**SUMMARY**

*Andrew has more than 27 years of professional experience in the United Kingdom and the United States working on and leading multi-disciplinary and multi-national projects in the fields of reactor physics, fuel and core design, plutonium disposition, fuel development and fuel cycle strategy (technical, economics, and safeguards). A delivery-focused Nuclear Engineer with demonstrated expertise and experience in performing, managing and leading international, multi-disciplinary and multi-agency projects and programs for a range of sponsors in the U.S., the U.K., and Europe. An extensive track record of working with a range of stakeholders, including sponsors, senior managers, government agencies, universities, regulators, and industry, both domestically and internationally. Experienced in initiating, leading and delivering on multi-organizational and multi-national programs, and is an effective communicator and collaborator. Recognized strategist, able to make complex arguments (technical and strategic) understood by a range of stakeholders and aid/lead them through the decision making process.*

*Andrew is currently the ‘Integrated Fuel Cycle Section Head’ in the ‘Nuclear Energy and Fuel Cycle Division’ at ORNL, and the Deputy Director of the Gateway for Accelerated Innovation in Nuclear (GAIN), a U.S. Department of Energy Office of Nuclear Energy (DOE-NE) initiative. In 2014, DOE-NE appointed Andrew as the Laboratory Lead Coordinator for nuclear energy research programs with the U.K.*

*Andrew is a Chartered Physicist (CPhys), a Fellow of the Institute of Physics (FInstP), and formerly a Royal Academy of Engineering Professor of Nuclear Engineering in the U.K. In January 2021 Andrew, as part a multi-laboratory project, was awarded the U.S. Secretary of Energy’s Achievement Award. In May 2021, he was given the Award for Outstanding Alumni by Lancaster University, UK, for “an outstanding national and international reputation”.*

**EDUCATION**

*University of Birmingham, U.K.*

**Master of Science in “Physics and Technology of Nuclear Reactors”**, October 1993

Thesis title: *Advanced Mixed Oxide (MOX) Fuel Designs for Boiling Water Reactors*

*Lancaster University, U.K.*

**Bachelor of Science in Applied Physics,** June 1992

**WORK EXPERIENCE**

*UT-Battelle, LLC working at the Oak Ridge National Laboratory*

*01/16-Present* **Section Head, Integrated Fuel Cycle**

**Nuclear Energy and Fuel Cycle Division (NEFCD)**

**Section Head, Integrated Fuel Cycle**

Provides Research and Development (R&D) leadership to this key thematic area, integrating several key research Groups. Works closely with the Division Director and other Section Heads and Group Leaders across the organization to establish amd implement the science and technology direction for the Section. support the Group Leaders to ensure their success and the success of the R&D groups as world-recognized leaders in their fields; ensure that staff members understand business opportunities; identify links to current and future funding opportunities and R&D programs; develop and implement consistent processes for the peer-review of proposals consistent with lab standards; model proper Environment, Safety, Security, Health, and Quality practices; and ensure a diverse and inclusivework environment where every employee feels safe, heard and appreciated—a workplace that sets an example for the broader community.

**Deputy Director, Gateway for Accelerated Innovation in Nuclear (GAIN)**

Deputy Director of the Gateway for Accelerated Innovation in Nuclear (GAIN), responsible for the overall management and integration of this U.S. Department of Energy, Office of Nuclear Energy (DOE-NE) multi-million dollar national initiative. GAIN provides the nuclear community with access to the technical, regulatory, and financial support necessary to move innovative nuclear energy technologies toward commercialization while ensuring the continued safe, reliable, and economic operation of the existing nuclear fleet.​ Involves leading on interactions with industry, DOE senior management, national laboratories, and other diverse stakeholders.

**U.K. Country Coordinator**

A national position on behalf of and nominated by U.S. DOE-NE. Based on demonstrable track record and knowledge of governments, national research programs, organizations and individuals, appointed to this key national position, approved by Deputy Secretary (Nuclear), Dr. Pete Lyons. Responsible for leading and coordinating the government-to-government agreement between the U.S. and U.K. on civil nuclear R&D cooperation.

