

Graphite Licensing (ASME) and Testing (ASTM) Technical Assistance

Michael E Davenport

August 2020



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

Graphite Licensing (ASME) and Testing (ASTM) Technical Assistance

Michael E Davenport

August 2020

**Idaho National Laboratory
Idaho Falls, Idaho 83415**

<http://www.inl.gov>

**Prepared for the
U.S. Department of Energy**

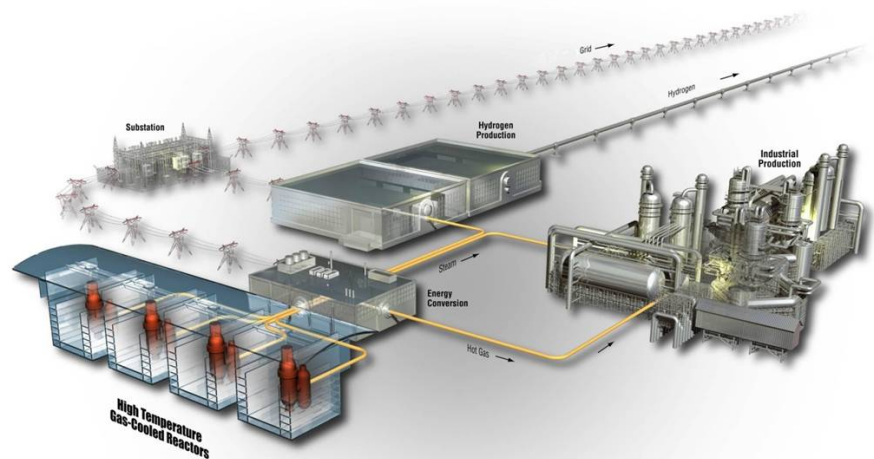
**Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517**

Statement of Work

Project No(s): 23747, 23843, 23841

Graphite Licensing (ASME) and Testing (ASTM) Technical Assistance

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



Idaho National Laboratory

GRAPHITE LICENSING (ASME) AND TESTING (ASTM) TECHNICAL ASSISTANCE	Identifier:	SOW-17598
	Revision:	0
	Effective Date:	07/14/2020

Page 2 of 9

ART Program	Statement of Work	eCR No. 679965
-------------	-------------------	----------------

Signatures			
Signature and Typed or Printed Name	Signature Code	Date (mm/dd/yyyy)	Organization/Discipline
See eCR 679965	P	See eCR 679965	ART Graphite R&D Technical Lead
William E. Windes			
See eCR 679965	R	See eCR 679965	Quality Assurance
Michelle T. Sharp			
See eCR 679965	A	See eCR 679965	INL ART Program Manager
Travis R. Mitchell			

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.

REVISION LOG

[illegible]

GRAPHITE LICENSING (ASME) AND TESTING (ASTM) TECHNICAL ASSISTANCE	Identifier:	SOW-17598
	Revision:	0
	Effective Date:	07/14/2020
Page 4 of 9		

CONTENTS

1. INTRODUCTION5

1.1 Background.....5

1.2 Purpose / Objectives.....5

1.3 Anticipated Benefits.....5

2. APPLICABLE CODES AND REFERENCES.....6

3. SCOPE6

3.1 Work to be Performed.....6

3.2 Work Excluded6

3.3 Requirements7

3.4 Place of Performance8

3.5 Interfaces8

3.6 Miscellaneous8

4. DELIVERABLES8

5. SCHEDULE AND MILESTONES.....8

6. COMPLETION CRITERIA AND FINAL ACCEPTANCE.....9

7. APPENDICES.....9

8. ATTACHMENTS9

GRAPHITE LICENSING (ASME) AND TESTING (ASTM) TECHNICAL ASSISTANCE	Identifier: SOW-17598 Revision: 0 Effective Date: 07/14/2020 Page 5 of 9
--	--

1. INTRODUCTION

1.1 Background

DOE ART Graphite R&D program is currently involved in developing the structural code for licensing the new High Temperature Reactor (HTR) designs through the ASME Boiler Pressure Vessel Code (BPVC). The basic structural design code for graphite core components has been written, approved, and within the BPVC since 2012. However, several areas within the graphite code remain to be improved, specifically the addition of material property changes resulting from environmental degradation (neutron flux and oxidation). The incorporation of this data, which can significantly affect the graphite components and alter the structural integrity of the core during operation, is proving to be an important activity. How this data will be incorporated within the code and how it will be used for license applications will be critical to a number of HTR applicants in the future. These modifications to the code must address the unique irradiation and oxidation response of the wide spectrum of available nuclear graphite grades currently under consideration for HTR applications.

