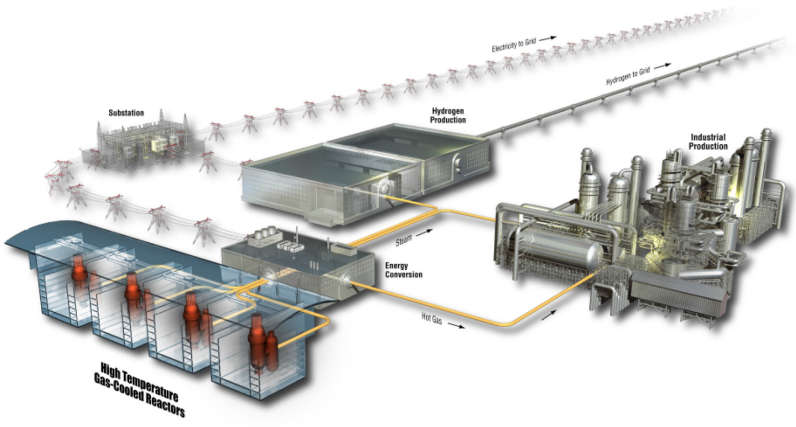
INL/EXT-17-41216
Revision 0

Readiness Review of BWXT for Fabrication of AGR-5/6/7 Compacts

Project # (s) 23841, 29412

D. W. Marshall
M. T. Sharp

February 2017



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Idaho National Laboratory

Readiness Review of BWXT for Fabrication of AGR-5/6/7 Compacts

February 2017

Idaho National Laboratory
INL ART TDO Program
Idaho Falls, Idaho 83415

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INL ART TDO Program

Readiness Review of BWXT for Fabrication of AGR-5/6/7 Compacts

INL/EXT-17-41216
Revision 0

February 2017

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2/15/2017
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2/15/17
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2/15/17
Date

SUMMARY

Battelle Energy Alliance, LLC (BEA) conducted a readiness review at the BWX Technologies (BWXT) facility in Lynchburg, Virginia on January 17-18, 2017 to assess readiness to commence fabrication of fuel compacts for the Advanced Gas Reactor (AGR) irradiation experiments 5, 6, and 7.

The BEA review team was welcomed into the BWXT facility and given the opportunity to examine procedures, training documents, and opportunities to interview performers and management.

The review team applied American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance Standard (NQA)-1-2008/1a-2009 criteria to the following focus areas for the review:

- Process instrumentation and measurement and test equipment calibrations
- Approval, control and accessibility of operating procedures
- Process record control and accessibility
- Configuration design and control
- Operator training, certification, and qualification
- Chemical inventories for fabrication and chemical characterization
- Consumables inventories
- Material Procurements
- Operability of essential equipment for fabrication and dimensional characterization
- Corrective actions system
- Product acceptance
- Handling and Storage
- Personnel have access to and are familiar with the latest AGR Work scope and requirements documents
- Miscellaneous items.

Three observations were identified during the readiness review. These were an incompletely finalized training record (corrected while the review team was on site), a document directing performers to use a paper form that has been replaced with an equivalent electronic spreadsheet, and incomplete flow down of Idaho National Laboratory (INL) chemical purity specifications to the argon gas vendor. The last observation is mitigated by the vendor's own internal gas specification for the purity grade BWXT purchases that matches the INL specification.

The review team finds BWXT ready to commence fabrication of fuel compacts for the AGR-5/6/7 irradiation experiments when a certified lot of tristructural isotropic (TRISO) fuel particles is available.

ACKNOWLEDGEMENTS

Personnel at the BWX Technologies facility in Lynchburg, Virginia were very accommodating to the review team and made a concerted effort to provide the objective evidence and requested data in advance of the readiness review. BWX Technologies views customer reviews as a means to identify improvements that can be made in their performances. The friendly and cooperative interaction with the BEA review team was appreciated.

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ACRONYMS

AGR	Advanced Gas Reactor
ASME	American Society of Mechanical Engineers
BEA	Battelle Energy Alliance, LLC
BWXT-NOG	BWX Technologies Nuclear Operations Group
CoC	Certificate of Conformance
INL	Idaho National Laboratory
M&TE	measuring and test equipment
NQA-1	(ASME) Nuclear Quality Assurance Requirements for Nuclear Facility Applications
OJT	on-the-job training
RTRT	Research and Test Reactors and Targets
SFF	Specialty Fuels Facility
TRISO	tristructural isotropic (coatings or particles)

Readiness Review of BWXT for Fabrication of AGR-5/6/7 Compacts

1. INTRODUCTION

Battelle Energy Alliance (BEA) of the Idaho National Laboratory (INL) conducted a readiness review of the BWX Technology (BWXT) procedures, processes, and equipment associated with compact fabrication activities at the BWXT Nuclear Operations Group (BWXT-NOG) facility outside Lynchburg, Virginia, in support of preparations for fabricating compacts for the Advanced Gas Reactor (AGR) fuel qualification irradiation experiments (AGR-5/6/7).