**Fuel Cycle Technology Integration Leader**

Senior leader responsible for developing and delivering on Directorate and Division strategy, providing technical leadership, coordination and integration for the numerous and diverse nuclear energy related fuel cycle R&D activities within the division consistent with existing programmatic missions and emerging opportunities. Works directly for and with the Associate Laboratory Director and Division Director. Fuel cycle R&D leadership areas of responsibility include nuclear fuel cycle systems analyses for open, limited recycle (such as MOX fuel cycles) and closed fuel cycles, actinide transmutation in thermal and fast reactors and externally driven systems, evaluation of uranium, plutonium and thorium fuel cycles, fuel resources, fuel manufacturing, materials recovery, materials safeguards and security, used fuel management and disposition, and waste forms. Leads the integration of safeguards concepts and approaches, and safeguards technology into advanced reactors and advanced fuel cycles.

In 2017, he was invited by the ANS President to lead on and present the Nuclear Grand Challenge for ‘Closing the Nuclear Fuel Cycle’, a reflection of his standing in ANS and as a leader in this area.

*06/12–01/16* **Senior Reactor Design and Analysis Engineer**

**Reactor Physics Group, Reactor and Nuclear Systems Division (RNSD)**

Responsible for managing, leading and delivering R&D programs across groups and sponsors in and outside of RNSD. Primary sponsors are the Department of Energy’s Office of Nuclear Energy (DOE-NE), and the National Nuclear Security Administration (NNSA). Principal Investigator for technical projects, and Nuclear Energy University Programs involving fuel cycle options evaluations, spent fuel characterization for safeguards, and development and demonstration of inventory codes. Provides technical support and advice to modeling and simulation capability within RNSD including CASL, and development of staff and interns, and has initiated and developed new training program materials based on previous international experience and expertise e.g., core design and the nuclear fuel cycle. Involved in a number of international activities, building on previous experience and expertise, and initiated a number of new opportunities with the U.K., both at the laboratory and government levels. Specific examples of projects/activities [sponsors] include:

* DOE Office of Nuclear Energy U.K. Country Coordinator. Based on demonstrable track record and knowledge of governments, national research programs, organizations and individuals, appointed in this key national position, approved by Deputy Energy Secretary, Dr. Pete Lyons. [DOE-NE]
* Molten Salt Reactor national programs. Responsible for the development of the technical strategy for fuel cycle and safeguards integrated research. [DOE-NE/NNSA]
* Fuel Cycle Options Campaign, Laboratory Lead for transition analysis and fuel cycle assessment methods and analysis. Utilized U.K. links and experience, initiated and leading the adoption of U.K. fuel cycle analysis software (ORION) to support U.S. research, and addressing ‘real world’ challenges and limitations on fuel cycle deployment to inform on future U.S. research needs. [DOE-NE]
* Plutonium Management Expert Group, U.S. representative on bilateral agreements with France, Japan, and U.K. Using expertise and experience from an industrial MOX background, plutonium strategy advice to U.K. government, and safeguards, able to provide insight and advice on international plutonium management issues from a range of technical, and strategic perspectives. Includes support to the ADR project for DOE-NE. [NNSA/DOE-NE]
* Accident Tolerant Fuels (ATF), Laboratory Lead for LWR neutronics and fuel performance, and co-PI on NEUP “Performance Assessment of Enhanced Accident Tolerant Fuels within Aggressive Operational Power Histories” (University of Tennessee). Supporting U.S. national program leads, including drafting recent IRP University call on ATF. [DOE-NE].
* Next Generation Safeguards Initiative (NGSI) Spent Fuel, PI. Technical and project management experience utilized to ensure project deliverable were achieved, and clarity provided to sponsor regarding scope, objectives, and milestones. Experience in fuel and reactor analysis used to improve overall analysis for project. [NNSA]
* New Passive Technique for Quantification of Plutonium, PI. Managing and delivery of experimental and modeling analysis of spent fuel samples. [NNSA]
* Development of Fuel Cycle Data Packages for Thorium Fuel Cycle Options, ORIGEN-based Nuclear Fuel Depletion Module for Fuel Cycle, co-PI. Using knowledge of SCALE toolset, and needs in fuel cycle modeling, and evaluation and screening, was able to direct proposals to ensure impactful and successful funding for Universities involved (Vanderbilt, University of Tennessee). [DOE-NE]
* Safety and regulatory issues of the thorium fuel cycle. Based on experience of irradiation programs in Europe, and knowledge of developments internationally, contributed significantly to overall report direction. Licensing experience was utilized to ensure appropriate review and issues were highlighted in final report. [Nuclear Regulatory Commission]
* Categorization of Used Nuclear Fuel Inventory in Support of a Comprehensive National Nuclear Fuel Cycle Strategy. Supported National Technical Director (NTD) related to broader fuel cycle implications and considerations of used fuel strategy, in particular related to potential that strategy may close off future options. Used experience on fuel cycle assessment to evaluate future plutonium needs in advanced fuel cycles. Led to recognition by ORNL Laboratory Director with Significant Event Award [DOE-NE].
* Initiated and leading on laboratory-to-laboratory (ORNL-NNL) collaborations in support of ORNL Associate Laboratory Director across nuclear technology and fuel cycle technical areas. Has resulted in 3-day visit by NNL on modeling and simulation collaboration related to future U.K. Nuclear Computing Centre of Excellence [NNCE].
* Initiated and lead on British Consulate-sponsored U.K. senior delegation visits to U.S. national laboratories. Identified and agreed scope with U.K. government, identified key participants from U.S. and U.K., and organized a number of key visits. [U.K. Govt].
* Lectures (included invited) at number of U.S. Universities on reactors, fuel cycle, and safeguards. Includes invited lecture at the Elliott School of International Affairs, George Washington University on “*Separated Plutonium: Friend or Foe*?” [numerous].