Additionally, the ASME BPVC requires material property testing within the expected operational conditions of the HTR core including neutron radiation flux, elevated temperatures, and after chronic/acute oxidation of the graphite components. Currently, no standardized graphite testing methods are approved for these environmental conditions. New American Society for Testing and Materials (ASTM) standardized tests for elevated temperature testing, small sample testing, and testing after oxidation must be developed to support the requirements within the ASME code.

1.2 Purpose/Objectives

Dr. Martin Metcalfe (formerly of the United Kingdom's National Nuclear Laboratory) has 42 years' experience working in research and development (R&D) and consultancy within the nuclear industry with several interconnected organizations, commencing with the Central Electricity Generating Board (CEGB) through Nuclear Electric, Magnox Electric, British Nuclear Fuels, LTD. (BNFL), Nexia Solutions to finally the UK National Nuclear Laboratory. He has worked in the fields of reactor coolant chemistry, graphite technology, graphite core structural integrity assessment and graphite characterization. More recently he has focused on graphite waste treatment and management. These activities have included involvement in R&D, strategic development and management of R&D programs, consultancy, expert review, and line management. He is internationally recognized as an expert in graphite technology, being a founding member of the International Nuclear Graphite Specialist Meetings and former chair of the influential ASTM subcommittee for Manufactured Carbon and Graphite Products. Martin has been an Honorary Visitor at the Materials Performance Centre, University of Manchester for more than 10 years and was recently appointed Honorary Professor to the Nuclear Graphite Research Group at the University of Manchester.

GRAPHITE LICENSING (ASME) AND TESTING (ASTM) TECHNICAL ASSISTANCE	Identifier: SOW-17598 Revision: 0 Effective Date: 07/14/2020 Page 6 of 9
--	--

Dr. Metcalfe will assist with the development of the ASME code for graphite core components using his extensive qualifications in nuclear graphite and nuclear reactor operations. Additionally, Dr. Martin will assist in the development of new ASTM testing standards as well as the modifications to existing standards for graphite testing.

Specifically, Dr. Martin will attend ASME Code Week and ASTM meetings assisting in the continued development of the code and standards. He will assist in technical research, data analysis, development of methodology, and modification of the actual code within the ASME BPVC. For the ASTM, he will introduce new graphite ASTM test standards based upon his understanding of the ASME material property requirements, modify any existing standards to improve the testing method, and assist in the periodic updating of current graphite ASTM test standards.

1.3 Anticipated Benefits

The addition of environmental degradation behavior for graphite core components is a critical component of the ASME code. Understanding the effects of the irradiation dose, high temperature, and oxidation behavior is key to calculating the probability failure of components and the structural integrity of the graphite core. Currently, significant amounts of irradiation and oxidation data from research facilities exist but the data have not been codified. This effort will allow the data to be incorporated within the BPVC and utilized by HTR applicants for NRC license. Without incorporating this data within the code the applicants would be required to generate new irradiation, high temperature, and oxidation data.

Additionally, new approved material property test standards for elevated temperature and after oxidation as well as small sample mechanical strength tests will be required under current ASME code rules. The development of these new test standards will be critical to the viability of the ASME code for licensing applicants.

2. APPLICABLE CODES AND REFERENCES

None for this scope of work.

3. SCOPE

3.1 Work to be Performed

Dr. Martin Metcalfe will attend two ASME code week meetings and one ASTM DO2.f meeting in the year 2020.