The readiness review used quality assurance requirements taken from the American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance Requirements for Nuclear Facility Applications (NQA-1-2008/1a-2009) as a basis to assess readiness to start compact fabrication.

2. READINESS REVIEW DESCRIPTION

A readiness review was held at the facilities of BWXT's Lynchburg, Virginia facility from January 17 through January 18, 2017. The purpose of the readiness review was to evaluate and determine readiness status of their compact fabrication processes. The readiness review was accomplished primarily through review of procedures and documents to NQA-1-2008/1a-2009 requirements. The scope of the review included:

- Process instrumentation and measurement and test equipment calibrations
- Approval, control and accessibility of operating procedures
- Process record control and accessibility
- Configuration design and control
- Operator training, certification, and qualification
- Chemical inventories for fabrication and chemical characterization
- Consumables inventories
- Material procurements
- Operability of essential equipment for fabrication and dimensional characterization
- Corrective actions system
- Product acceptance
- Handling and storage
- Personnel have access to and are familiar with the latest AGR work scope and requirements documents
- Miscellaneous items.

3. RESULTS

3.1 General

BWXT was prepared for the readiness review in that they had compiled binders of objective evidence for the reviewers and had arranged for a tour of the facility and equipment. BWXT personnel were interviewed, as needed, to obtain answers to reviewer questions and to provide additional data and information.

On-the-Job (OJT) training of the operations staff is still in progress. BWXT is cross-training operators to ensure adequate staffing for fuel compact fabrication processes. Direct engineering and management oversight will be used during fuel fabrication to compensate for the shortfalls in operator experience.

3.2 Notable Practices

BWXT proactively conducted an NQA-1 surveillance on the equipment, training, and procedures supporting AGR fuel compact fabrication. One issue was identified: the requirement that AGR waste and scrap materials must be kept separate from other waste and scrap materials in Research and Test Reactors and Targets (RTRT) facility and separated by enrichment was not being met. The issue is being evaluated for entry into the corrective action system.

3.3 Findings

No findings were identified.

3.4 Observations

Observation O-1: Corrections to a Specialty Fuels Facility (SFF) Operator training record were not initialed and dated properly. The record was corrected during the Readiness Review. No further actions are required.

Observation O-2: PPO-0960002-002, AGR compacting provides direction to use a form, M35-340. However, the information is currently entered in an electronic spreadsheet and hard-copy form is not used. The spreadsheet references M35-340 and it was verified that all the required information is included on the spreadsheet. PPO-0960002-002 should be revised to reflect the current electronic process.

Observation O-3: The argon purity specification of $O_2 \leq 50$ ppm was not communicated to the supplier via the procurement system. The Certificate of Conformance (CoC) provided by the manufacturer specified $O_2 \leq 50$ ppm and the specification was met. Argon is purchased in bulk quantities for BWXT for various projects. Based on the supplier specification matching the INL chemical specification, SPC-1363; "AGR-5/6/7 Fuel Fabrication Feedstock Chemical Purity Specifications" compliance for the argon purity will be verified by BWXT and INL review of the CoC's from the two most recent argon deliveries prior to use of argon in AGR activities.

4. REVIEW DETAILS

4.1 Process Instrumentation & Measurement and Test Equipment (M&TE) Calibrations

BWXT provided a list of calibrated instruments used in the compact fabrication process and dates when the instruments are due for recalibration. Instruments readily visible from the processing floor without breaching radiological control barriers were verified by the review team. Additionally, check weights used for field calibration of analytical scales were verified to be uniquely identified and that only a single set was in use at each scale location. The BWXT calibration tracking process appears to be functioning as intended and no shortcomings were identified.

Objective Evidence: Process Instrumentation & Measurement and Test Equipment (M&TE) Calibrations		
1.	OP-1008156	Quality Plan, Section N
2.	QWI-11.1	Control of Measuring and Test Equipment (Calibrations)
3.	---	Calibrated equipment list – all equipment is currently in calibration
4.	OP-1008157, Rev 9	Operation Procedure for Calibration and Standard Checks for Mass Measurement Systems
5.		Field inspection – Compact Caliper, CS-01531, calibrated 11/29/16 - due 6/3/17 Overcoater, SAP10006984, calibrated 8/23/16 - due 8/31/17 Compactor, SAP10006986, CS-02112, calibrated 4/7/16 - due 4/8/17 Laser Micrometer, CS-01605, calibrated 7/21/16 - due 4/8/17 AGR Compacting Furnace, CS-00394, calibrated 5/4/16 - due 5/6/17 Furnace Temperature, CS-01709, calibrated 5/5/16 - due 5/6/17 Furnace Over Temperature, CS-01710, calibrated 5/5/16 - due 5/6/17 Furnace Pressure, CS-02102, calibrated 5/5/16 - due 5/6/17 Pyrometer, CS-01806, calibrated 7/25/16 - due 7/29/17 Pressure sensor, CS-03524, calibrated 7/29/15 - due 7/29/17 TC-1 tag is not visible without ladder Calibration Standards – Laser Micrometer, RRFE000594, calibrated 3/31/16 - due 1/21/17 Caliper, RRFE-00596, calibrated 3/31/16 - due 4/1/17 Caliper, RRFE-00599, calibrated 3/31/16 - due 4/1/17 Check weights uniquely identified and clean
6.	---	Interviews with engineering staff and management