*U.K. National Nuclear Laboratory (NNL), formerly British Nuclear Fuels Ltd (BNFL)*

*10/93 – 06/12* Positions of increasing responsibility in initiation and development of R&D programs, technical leadership in, and directing performance of nuclear R&D projects in the fields of nuclear fuels, reactors, fuel cycle technologies, and safeguards technologies, as well as project management, and staff supervision, development, and recruitment in support of Group, Division and NNL.

*04/07–06/12* **Technical Authority, Reactors and Fuels**

*{Equivalent to U.S.Senior Program Manager}*

**Fuels and Reactors Team; Fuel Cycle Solutions Division, NNL**

Responsible for the technical direction, management, quality, approval and delivery of all reactors and fuels programs across NNL, including NNL’s own Reactors and Fuels Signature Research Program. Responsibilities included development of international links, domestic program development, and capability development (staff, and products and services). Primary sponsors included the Nuclear Decommissioning Authority (NDA), Department of Energy and Climate Change (DECC), EdF Energy, and Office of Nuclear Regulation (ONR). Primary focus/role was U.K. national lead for the technical evaluation and strategy for reactor-based plutonium disposition for NDA, and providing associated strategic advice to U.K. government (NDA and DECC). Specific examples of projects/activities [sponsor] include:

* U.K. Government plutonium management strategy, specifically reactor re-use from a licensing, technical, safety, strategic, economic and non-proliferation perspective, National Lead. Resulted in “Plutonium Credible Options” paper and public consultation, and underpinned U.K. government policy on reactor re-use. [NDA].
* Reactors and Fuels Signature Research Program, National Lead. Responsible for NNL’s internal re-investment of funding in reactors and fuels products and services. This program ensured a sustainable research base, focusing on national objectives. E.g., program resulted in development of ENIGMA and NEXUS (fuel performance codes), ORION (fuel cycle modeling code), and an integrated strategy as the basis for the Nuclear Fuel Center of Excellence (NFCE). Produced a laboratory-wide “capability brochure” to summarize, capture and promote reactor and fuels capabilities in NNL as a resource, and used with sponsors and executives to promote expertise. [NNL]
* Industry partner in DOE-NE Global Nuclear Energy Partnership (GNEP) and subsequent support programs, Lab Lead. Direct technical lead and management for the collaboration’s contributions to advanced fuels, NEAMS and fuel cycle R&D programs, bringing unique industrial experience, including licensing and economics, to the program e.g., use of Np in MOX fuel, multiple recycle of materials, including uranium. [Energy Solutions/DOE-NE]
* Assessment of advanced reactor systems against U.K. performance metrics, National Lead. Led the early development of metrics, and analysis of advanced reactors against those metrics for application in the U.K. to assist U.K. government in research priorities in the medium to long term. [DECC]
* Justification for new nuclear build in the U.K., NNL lead. Working with other consultancy organizations, underpinned the technical data and justification for new build in the U.K., including review of submittals by each of the nuclear utilities. [DECC]
* U.K. nuclear naval propulsion expert panelist for severe accident, and thermal hydraulics working groups, National Lead. Invited to review panels based on broader nuclear expertise, and challenging approach to technical design and safety cases. [Rolls Royce/Ministry of Defence]