- A. ASME: Utilizing his significant experience in graphite behavior within nuclear reactor environments Dr. Metcalfe will participate in the discussions, analysis, and eventual modifications of the code to properly encompass the expected behavior of the graphite components. Specifically:

Idaho National Laboratory

GRAPHITE LICENSING (ASME) AND TESTING (ASTM) TECHNICAL ASSISTANCE	Identifier: SOW-17598 Revision: 0 Effective Date: 07/14/2020
--	--

Page 7 of 9

- a. He will assist in the development of ASME code incorporating the irradiation, high temperature, and oxidation degradation data existing from the USA and other international sources.
 - b. He will assist in the general duties of the ASME Nonmetallic Design and Material working groups.
 - c. He will attend various ASME working group and subgroup meetings within Code Week as directed by Will Windes (INL).
- B. ASTM: Dr. Metcalfe will assist in the introduction and development of new ASTM test standards. Specifically:
- a. He will assist in the completion of the new small sample “split disk” test standard.
 - b. He will assist the INL (Austin Matthews) in developing a new mechanical strength after oxidation test standard.
 - c. He will assist in the general duties of an ASTM committee member.
- C. ASTM STP Publication: Dr. Metcalfe will lead the effort in a new ASTM Selected Technical Papers (STP) publication focusing on testing of irradiated and degraded graphite specimens. Duties will include assembling the required authors who will submit papers, developing and participating in the formal review committee of papers, and coordinating the STP meeting where the papers will be presented. It is anticipated that this STP meeting can be held in conjunction with the next INGSM meeting in 2021.

3.2 Work Excluded

Dr. Metcalfe will not be required to undertake leadership roles for ASME or ASTM.

3.3 Requirements

Dr. Metcalfe will provide Idaho National Laboratory (INL) with written documentation (through e-mail) of his progress in both ASME and ASTM duties. Specifically:

- A. He will provide a written status report after each meeting (ASME and ASTM) documenting the progress of ASME code and ASTM test standard development. These reports will include any analysis, assessments, and code/standard modifications.
- B. He will provide periodic email status reports on the progress of the STP publication.

GRAPHITE LICENSING (ASME) AND TESTING (ASTM) TECHNICAL ASSISTANCE	Identifier: SOW-17598 Revision: 0 Effective Date: 07/14/2020 Page 8 of 9
--	--

3.4 Place of Performance

Dr. Martins activities will be performed at his private residence or a similar location. He will physically attend one ASME and one ASTM meeting if COVID-19 travel restrictions allow. The remaining meetings shall be conducted through telecommuting unless Dr. Martin agrees to attend the meeting physically. All other activities (report writing, analysis, assessments, code writing) will occur at his private residence or a similar location.

3.5 Interfaces

None

3.6 Miscellaneous

None

4. DELIVERABLES

4.1 Dr. Martin Metcalfe shall attend two ASME code week meeting and two ASTM D02.f meeting in the year 2020. Due to the COVID-19 restrictions some or all of these meetings may be designated as virtual meetings and will need to be attended through telecommuting processes.

4.1.1 ASME Code Week

(August 16 – 20, 2020), Washington Marriott Wardman Park,
Washington, DC

(November 8 – 13, 2020), Westin Peachtree Plaza, Atlanta, GA

4.1.2 ASTM D02 Meetings

(June 28 - July 02, 2020), Washington Marriott Wardman Park,
Washington, DC USA.

(December 6 - 10, 2020), JW Marriott Austin; Austin, TX USA

4.2 Dr. Metcalfe will provide a written status report after each meeting (ASME and ASTM) documenting the progress of ASME code and ASTM test standard development. These reports will include any analysis, assessments, and code/standard modifications.

4.3 Dr. Metcalfe will provide periodic electronic status (i.e., email) on the progress of the ASTM STP publication.

Idaho National Laboratory

GRAPHITE LICENSING (ASME) AND TESTING (ASTM) TECHNICAL ASSISTANCE	Identifier: SOW-17598
	Revision: 0
	Effective Date: 07/14/2020 Page 9 of 9

- 4.4 Dr. Metcalfe will issue a final status report of his activities during year 2020 to INL on or before December 31, 2020

5. SCHEDULE AND MILESTONES

- 5.1 Dr. Metcalfe will attend meetings and contribute to ASME code development and ASTM test standard development through 2020.
- 5.2 Dr. Metcalfe will issue a final status report of his activities during year 2020 to INL on or before December 31, 2020.

6. COMPLETION CRITERIA AND FINAL ACCEPTANCE

Year 2020 activities are considered complete once the final status report has been delivered to INL.

7. APPENDICES

None

8. ATTACHMENTS

None