4.2 Approval, Control, and Accessibility of Operating Procedures

Managers and engineering staff review proposed changes to operating procedures and process plan outlines. Changes that could impact quality or safety are submitted to a change review board prior to issuance. Approved revisions are submitted to document control personnel who upload an electronic copy onto the SOLUMINA computer system. Qualified operators are required to document reading of revised procedures on forms Q2-193 or N-50, and also electronically in SOLUMINA prior to use of the procedure. A revision history is included in an appendix of operating procedures that includes the change number associated with the revision and a summary of changes. Only the latest revision of documents is available to plant personnel via SOLUMINA.

The approval, control, and accessibility of operating procedures and instructions are effective and no shortcomings were identified.

Objective Evidence: Approval, Control, and Accessibility of Operating Procedures		
1.	QWI 5.1.12	Change Control
2.	OP-1008156	Quality Plan, Section H
3.	N-50 form	OP1034965 Rev 5, Operating Procedure for AGR Overcoating Operations
4.	Q2-193 forms	OP1004089 Rev 5, Impurity Analysis in Uranyl Nitrate Material by ICP-MS OP1026454 Rev 14, Leachable Uranium in AGR Uranium Carbide Material OP1004139 Rev 6, Uranium Isotopic Analysis in Uranium Based Material by ICP-MS
5.	PPO-0960002-002	AGR Compacting, 8/22/2012
6.	PPO-0960003-003	Debind and Heat Treatment of AGR Compacts, 8/22/2012
7.	OP-1035101 Rev 7	Operating Procedure for AGR Compactor Operation
8.	OP-1035192 Rev 6	Debind and Heat Treatment of AGR Compacts in the Centorr Furnace
9.	OP-1034965 Rev 5	Operating Procedure for AGR Over-Coating Operations
10.	---	Interviews with engineering staff and management

4.3 Process Record Control and Accessibility

QWI -16.1.2, UPRR Quality Assurance Records was reviewed and found compliant with NQA-1-2008/-1a-2009 requirements. Records are validated if stamped and signed by authorized personnel. QWI -16.1.2, Table 1 provides a comprehensive list of the project quality assurance records. Corrections to records are not allowed unless they are approved in the formal change system.

Objective Evidence: Process Record Control and Accessibility		
1.	OP-1008156	Quality Plan, Section S
2.	QWI -16.1.2	UPRR Quality Assurance Records
3.	E61-001	Training Record for Stanley Gloves, Monica Culpepper, Rob Lindsay
4.	BWED16-204	AGR-5/6/7 Overcoating and Compact Development for 25% Packing Fraction 7/28/16 – Report to INL
5.	Spreadsheet	Fired Compacts T.R. Markham 6/8/16- Boats 1, 2, 3 a) Furnace/Tray Run ID - J52R-NU-14138 b) Compact Batch ID - J52R-NU-13138 c) c) Overcoat Batch ID - J52R-NU-11029
6.	Spreadsheet	Green Compacts Rob Lindsey 6/2/16- Boats 1, 2, 3 a) Furnace/Tray Run ID - J52R-NU-14138 b) Compact Batch ID - J52R-NU-13138 c) Overcoat Batch ID - J52R-NU-11029
7.	Electronic M35-025	Electronic AGR Glovebox Sheet 31, SFF Station Inventory
8.	---	Interviews with engineering staff and management

4.4 Configuration Design and Control

Configuration control is maintained by invoking a change review board whenever configuration changes are proposed and by communicating tolerances on fabrication drawings. No design changes have been made in the compacting and overcoating processes. BWXT provided documentation of a recent change to the glove boxes to install pre-filter ventilation on the glove box exhaust; limiting migration of radiologically contaminated dust into the exhaust system as an example of a recent facility modification. Configuration control appears to be effective for consumable parts.

Objective Evidence: Configuration Design and Control		
1.	OP-1008156	Quality Plan, Section E
2.	QWI 5.1.12	Change Control
3.	10004 B-0	Drawing, AGR Compacting Interim Storage Rack, 6/8/10
4.	46856-1	Drawing, VFC-LAB3 FLO-COATER Specification Drawing, 7/18/13
5.	99-0189	Drawing, Process and Instrumentation Diagram, CENTORR Industries
6.	J26061-000-000	Drawing, AGR Compacting Press, Miller Tool & Die, 7/8/2010
7.	J26061-100-000	Drawing, Load Assembly, Miller Tool & Die, 7/8/2010
8.	J26061-100-022	Drawing, BW-AG Compactor Load Assembly Load Cartridge, 6cc, Miller Tool & Die, 7/8/2010
9.	UPRR-10041 B-00	Drawing, AGR Boat, 1/20/16
10	UPRR-100065 Rev 0	Drawing, AGR Compacting Glove Box, 11/01/16
11.	UPRR-10016 Rev 3	Compactor Load Cartridges, 7/11/11
12.	---	Interviews with engineering staff and management

4.5 Operator Training, Certification, and Qualification

Operators are trained on On-the-Job-Training (OJT) Checklists as detailed in QWI-18.1.3. These checklists include required plant system training, required reading, written examination, and proficiency of operating the specific equipment being used (under the supervision of Engineer). Operators cannot run the equipment unsupervised until the checklist is complete and signed. Corrections to Rob Lindsey's checklist were not initialed and dated properly, see Observation O-1. The record was corrected during the Readiness Review. Eight operators are being cross-trained in all processes to ensure adequate operator availability. Engineering oversight will be provided during process operations until OJT requirements are satisfied.