* Proliferation risk and physical protection, Lab Lead. Developed a proliferation risk assessment methodology that was adopted by U.K. government for informing on policy decisions (including plutonium management). Work also required giving evidence to a Royal Society study that provided recommendations to the U.K. government and international community regarding the future direction of the nuclear fuel cycle. [NDA/DECC]
* Initiated and developed domestic and international links and opportunities with U.S.national laboratories, Institute of Nuclear Materials Management (INMM), and Foreign and Commonwealth Office U.K.-U.S.Collaboration Development Award Programme, National Lead. Actively sought out collaboration and funding opportunities in support of future U.K. national programs. [DECC]
* Authored influential position papers on the Thorium fuel cycle, Small Modular Reactors and U.K. nuclear energy scenarios, Lab Lead. Resulted in extensive sponsor interest including U.K. government’s commissioning of a “Nuclear Energy Roadmap”, and U.K. nuclear scenario development. [DECC]
* Euratom Framework Programs (FPs) Work Package leader on design, analysis and irradiation of thorium fuels in LWRs. Responsible for the fuel and core design analysis of LWR concepts, and co-ordination of international activities across four organizations in four different countries. [EU]
* Advisor on the design and implementation of European Atomic Energy Community (Euratom) research policy in advanced nuclear systems, nuclear safety, and training, over a 5 year period, equating to a $250m program. [EU]
* Independent Expert Evaluator for Euratom FP-7 proposals across fuels, reactors and recycle programs, equating to a $50m program. [EU]
* Royal Academy of Engineering Professor in Nuclear Engineering. An elected position, endorsed by the highly prestigious Royal Academy, based on significant contributions to nuclear education and research in the academic sector. Role involved providing lectures, research leadership and direction to U.K. leading nuclear academic researchers. [NNL]
* U.K. representative on European Technical Safety Organization Network (ETSON). Nominated position by the U.K. nuclear regulator (Office of Nuclear Regulation, ONR), which included review and recommendations of research needs associated with nuclear safety. Played a critical role in developing the foundation for the European Nuclear Safety Training and Tutoring Institute (ENSTTI) in Europe. [ONR]
* Professional development courses on reactor analysis and introduction to the nuclear fuel cycle. Initiated, developed and delivered a range of courses to utilities, vendors, and regulators, including Holtec, Horizon Nuclear Power, and ONR. [numerous]
* Development of U.K.-U.S.links. Received funding award from the U.K. Foreign & Commonwealth Office’s (FCO) Global Partnership Fund to develop links between researchers in the U.K. and US. As well as individual exchanges, organized and co-chaired a workshop at ORNL to establish connections between the U.K. and U.S.researchers with a specific focus on connecting R&D and nuclear facilities. This work led to the development of links between NEUP in the U.S.and EPSRC in the U.K. for academics. [FCO]

*10/02–04/07* **Team Manager**

*{Equivalent to U.S.National Laboratory Group Leader}*

**Advanced Reactors and Instrumentation, Research and Technology Division (R&T), BNFL**

Responsible for managing a multi-disciplinary team of 25+ staff, with a total team budget of ~$8m, distributed over tens of projects across multiple nuclear installations and sites, with multiple customers. The role included planning, project management, financial management, mentoring, staff and program development, and resource management. Included projects in the fields of fuels and reactor modeling and simulation, licensing support, fuel development and manufacturing, instrumentation development and testing on nuclear facilities (on fuel manufacturing and reprocessing facilities).

