-4, and AGR-3/4 experiments and for university studies, and provided characterization, coating, and compaction support for INL and BWX Technologies Nuclear Operations Group (BWXT).

In fiscal year (FY) 2017, the activities for the INL ART TDO fuel development are focused on preparations for the AGR-5/6/7 experiments and technical support to the Generation-IV International Forum (GIF) pre-irradiation leach-burn-leach (LBL) round robin effort with China and South Korea. With the successful transfer of fuel fabrication technology to BWXT, ORNL's involvement has shifted toward transferring fuel characterization methods, providing technical support, verification of BWXT laboratory results, and fabricating surrogate fuel materials for university collaborations. ORNL will also provide analytical support to BWXT and INL for uranium dispersion analysis and confirmatory fuel characterization analyses as needed.

1.2 Purpose/Objectives

1.2.1 Inner Pyrolytic Carbon (IPyC) Defect – Uranium Dispersion Analysis

BWXT does not have the capability to examine either loose TRISO or particles liberated from compacts for uranium dispersion as an indication of defective IPyC layers. Support by ORNL is needed to perform these analyses on select TRISO samples to be provided by BWXT.

1.2.2 ORNL Laboratory Operations and Support Services

This task incorporates miscellaneous physical and administrative work activities needed to maintain the characterization laboratory in an operable state to support fuel characterization in support of AGR-5/6/7 fuel fabrication.

1.2.3 ORNL Project Management and Reporting

This task embodies work activities related to project planning, administration, and reporting status and outcomes of work performed.

1.2.4 ORNL Confirmatory Analyses and Characterization Support

1.2.4.1 ORNL will provide analytical and characterization support as requested for AGR-5/6/7 low-enriched UCO kernel fabrication and TRISO coated particle fabrication.

1.2.4.2 ORNL will provide analytical and characterization support to INL and BWXT as requested to validate and/or verify the results obtained for the additional TRISO coating process qualification

activities in preparation for AGR-5/6/7 LEUCO coating. This may also include x-ray and metallography of samples.

1.2.4.3 ORNL shall provide technical support as needed to INL and BWXT for the refinement of the AGR-5/6/7 compact development process to be used.

1.2.4.4 ORNL will provide analytical and characterization support to INL and BWXT as requested to validate and/or verify the results obtained for AGR-5/6/7 fuel compact characterization.

1.2.5 ORNL Technical Support and Participation in Generation-IV International Forum Activities

ORNL shall provide technical support to the GIF LBL round robin being conducted with China and South Korea. The technical support will include collaboration meetings, analysis and shipment of simulated LBL defects made from archived US TRISO particles, receipt of Chinese TRISO particles for leach-burn-leach analysis in the ORNL Uranium Lab, and preparation and issuance of reports of results and analysis.

1.3 Anticipated Benefits

Activities related to compact deconsolidation leach burn leach (DLBL) are intended to provide corroboration of the results generated in the BWXT laboratory.

The uranium dispersion analysis is important to ensure that the fabrication-process parameters can reliably fabricate fuel meeting the specifications in SPC-1352. Whereas BWXT does not have a suitable micro-focus x-ray machine to image the particles, it is essential that this analysis be performed at ORNL.

The analytical and characterization support provided by ORNL per this statement of work (SOW) allows for verification of results obtained from the BWXT lab analysis for the same or similar samples.

2. APPLICABLE CODES AND REFERENCES

American Society of Mechanical Engineers NQA-1 2008, 1a 2009, Part I is applicable to the work scope performed.

Specification (SPC)-1352, “AGR-5/6/7 Fuel Specification”, Revision 8, March 9, 2017.

3. SCOPE

3.1 Work to Be Performed

3.1.1 IPyC Defect – Uranium Dispersion Analysis

ORNL shall quantify the uranium dispersion, as a metric for IPyC defects, on up to five LEU TRISO samples, provided by BWXT to ORNL for analysis, at the request of INL.

3.1.2 ORNL Laboratory Operations and Support Services

ORNL shall maintain the data acquisition methods and equipment in the uranium fuel characterization laboratory in an operable state to support the planned work scope.

3.1.3 ORNL Project Management and Reporting

ORNL shall conduct necessary activities for project management and reporting activity status and progress.

3.1.4 ORNL Characterization and Analyses Support

3.1.4.1 ORNL will provide analytical and characterization support to INL and BWXT as requested to validate and/or verify the results obtained for the TRISO coating process qualification activities in preparation for AGR-5/6/7 LEUCO coating. This may also include x-ray and metallography of samples.

3.1.4.2 ORNL will provide analytical and characterization support to INL and BWXT as requested to validate and/or verify the results obtained for the LEUCO TRISO coated particle fabrication and overcoating activities. This may also include x-ray and metallography of statistically significant samples.

3.1.4.3 ORNL shall provide technical support as needed to INL and BWXT for the refinement of the AGR-5/6/7 compact development process to be used.

3.1.4.4 ORNL will provide analytical and characterization support to validate and/or verify the results obtained for AGR-5/6/7 fuel compact characterization. This includes washing resinated graphite powder from TRISO particles, compact deconsolidation, leach-burn-leach of liberated TRISO, and impurities analyses.

3.1.5 ORNL Technical Support and Participation in Generation-IV International Forum Activities

ORNL shall provide technical support and participate in GIF activities, including an LBL round-robin and a SiC Materials Workshop. The US, China, and South Korea will be the primary participants in the LBL benchmarking round-robin. ORNL will ship to each primary participant a series of samples prepared for this experiment that contain depleted-uranium-bearing coated particles with simulated LBL defects, and each primary participant will perform LBL analysis. China will ship large-coater depleted-uranium TRISO particles to primary participants for similar analysis. Other ORNL LBL benchmark activities will include collaboration meetings and preparation of reports on results and analysis. ORNL will also help plan and provide a technical chair for the SiC Workshop, which will be held in coordination with a GIF project management board meeting.

3.2 Work Excluded

Work not specifically identified to be performed in this SOW is excluded.

3.3 Requirements

ORNL internal environmental, safety and health, quality assurance program, and radiological control requirements apply to all work performed under this SOW.

3.4 Place of Performance

The primary place where this work will be executed is at ORNL.

3.5 Interfaces

BWXT, ORNL and INL investigators will interface with each other.

3.6 Miscellaneous

None

4. DELIVERABLES AND SCHEDULE

Principal investigator(s) shall report progress in bi-weekly INL ART TDO AGR teleconferences and written monthly progress reports.

Activity Description	Completion Date	Deliverable	Associated INL Milestone
Defective IPyC analysis (U dispersion)	As completed	Measurements of BWXT LEU TRISO properties shall be submitted by email or letter after each analysis is completed.	N/A
Characterization of samples	As completed	Reports, charts, graphs, photographs, micrographs, etc. detailing results of characterization.	N/A

5. COMPLETION CRITERIA AND FINAL ACCEPTANCE

Acceptance of task completion will be upon receipt and review by INL personnel of the applicable deliverable documentation.

6. APPENDICES

None

7. ATTACHMENTS

None