Objective Evidence: Operator Training, Certification, and Qualification		
1.	OP-1008156	Quality Plan, Section D
2.	QWI-18.1.3	On-the -Job Training
3.	QWI-16.1.2	Quality Assurance Records
4.	OP-1034965 Rev 5	Operating Procedure for AGR Overcoating Operations (reading record)
5.	OP-1035101 Rev 7	Operating Procedure for AGR Compactor Operation (reading record)
6.	E61-001A	SFF Operator OJT checklists reviewed: Tom Markham, Rob Lindsey, Stanley Glover, and Monica Culpepper
7.	---	Interviews with engineering staff and management

4.6 Chemical Inventories for Fabrication and Chemical Characterization

INL shipped compact mold release compound and resinated graphite powders to BWXT for use in forming the compacts. These materials are within their "Use-by" dates, meet INL specifications, and were procured from qualified suppliers as QL-2 procurements.

Other consumable chemicals include laboratory chemicals (nitric acid, standards, etc.), argon gas, and high-purity (Type III reagent grade) water. Argon is received in bulk and used by several programs at the BWXT facility. An observation was noted that the BWXT procurement specification for argon does not flow down all of the INL specifications for argon concentration and purity to the vendor, but the long-time supplier of bulk argon, Air Products, has an internal specification that does meet the INL argon purity specification. Review of recent Certificates of Conformance from Air Products for argon shipments to BWXT show that the argon quality routinely meets the INL specifications with substantial margin on the impurities. BWXT has agreed to forward the Certificates of Conformance for any additional argon shipments received prior to completion of the fuel compact fabrication.

The reagent grade water supplied to the overcoating and compacting area meets a more stringent standard for conductivity than is specified by INL.

Objective Evidence: Chemical Inventories for Fabrication and Chemical Characterization		
1.	PO# 4700037972-0	Purchase order to Air Products & Chemicals, Inc., 9/12/2016
2.	Lot 515174	Air Products, Certificate of Analysis, 1/02/2017 07:00
3.	Order 4700037972	Air Products, Certificate of Conformance (showing impurities)
4.	Internal Email	Compton, Steve L. to Vassar, Roger A. January 6, 2017 8:49a, "spec info" - procurement specification for argon concentration and purity.
5.	Internal Email	Sigler, James A. to Jones, Aaron C. dated Wednesday, January 18, 2017, 12:36p, "RE: Plant DI water resistivity"
	---	Interviews with engineering staff and management

4.7 Consumables Inventory

INL shipped compact mold release compound and resinated graphite powders to BWXT for use in forming the compacts. These materials are within their "Use-by" dates, meet INL specifications, and were procured from qualified suppliers as QL-2 procurements. These quantities of the mold release and graphite powder, shipped to BWXT, exceed expected needs for fuel fabrication.

Laboratory chemicals are in adequate supply to meet the needs of the AGR program during fuel compact fabrication or, as is the case for argon and nitric acid, the chemicals are used by multiple programs and are automatically ordered when the on-hand supplies reach minimum inventories.

BWXT engineering obtained INL concurrence on the procurement of packaging materials for individual compacts prior to the readiness review and had vendor quotes for INL review. BWXT engineering staff verbally confirmed that the orders had been placed for the materials.

Objective Evidence: Consumables Inventory		
1.	N-74 Document Transmittal Form	AGR Compacting and Shipping Materials, 1/10/2017
2.	---	Interviews with chemical laboratory staff, engineering staff, and management

4.8 Material Procurements

Procurements for the mold release compound and the resinated graphite powder were performed by INL using INL qualified suppliers. It was less expensive and more expeditious for INL to procure and test the purity of the mold release compound and resinated graphite powder than to have BWXT qualify the suppliers and arrange for the impurities analyses.

BWXT placed orders for new inserts for the volumetric feeder and compact packaging materials (vials, ashless filter papers, and vinyl labels). The inserts augment the existing inventory to provide an improved selection of inserts and better accuracy in targeting the compact lengths within fuel specifications.

Objective Evidence: Material Procurements		
1.	---	SAP Requisition & Purchase Orders
2.	---	Interviews with engineering staff and management

4.9 Operability of Essential Equipment for Fabrication and Dimensional Characterization

The essential equipment was used in 2016 to overcoat, press, and heat-treat compacts as part of process parameter development and is believed to be operable condition. Spreadsheets with data from recent operations were provided for review. Engineering staff has replacement feed lines for the press mold release dispensing system on hand, which is the item most likely to plug from extended down time.