*03/99–10/02* **Senior Technology Manager**

**Nuclear Design Group, Fuel Engineering Division (FED), BNFL**

Responsible for leading a variety of projects in the fields of plutonium disposition, fuel and reactor analysis, fuel cycle assessment, both for domestic and international customers. Worked closely with BNFL commercial departments and executives to support sales of services and technologies associated with each project. Specific examples of projects/activities [sponsor] include:

* U.S.weapons plutonium disposition program, “MOX-USA”. Lead Author of the fuel qualification and reactor burn strategy in BNFL-Bechtel-Westinghouse-BWXT proposal on the Savannah River MOX fuel plant. Working in the U.S.with senior executives on a four-month proposal, writing technical and commercial text for the proposal to DOE/NNSA. [DOE/NNSA]
* AP600 and AP1000 MOX core analysis, Technical Lead. Designed and analyzed the first viable 100% MOX cores for AP600 and AP1000 in support of Westinghouse. Used as evidence and justification for the MOX capability of the reactor designs. [BNFL/Westinghouse]
* Development of Westinghouse IRIS (International Reactor Innovative and Secure) small modular reactor. Developed fuel and core designs for IRIS, including benchmark comparisons with international partners, MOX, and long life core concepts. Responsible for the funding and management of the IRIS consortium, through BNFL Corporate Centre. [BNFL/Westinghouse]
* Generation IV International Forum. Responsible for the project management and technical direction of the U.K.’s contribution to Generation IV across 3 reactor systems, and cross-cutting activities such as recycle and fuel cycle assessment. This included managing contributions from BNFL, other industrial partners (such as AMEC and SERCO), and the associated University programs (e.g., University of Manchester, Imperial College etc.). [DECC]
* BNFL’s Energy Unit, to promote with U.K. government the future need for nuclear energy. Responsible for generating the technical information to underpin the case for new nuclear build in the U.K., including determining U.K. needs for fuel and core design, writing papers on historic operating and maintenance and capacity factor effects on economics, identifying fuel cycle issues (e.g., ore availability, plutonium management, recycle etc.), and assessing the need for additional teaching and research capacity in the U.K. academic sector. [BNFL]
* International Science and Technology Centre (ISTC) plutonium management programs. U.K. representative on Euratom review boards of ISTC programs and proposals over several years. Worked closely with Russian and European scientists on development of research programs, including representing Euratom on senior delegation visit to Obninsk. [Euratom/BNFL]
* Design and licensing of BNFL’s first commercial MOX fuel irradiation in the Beznau reactor, Switzerland. Involved core tracking analysis of irradiation history of BNFL’s fuel to ensure within expected operating performance, and predictions of fuel and core were accurate compared with plant data. Generated detailed operating power histories to support fuel performance analysis and subsequent comparison with destructive post irradiation examination (PIE) for validation of neutronics (including inventory) and fuel performance for warranties of fuel. [BNFL]
* Organization of international conferences on behalf of the U.K. Organizational Chair for the OECD-NEA Advanced Reactors With Innovative Fuels (ARWIF) in Chester in 2001 (~100 attendees from ~15 countries), Studsvik Scandpower international User Group Meetings (UGMs) in 1999 and 2009 (~70 attendees from ~10 countries), and a five day international summer school on “Irradiated Fuel Management, Waste Treatment, Recycle and Decommissioning” on behalf of the Frederic Joliot and Otto Hann Summer School on Nuclear Reactors. [numerous]

*10/93–03/99* **Nuclear Design Engineer**

**Nuclear Design Group, Fuel Engineering Division (FED), BNFL**

Accomplishments and responsibilities included:

* Evaluation of Studsvik-Scandpower’s CASMO-SIMULATE core simulator analysis package for core design and analysis in support of BNFL’s LWR fuel business. Required assessment of a range of software packages for their technical methodologies, accuracy, user interface, documentation, and validation. Recommendation led to the adoption of CASMO-SIMULATE by BNFL for all LWR analysis.
* Core design analysis for U.K. Westinghouse PWR, Sizewell ‘B’. In parallel with lead design engineer, developed models and optimized core designs with CASMO-SIMULATE to demonstrate capability of tools. Several fuel and core designs were adopted and used in reloads.
* Development of advanced LWR MOX fuel designs. Using the U.K.’s WIMS-PANTHER core simulator tools, developed fuel concepts to better utilize U.K.’s separated plutonium in terms of energy output, and plutonium destruction rates. Once CASMO-SIMULATE was adopted by BNFL, work was repeated to ensure consistency in findings.
* Completed core design and economic analysis of reprocessed uranium fuels in PWRs. The European reprocessing customers required fuel and core designs to utilize the reprocessed uranium, as well as plutonium. Economics analysis underpinned the commercial case for use of recycled material compared with fresh ore.
* Assessed impact of plutonium quality on MOX core design and performance. The OECD-NEA and BNFL considered the potential to multiple-recycle MOX fuel to extract maximum energy from separated material. Reduction in fissile quality of material has impact on core performance (operational and safety) that was quantified, and demonstrated the limited number of times recycle could be completed for MOX fuel.