Objective Evidence: Operability of Essential Equipment for Fabrication and Dimensional Characterization		
1.	OP-1008157 Rev 9	Operating Procedure for Calibration and Standard Checks for Mass Measurement Systems, 7/17/2016
2.	---	Spreadsheets with recent development product data
3.	---	Interviews with engineering staff and management

4.10 Corrective Actions System

BWXT has a defined corrective action process that is compliant with NQA-1-2008/-1a-2009 requirements that have three paths of investigation depending on the level of severity. CA201601408, Unfiltered ventilation duct in glovebox not labeled “for maintenance only,” had a thorough extent of condition review which enabled identification of other unlabeled equipment. The corrective actions included taking identified gloveboxes out of service, adding the appropriate labels, revising the implementing procedures and creating a maintenance plan. The corrective action process is adequately documented and compliant.

Objective Evidence: Corrective Actions System		
1.	OP-1008156	Quality Plan, Section R
2.	QWI-14.1.1	Preventative/Corrective Action System
3.	QWI-14.1.1 Attachment 1	Preventative/Corrective Action System Severity Level
4.	QWI-14.1.3	Lessons Learned Report
5.	CA201601408	Unfiltered ventilation duct in glovebox not labeled “for maintenance only”
6.	NQA-1 Surveillance for AGR	Review of the AGR Compact process and AGR Coating process.

4.11 Product Acceptance

Not reviewed beyond MT&E calibrations.

4.12 Handling and Storage

Not reviewed.

4.13 Personnel Access and Familiarity with Latest AGR Work Scope and Requirements Documents

The AGR work scope and specification documents are controlled at the INL and formally transmitted to BWXT management through procurement and contract management. INL requirements documents are digitized and made available on the BWXT intranet to insure that they have access to the most recent revisions. These documents are reviewed and approved by BWXT and incorporated into BWXT procedures. Qualified operators are required to document reading of procedures on forms Q2-193 or N-50 and also electronically in SOLUMINA prior to use of the procedure. Only the latest revision of a document is available to plant personnel via SOLUMINA. The Lead Engineer may also distribute the applicable requirements to the production floor via OJT checklists and briefings.

Objective Evidence: Personnel Access and Familiarity with Latest AGR Work Scope and Requirements Documents		
1.	OP-1008156	Quality Plan, Section H
2.	Process OJT Checklists	Tom Markham, Rob Lindsey, Stanley Glover, and Monica Culpepper
3.	---	Interviews with engineering staff and management

4.14 Miscellaneous Items

INL verified that adequate compact boats are on hand and storage racks are present to hold those boats in a criticality safe configuration. BWXT has eight compact boats; four in use and four spares. The compact boats were inspected for orientation markings to help maintain compact position identification during dimensional characterization and heat-treatment.

Overcoating, compacting equipment, heat-treatment furnace, and M&TE for dimensional characterization appeared to be in operable condition and area conditions were neat and tidy. Physical space for conducting the operations and laboratory analyses appeared to be adequate.

A dummy compact and sample packaging materials were provided for a demonstration by an operator that the compacts could be easily handled and packaged while the operator was wearing examination gloves with cotton liners.

Objective Evidence: Miscellaneous Items		
1.	---	Facility tour of the chemical laboratory and compacting area
2.	---	Interviews with operators, engineering staff, analytical staff, and management

5. CONCLUSIONS

The readiness review team was cordially received and provided with a lot of information that BWXT compiled in advance of the review. The review was productive and professionally facilitated by BWXT. Arrangements were made in a timely manner by BWXT for the team to meet with key individuals and to conduct spot checks in the field.

The readiness review team finds that BWXT is ready to fabricate low-enriched, tristructural isotropic (TRISO) fuel compacts for the AGR-5/6/7 irradiation experiments when a TRISO particle lot is available. Three observations were made during the course of the readiness review. These were:

- Observation O-1: Corrections to a SFF Operator training record were not initialed and dated properly.
- Observation O-2: Compacting procedures direct the use of form, M35-340. An equivalent electronic spreadsheet is used in place of the form, but not expressly stated in the procedure.
- Observation O-3: The argon purity specification of $O_2 \leq 50$ ppm was not communicated to the supplier via the procurement system, but the supplier's internal argon specifications meet the INL chemical purity specification.

Observation O-1: The record in was corrected during the readiness review. No further actions are required.

Observation O-2: BWXT indicated that they will revise their procedure to use electronic spreadsheet. Since all required fields were on the electronic spreadsheet, no action is required prior to commencing fuel compact fabrication.

Observation O-3: BWXT and INL will review the CoCs for the two most recent argon deliveries to ensure that the INL chemical specification is being met by with the delivered argon.

Appendix A
Contents of the BWXT Objective Evidence Binder

BWX Technologies, Inc.