**CITIZENSHIP / SECURITY CLEARANCE**

British Citizen, United Kingdom

Legal Permanent Resident, United States of America

*06/03–06/12* U.K. government SC-level security clearance

*10/93-06/03* U.K. government BC-level security clearance

**HONORS & ACTIVITIES**

1. Fellow of the Institute of Physics
2. Chartered Physicist, Institute of Physics
3. Award for Outstanding Alumni, Lancaster University, UK (May 2021)
4. Secretary of Energy’s Achievement Award for contributions to the Department of Energy and the Nation, as part of the Spent Fuel Nondestructive Assay Project Team (January 2021)
5. Royal Academy of Engineering Professor in Nuclear Engineering, (2009-2014)
6. Visiting Professor at Imperial College, London (2009-2012)
7. Member of the American Nuclear Society (current)
8. Elected to the ANS Reactor Physics Division Executive Committee (current)
9. Elected to the ANS Reactor Physics Division Program Committee (2010-2013)
10. Elected to Board, American Nuclear Society (ANS) Oak Ridge/Knoxville Local Section (2013)
11. Elected Chair, ANS Oak Ridge/Knoxville Local Section (2014)
12. Member of the Institute of Nuclear Materials Management (current)
13. Member of the INMM Technical Program Committee (current)
14. Laboratory Director Significant Event Award *“in recognition of significant contribution to the ORNL-led, multi-laboratory technical assessment of the used nuclear fuel inventory”.*
15. Member of Laboratory Leadership Team (LLT), U.K. National Nuclear Laboratory, (2008-2011)
16. Chairman of Nuclear Industry Steering Committee for Post Graduate studies, University of Birmingham (2008-2012)
17. External Examiner for Masters in “Physics and Technology of Nuclear Reactors”, University of Birmingham (2004-2008)
18. Member of Post Graduate teaching and research steering committee, Imperial College, London (2009-2012)
19. Nuclear Expert Commissioner of the Policy Commission on “Nuclear Power: What does the future hold?” at the University of Birmingham, U.K.
20. Member of European Technical Safety Organisations Network (ETSON), on behalf of U.K. nuclear regulator (ONR).
21. Provided evidence to the U.K. Royal Society on non-proliferation and future fuel cycle issues in their study on stewardship of the nuclear fuel cycle
22. Member of International Technical Programme Committee, Session Organizer and similar roles for “Advances in Nuclear Fuel Management”, including panel chair at ANFM-V, GLOBAL, PHYSOR, as well as numerous ANS events.
23. Member of the OECD-NEA Working Party on Scientific Issues of Reactor Systems (WPRS)
24. Member of the OECD-NEA Task Force on Reactor Based Plutonium Disposition (TFRPD)
25. Member of the OECD-NEA WPRS publication group “Minor Actinide Burning in Thermal Reactors”
26. Reviewer for *Nuclear Technology, Annals of Nuclear Energy, Nuclear Engineering and Design, Progress in Nuclear Energy*.
27. Awarded *Outstanding Reviewer* status by Elsevier (2014)
28. Member of the Engineering and Physical Sciences Research Council Review College, U.K. (2009-present)
29. Member of the National Physical Laboratory (NPL) advisory panel on metrology for nuclear application
30. Member of the EURATOM Framework Program Review Committee
31. Member of the British Nuclear Energy Society’s Board of Trustees (2005-2008)