AGR COMPACT FABRICTION

READINESS REVIEW

BOOK 1-A

CORRECTIVE ACTION (CA201601408)

PPO-0960001-002

PPO-096002-002

PPO-096003-003

CALIBRATION EQUIPMENT

ARGON SPEC

OPERATING PROCEDURE FOR METALLOGAPHIC PREPARATION AND EVALUTION OF AGR FUEL KERNELS/PARTICLES (OP-1015309)

OPERATING PROCEDURE FOR DETERMINATION OF AVERAGE WEIGHT/PARTICLE USING AMNEMONICS ITEM CONTER (OP-1021133)

OPERATING PROCEDURE FOR IMPURITY ANALYSES IN URANYL NITRATE MATERIAL BY ICP-MS (OP-1004089)

OPERATING PROCEDURE FOR LEACHABLE URANIUM IN AGR URANIUM CARBIDE MATERIAL (OP-1026454)

OPERATING PROCEDURE FOR URANIUM ISOTOPIC ANALYSES IN URANIUM BASED MATERIAL BY ICP-MS (OP-1004139)

OPERATING PROCEDURE FOR URANIUM ANALYSIS IN U OXIDE/CARBIDE MATERIAL BY MODIFIED DAVIS 7 GRAY METHOD (OP-1015300)

OPERATING PROCEDURE FOR MEASUREMENT OF OPEN POROSITY BY MERCURY POROSIMETRY (OP-1026158)

OPERAING PROCEDURE FOR DENSITY OF SI-C FRAGMENTS USING A SINK-FLOAT DENSITY GRADIENT COLUMN (OP-1025893

OPERATING PROCEDURE FOR ENVELOPE DENSITY OF U AND NON-U BASED MATERIAL BY MERCURY POROSIMETERY (OP-1025892)

OPERATING PROCEDURE FOR AGR COMPACTOR OPERATION (OP-1035101)

OPERATION PROCEDURE FOR DEBINE & HEAT TREATMENT OF AGR COMPACTS IN THE CENTORR FURNACE (OP-10335192)

OPERATING PROCEDURE FOR AGR OVER-COATING OPERATIONS (OP-1034965)

OPERATING PROCEDURE FOR INSPECTION OF AGR HEAT TREATED OR NON-HEAT TREATED FUEL COMPACTS (OP-1035118)

SFF OPERATOR OJT (E61-001A)

SAP REQUISITION & PURCHASE ORDERS

BWX Technologies, Inc.

AGR COMPACT FABRICTION

READINESS REVIEW

BOOK 2-A

AGR DRAWINGS

AGR COMPACTING INTERIM STORAGE RACK UPRR-1004

FREUND VECTOR VFC-LAB 3 FLO-COATER SPECIFICATION DRAWING 46856-1

CENTORR PROCESS AND INSTRUMENT DIAG. 99-0189

MILLER TOOL & DIE AGR COMPACTING PRESS J26061-000-000

MILLER TOOL & DIE AGR COMPACTING PRESS J26061-100-000

MILLER TOOL & DIE BW AGR COMPACTOR SPRYER ASSEMBLY J26061-150-000

MILLER TOOL & DIE BW AGR COMPACTOR PRESS ASSEMBLY J26061-200-000

MILLER TOOL & DIE BW AGR COMPACTOR INDEX ASSEMBLY J26061-300-000

MILLER TOOL & DIE BW AGR COMPACTOR DIE MOUNT ADAPTER J26061-400-001

AGR COMPACTTOR LOAD CARTRIDGES UPRR-10016

AGR COMPACT CALIBRATION PLATES UPRR 10027

AGR BOAT UPRR10041

AGR COMPACTING GLOVEBOX UPRR-10065

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Appendix B
Readiness Review Attendance Sheet

AGR-5/6/7 COMPACT FABRICATION
READINESS REVIEW ATTENDANCE ROSTER

Vendor BWXT

Dates 1/17/17 – 1/18/17 Location Lynchburg, VA

Technical Lead Douglas Marshall Quality Engineer Michelle Sharp

Attendees:

NAME (Print)	POSITION	Entrance Meeting	Exit Meeting	Interviewed
Joseph Keeley	Mateial Specialist	✓		✓
Alvin Short	Process Engineer	✓		✓
Scott Wall	Chemist	✓		✓
JAMES A. BOOKS JR	FLM CHEM LAB	✓		
Kelly Hartless	Process Engineer	✓		✓
AARON JONES	Process Engineer	✓		✓
Karen Crosby	Chemist			✓
Scott Wall	Chemist			✓
Grant Ward	ChemLab Tech.			✓
Monica Culpepper	Fuel Tech B			✓
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Comments:

Appendix C
Readiness Review Plan

Readiness Review Criteria
AGR-5/6/7 Compact Fabrication

The following focus areas are subject to scrutiny by the readiness review team as each applies to LEU fuel compact fabrication activities (e.g., overcoating, compacting, etc.) described in SOW-11518 (Rev. 10) "AGR-5/6/7 Fuel Fabrication." INL will focus the areas below as they apply to LEU fuel compact fabrication, but INL will respond to the information and objective evidence obtained and follow leads as necessary to assess readiness.

A visit to the processing area is requested to allow reviewers to see the equipment and make limited inspections of calibration stickers and equipment condition.

References to NQA-1 mean ASME-NQA-1-2008/1a-2009. The outline below may not quote the entire text of each referenced paragraph within a NQA-1 requirement. Nevertheless, objective evidence may be requested by the review team to demonstrate compliance with all requirements within the referenced paragraph.

Documents and objective evidence presented by BWXT to INL should be associated with activities related to the AGR fuel fabrication. It is understood that BWXT has the prerogative to either refuse presentation of evidence that may contain classified or sensitive information or to present redacted documents as evidence of compliance.

Focus Area	Suggested Objective Evidence
I. Process instrumentation and M&TE calibrations a. Tools, gages, instruments, etc. are controlled, calibrated, adjusted, and maintained to required accuracy limits (NQA-1 Req't 12 ¶100) b. Calibrations performed at prescribed intervals against traceable or certified equipment/standards (NQA-1 Req't 12 ¶301) c. M&TE consistently found out of calibration is repaired or replaced (NQA-1 Req't 12 ¶303) d. When M&TE is found out of calibration or damaged, data collected since the last known acceptable calibration shall be evaluated for acceptability (NQA-1 Req't 12 ¶303.2) e. M&TE calibration status can be readily determined by inspection and documented (NQA-1 Req't 12 ¶303.6, 401 - 402)	• List of calibrated process instruments with dates of most recent and next pending calibration checks • List of tools, gages, weights, etc. that require calibration with dates of most recent and next pending calibration checks • Evidence that the calibrations are traceable to certified equipment or standards • Acceptability evaluations for M&TE out of calibration • Procedure and evidence of product re-evaluation when M&TE is found out of calibration or damaged • Visual inspection of calibration stickers on a sampling of M&TE

Focus Area	Suggested Objective Evidence
II. Approval, control, and accessibility of operating procedures and analytical methods a. Activities affecting quality prescribed by and performed in accordance with documented instructions, procedures, etc. (NQA-1 Req't 5 ¶100) b. Operating procedures and instructions are controlled to ensure the latest revision is used (NQA-1 Req't 6 ¶100) c. Operating procedures and instructions are reviewed and approved prior to releasing them for use (NQA-1 Req't 6 ¶100) d. Documents and changes to documents are controlled (NQA-1 Req't 6 ¶200) e. Test (process) requirements and acceptance criteria based upon documented specifications [NQA-1 Req't 11 ¶200(b); 300(a-b)] f. Review, authorization, and control of operator instructions (e.g., recipe sheets)	• Binder containing copies of current operating procedures applicable to activities associated with fuel compact fabrication and analytical methods for characterization • Evidence that only the current procedures and instructions are available to those performing the work • Evidence that changes to controlled instructions, methods, or procedures are authorized by management • Evidence of operating instructions or recipe sheets being authorized • Records showing how performers know that they have the latest recipe sheet/instruction version Of particular interest are the reviews and changes associated with the operations stand down this past summer.
III. Process record control and accessibility a. Records are validated or authenticated by authorized personnel [NQA-1 Req't 17 ¶300(a)]	• Records management procedure • Examples of validated/authenticated AGR records – inspection reports, training records, etc.

Focus Area	Suggested Objective Evidence
IV. Configuration design and control a. Procedures established to implement configuration management and responsibilities/authorities are identified (NQA-1 Req't 3 ¶601) b. Configuration changes affecting quality are (NQA-1 Req't 3 ¶601.1 – 601.9): i. Recognized before implementation ii. Analyzed against design bases and requirements iii. Approved by responsible persons iv. Documented (incl. basis) c. Controls are established to ensure that only correct and accepted items (e.g., materials of construction) are used or installed (NQA-1 Req't 8 ¶100 - 303)	• Documentation associated with recent maintenance or configuration changes
V. Operator training, certification and qualification a. Indoctrination and training (NQA-1 Req't 2 ¶200) b. Performers indoctrinated and trained (NQA-1 Req't 2 ¶201) c. Formal training program (NQA-1 Req't 2 ¶202)	• Training plans, training rosters, etc. showing completion of required training, qualifications, or certifications or how they will be completed to support compact fabrication • Management concurrence that training was completed and effective • Staffing plan showing adequate personnel are trained and available to support timely fuel compact fabrication and analysis