**PUBLICATIONS** (707 citations, h-index 12, i10-index 16, *Google scholar*)

# 

# Book Chapters

A. Worrall, Chapter 4, “Core and fuel technologies in integral pressurised-water reactors (iPWRs)”, in book by MD Carelli, DT Ingersoll, Handbook of Small Modular Nuclear Reactors, ISBN 978-0-85709-851-1

# Journal Articles (2016-current)

E Hoffman et al, "Reassessing Methods to Close the Nuclear Fuel Cycle", Annals of Nuclear Energy, July 2020

EE Davidson, BR Betzler, RWH Gregg, A Worrall, "Modeling a fast spectrum molten salt reactor in a systems dynamics fuel cycles code", Annals of Nuclear Energy, June 2019

N George, R Sweet, A Worrall et al, "Full Core Analysis for FeCrAl Enhanced Accident Tolerant Fuel in BWRs", Annals of Nuclear Energy, April 2019

BR Betzler, S Robertson, EE Davidson, JJ Powers, A Worrall, L Dewan, M Masie, "Fuel cycle and neutronic performance of a spectral shift molten salt reactor design", Annals of Nuclear Energy 119 (2018) 396–410

T Ault, S Krahn, A Worrall, A Croff, "Applications for Thorium in Multi-Stage Fuel Cycles with Heavy Water Reactors", Nuclear Technology, June 2018

BR Betzler, S Robertson, EE Davidson, JJ Powers, A Worrall, L Dewan, M Masie, "Fuel cycle and neutronic performance of a spectral shift molten salt reactor design", Annals of Nuclear Energy 119 (2018) 396–410

KW Hesketh, RWH Gregg, G Butler, A Worrall, "Key conclusions from U.K. strategic assessment studies of fast reactor fuel cycles", Annals of Nuclear Energy 110 (2017) 330–337

AL Qualls et al, “Preconceptual design of a fluoride high temperature salt-cooled engineering demonstration reactor: Motivation and overview”, Annals of Nuclear Energy 107 (2016) 144-155

BR Betzler, JJ Power, A Worrall, “Molten salt reactor neutronics and fuel cycle modeling and simulation with SCALE”, Annals of Nuclear Energy 101 (2017) 489–503

NR Brown, A Worrall, M Todosow, “Impact of thermal spectrum small modular reactors on performance of once-through nuclear fuel cycles with low-enriched uranium”, Annals of Nuclear Energy 101 (2017) 166–173

B Feng et al "Standardized verification of fuel cycle modeling", Annals of Nuclear Energy, 94 (2016) 300–312

NR Brown, et al, “Identification of fuel cycle simulator functionalities for analysis of transition to a new fuel cycle”, Annals of Nuclear Energy 96 (2016) 88-95

S Krahn, A Worrall, "The Reemergence of the Thorium Fuel Cycle: A Special Issue of Nuclear Technology", Nuclear Technology, Volume 194, May 2016, iii-iv

LG Worrall, A Worrall, et al "Safeguards Considerations for Thorium Fuel Cycles", Nuclear Technology, Volume 194, pp281-293, May 2016

BJ Ade, A Worrall, JJ Powers, SM Bowman, "Analysis of Key Safety Metrics of Thorium Utilization in LWRs", Nuclear Technology, Volume 194 pp 162-177, May 2016

# Conference Papers (2016-current)

A Rykhlevskii, BR Betzler, A Worrall, and K Huff, "Fuel Cycle Performance of Fast Spectrum Molten Salt Reactor Desgins", M&C2019, Portland, OR, Aug 2019

EE Davidson, BR Betzler, RWH Gregg, A Worrall, "Modeling a fast spectrum molten salt reactor in a systems dynamics fuel cycles code", Annals of Nuclear Energy, June 2019

TK Kim, TA Taiwo, BW Dixon, M Todosow, A Worrall, "Prospective Nuclear Fuel Cycle Characteristics of Advanced Nuclear Energy Systems, Global 2019, Seattle, WA, September 2019

A Worrall, BR Betzler, GF Flanagan, DE Holcomb, DN Kovacic, L Qualls, LG Worrall, "Molten Salt Reactors and Associated Safeguards Challenges and Opportunities", IAEA Safeguards Symposium, Vienna, Austria, November 2018