Focus Area	Suggested Objective Evidence
VI. Chemical inventories for fabrication and chemical characterization a. Chemical inventories are sufficient for expected needs or a plan is in place to acquire chemicals before the inventory is depleted. b. Chemical shelf-lives will not be exceeded during the period of compact fabrication (NQA-1 Req't 8 ¶302) c. Chemicals comply with SPC-1363, "AGR-5/6/7 Fuel Fabrication Feedstock Chemical Purity Specifications," Rev. 3 (or latest revision)	• Chemical certificates of conformance and expiration dates (as applicable) for other than government furnished chemicals and materials • Evidence that expired chemicals and materials are isolated to prevent inadvertent use • Spreadsheet of process and analytical chemicals with: ○ Quantities on hand ○ Quantities needed for 25% and 40% PF compacting (2-batches each, minimum) ○ Plans to augment any deficient inventories ○ Purified water supply is available
VII. Consumables inventory is adequate for expected needs and spares	• Quantities of packing materials, mold release feed lines, critical spares, etc. needed to support fabrication and shipping • Quantities currently in inventory • Plans to augment deficient inventories
VIII. Material procurements a. Procured from qualified suppliers (or with commercial grade dedication) (NQA-1 Req't 4 ¶100; NQA-1 Req't 7 ¶100, 700) b. Technical & functional requirements and non-conformance reporting requirements are communicated to suppliers (NQA-1 Req't 4 ¶202, 206; NQA-1 Req't 7 ¶501 - 503) c. Receiving inspection is performed to verify conformance with technical and functional requirements (NQA-1 Req't 7 ¶505)	• Sample procurement documents • Qualified supplier list (as applicable to compact fabrication) • Evidence that technical and functional requirements were communicated to the vendor • Evidence of receipt inspections being completed and conformance of items to the technical and functional requirements
IX. Operability of essential equipment for fabrication and dimensional characterization	• Equipment walk-down to inspect equipment and instrumentation for out-of-service tags, current calibrations, general condition, etc. • Data from recent operation

Focus Area	Suggested Objective Evidence
X. Corrective action system effectiveness to capture "lessons learned" a. Conditions adverse to quality identified and corrected ASAP (NQA-1 Req't 16 ¶100) b. Significant conditions adverse to quality investigated to determine the cause and actions taken to prevent recurrence (NQA-1 Req't 16 ¶100) c. Significant conditions and corrective actions are documented and reported to appropriate management (NQA-1 Req't 16 ¶100) d. Completion of corrective actions is verified (NQA-1 Req't 16 ¶100)	• Documentation of conducted reviews/audits; including the moderator control incident and the stand down, findings involving the fuel fabrication processes, and corrective actions taken • Evidence demonstrating that the corrective actions are still effective (lessons learned are not forgotten)
XI. Product acceptance a. Inspection for acceptance by an independent, qualified person (NQA-1 Req't 10 ¶100) b. Inspection requirements and acceptance criteria are specified and documented (NQA-1 Req't 10 ¶200) c. Sampling procedures based on standard statistical methods with engineering approval (NQA-1 Req't 10 ¶402) [INL sampling plan, PLN-4352 Rev. 4 is used] d. Performance of the analytical laboratory in product characterization i. ASTM or other standards used ii. Internal standards are documented and traceable to national standards e. Acceptance is approved by authorized personnel (NQA-1 Req't 10 ¶604)	• Documentation showing acceptance or rejection of product to documented criteria/specifications • Documentation that sampling procedures provide representative samples in quantities sufficient to satisfy the sampling plan • Evidence that analytical results are reviewed for quality and approved prior to official release

Focus Area	Suggested Objective Evidence
XII. Handling and Storage a. Product stored to prevent loss, damage, and minimize deterioration (NQA-1 Req't 13 ¶100, 200, 300) b. Product containers are marked or labeled with special handling/storage requirements (NQA-1 Req't 13 ¶600) c. Controls are in place to prevent inadvertent use of non-conforming product [NQA-1 Req't 15 ¶100, 300(a-b)] d. Non-conforming product shall be evaluated for alternative use or disposition (NQA-1 Req't 15 ¶401) e. The disposition of non-conforming product shall be documented (NQA-1 Req't 15 ¶404)	• Procedures and documents showing how product is segregated from non-conforming material and controlled to prevent loss of identity • Procedures and documents for individually identifying and packaging the compacts for storage and eventual shipment to INL • Format for uniquely identifying compacts in accordance with SOW-11518 has been documented and implemented in procedures
XIII. Personnel have access to and are familiar with the latest AGR work scope and requirements documents a. SOW-11518, "AGR-5/6/7 Fuel Fabrication," Rev. 10 b. SPC-1352, "AGR-5/6/7 Fuel Specification," Rev. 7 c. SPC-1363, "AGR-5/6/7 Fuel Fabrication Feedstock Chemical Purity Specifications," Rev. 3 (or latest revision) d. PLN-4352, "Statistical Sampling Plan for AGR-5/6/7 Fuel Materials," Rev. 5	• Show how superseded AGR documents are controlled • Show how current AGR documents are controlled

Focus Area	Suggested Objective Evidence
XIV. Miscellaneous Items a. Laboratory work space (lab bench and hood) has been allocated for conducting analyses b. Equipment is in operable condition c. Critical spares are on hand for higher probability failures (I/O cards, thermocouples, etc.) d. The number of compact boats is adequate to support handling of 'green', in-process, and heat-treated compact handling operations e. Compact boats are marked to maintain orientation and compact identities	• Walk down of laboratory space and interview with analytical personnel • Maintenance logs are complete • QCDNs on associated equipment have been written and corrective actions taken to restore functionality • List of critical spares needed, inventory of spares, and plans to address inventory shortages • List of volumetric feeder inserts in inventory (6.6 cc – 7.6 cc) with dimensions and verified capacities

Prepared by

Quality Engineer _____

Technical Lead _____