LG Worrall, E Collins, J Cooley, S Croft, B Davies, A Flavalli, B Grogan, V Henzl, K Hogue, A Krichinsky, N Luciano, A Swift, A Worrall, J Yang, "Safeguards Challenges and Safeguards Technology Needs Assessment for Leading Thorium Fuel Cycles, IAEA Safeguards Symposium, Vienna, Austria, November 2018

EE Davidson, BR Betzler, RHW Gregg, A Worrall, "Modeling a Fast Molten Salt Reactor with ORION", International Expert Meeting on Partitioning and Transmutation (IEMPT), Manchester, U.K., September 2018

DN Kovacic, LG Worrall, A Worrall et al, “IAEA Safeguards Challenges for Molten Salt Reactors”, INMM, Baltimore, MD, July 2018

A Sagedevan, S Chirayath, A Worrall, "Risk Informed Safeguards Approach for Molten Salt Reactors", INMM, Baltimore, MD, July 2018

EE Davidson, JL Peterson-Droogh, A Worrall, RWH Gregg, "A US-U.K. Collaboration on Fuel Cycle Assessment", ANS Winter Meeting, Washington, DC, October 2017

BR Betzler, JJ Powers, JL Peterson-Droogh, and A. Worrall, “Fuel Cycle Analysis of Thermal and Fast Spectrum Molten Salt Reactors”, Global 2017, Seoul, Korea, September 2017

A Worrall et al, “Transition to a Thorium-Based Fuel Cycle—Choices, Challenges, and Options”, ANS Winter Meeting, Las Vegas, NV, November 2016

BR Betzler, JJ Power, A Worrall, “Reactor Physics Analysis of Transitioning to a Thorium Fuel Cycle with Molten Salt Reactors”,  ANS Winter Meeting, Las Vegas, NV, November 2016

Bo Feng et al, “Transition to a U/Pu Fuel Cycle with Fast and Thermal Reactors”, ANS Winter Meeting, Las Vegas, NV, November 2016

E Hoffman et al, “Transition to Uranium-Based Fast Reactor Fuel Cycle Options”, ANS Winter Meeting, Las Vegas, NV, November 2016

E Hoffman et al, “Analysis of Transition to Fast Reactor U/Pu Continuous Recycle”, 14th Information Exchange Meeting on actinide product Partitioning and Transmutation (IEMPT), San Diego, CA, October 2016

M Todosow et al, “Fuel Cycle Impacts of Accident Tolerant Fuels”, TopFuel, Boise, ID, September 2016

T Ault, S Krahn, A Worrall, A Croff, "Analysis of Synergistic Fuel Cycle Options with Thorium and Heavy Water Reactors", ANS Annual Meeting, New Orleans, LA, June 2016

T Ault, S Krahn, A Worrall, B Burkhardt, C Caldwell, A Croff, "Insights and Trends from a Literature Assessment of the Thorium Fuel Cycle", ANS Annual Meeting, New Orleans, LA, 2016

BR Betzler, JJ Powers, A Worrall "Modeling and Simulation of the Start-up of a Thorium-Based Molten Salt Reactor", PHYSOR 2016, Sun Valley, ID, May 2016

J Littell, S Skutnik, A Worrall, E Sunny, "Assessment and Benchmarking with ORION and CYCLUS for U.S. Fuel Cycle Options", PHYSOR 2016, Sun Valley, ID, May 2016

JL Peterson, E Sunny, W Wieselquist, A Worrall, RWH Gregg, "Generating Cross Sections for ORION Fuel Cycle Models", PHYSOR 2016, Sun Valley, ID, May 2016

E. Hoffman, N. Brown, B. Carlsen, B. Feng, R. Hays,G. Raitses, N. Stauff, E. Sunny, A. Worrall, "Expanded Analysis of Transition to an Alternative Fuel Cycle", ICAPP 2016, San Francisco, CA, April 17-20 2016

NR Brown, A Worrall, M Todosow, "Fuel Cycle Performance of Thermal Spectrum Small Modular Reactors", ICAPP 2016, San Francisco, CA, April 17-20 2016

**Other Key Publications**

Minor Actinide Burning in Thermal Reactors, Nuclear Science 2013, OECD Nuclear Energy Agency, 2013

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