

CAES Associate Director Quarterly Report
Idaho State University, FY21Q4: July, August, September 2021

Section 1. 2021 Publications on behalf of CAES

- Iqbal, M., McDonald, A., Moss, R., **van Woerden, I.** Assessing Perceptions and Attitude to Nuclear Energy and Disaster and Pandemic Preparedness in the City of Idaho Falls and its Suburbs: A Feasibility Study. *Energy Policy. In Review*
- McBeth, M., Wrobel, M., **van Woerden, I.** Political Ideology and Nuclear Energy: Perception and Trust. *Review of Policy Research. In Review*
- J. Miller, S. Ercanbrack, **C. L. Pope**, The Versatile Economic Risk Tool (VERT), *International Topical Meeting on Probabilistic Safety Assessment and Analysis - American Nuclear Society*, in review (2021).
- Z. Ma, S. Zhang, C. Smith, **C. L. Pope**, Research to Develop Flood Barrier Testing Strategies for Nuclear Power Plants, *International Topical Meeting on Probabilistic Safety Assessment and Analysis - American Nuclear Society*, in review (2021).
- J. Miller, S. Ercanbrack, **C. L. Pope**, U.S. Nuclear Power Plant Performance Assessment Using the Versatile Economic Risk Tool (VERT), *28th International Conference on Nuclear Engineering (ICONE 28)*, ICONE2021-65769, (2021).
- J. D. Bess, **C. L. Pope**, A. Chipman, C. B. Jensen, Utility of EBR-II Benchmark Model to Enable MOX Fuel Pin Characterization, *Transactions of the American Nuclear Society*, **124** (2021).
- Z. Ma, S. Zhang, **C. L. Pope**, C. Smith, Research to Develop Flood Barrier Testing Strategies for Nuclear Power Plants, US Nuclear Regulatory Commission, NUREG/CR-7279, in review, (2021).
- S. H. Giegel, A. E. Craft, G. C. Papaioannou, A. T. Smolinski, **C. L. Pope**, Neutron Beam Characterization at Neutron Radiography (NRAD) Reactor East Beam Following Reactor Modifications, *Quantum Beam Science*, 5(2):8 (2021), DOI: 10.3390/qubs5020008.
- E. S. Lum, **C. L. Pope**, Simulation of the Fast Reactor Fuel Assembly Duct-Bowing Reactivity Effect using Monte Carlo Neutron Transport and Finite Element Analysis, *Nuclear Technology*, **207** (2021), DOI: 10.1020/00295450.2020.1794190.
- C. L. Pope**, R. Stewart, E. Lum, *Experimental Breeder Reactor II*, IntechOpen, (2021), Book Chapter in review.
- C. L. Pope**, W. Phoenix, *Idaho State University Low Power Teaching Reactor – An Overlooked Gem*, IntechOpen, (2021), Book Chapter in review.
- A. Wells, E. D. Ryan, **C. L. Pope**, *Improving Nuclear Power Plant Flooding Hazard Analysis Through Component Performance Experiment, Fragility Model Development, and Smoothed Particle Hydrodynamic Simulation*, (2021), Elsevier, Book Chapter in review
- A. Wells, **C. L. Pope**, *Flooding Fragility Model Development Using Bayesian Regression*, (2021), DOI: 10.5772/intechopen.99556.
- Industry Use Cases for Risk-Informed System Health and Asset Management*, D. Mandelli, C. Wang, M. Abdo, K. Vedros, J. Cogliati, J. Farber, A. Al Rashdan, S. Lawrence, D. Morton, I. Pova, S. Hess, **C. Pope**, J. Miller, S. Ercanbrack, INL-EXT-21-64377, Idaho National Laboratory Research Report (2021). (Technical Report)
- Development and Release of the Methods and Tools for Risk-Informed Asset Management*, C. Wang, D. Mandelli, M. Abdo, A. Alfonsi, J. Cogliati, P. Talbot, S. Lawrence, C. Smith, D. Morton, I. Popova, S. Hess, **C. L. Pope**, J. Miller, S. Ercanbrack, INL/EXT-21-63255, Idaho National Laboratory, Research Report (2021). Technical Report)
- Rodriguez, R.**, Baek, D., Case, M., Fox, R., Electrochemical, Thermodynamic, and Physical Properties of Tetradecyltriethylphosphonium ([P6,6, 6,14]⁺) and Methyl-propyl Piperidinium Containing Ionic Liquids and their Propylene Carbonate Solutions. *J. of Molecular Liquids*, in revision
- De Jesus, K., **Rodriguez, R.**, Baek, D., Fox, R., Pashikanti, S., Sharma, K. Extraction of lanthanides and actinides present in spent nuclear fuel partitioning and in electronic waste. *J. of Molecular Liquids*, Volume 336, 15 August 2021, 116006
- B. Durtshi, M. Mahet, **M. Mashal, A. M. Chrysler**, " Preliminary Analysis of RFID Localization System for Moving Precast Concrete Units using Multiple-Tags and Weighted Euclid Distance k-NN algorithm," in *2021 IEEE International Conference on RFID* Atlanta, Georgia, 2021.
- J. Aamir, B. Durtshi, **A. M. Chrysler** and P. Bodily, "Radio-Frequency Identification Vibration Detection," in *The 34th International Conference on Computer Applications in Industry and Engineering (CAINE 2021)*, 2021.
- L. Senis, V. Rathore, A. Anastasios, E. Andersson Sundén, Z. Elter, S. Holcombe, A. Håkansson, P. Jansson, **D. LaBrier**, J. Schulthess, P. Andersson, "Evaluation of gamma-ray transmission through rectangular collimator slits for application in nuclear fuel spectrometry," *Nuclear Inst. and Methods in Physics Research*, A. August 2021 (accepted).

- D. LaBrier**, W. Marcum, et al., “Design of an Experimental Test Loop for Fast Spectrum Test Conditions,” Annals of Nuclear Energy. June 2021.
- Evaluation of Novel High Performance Concrete for Utilization in the Nuclear Industry” by **D. LaBrier, Mustafa Mashal**, Arya Ebrahimpour, Kunal Mondal, Elmar Eidelpes, Drew Johnson, has been accepted for inclusion in the 2021 American Nuclear Society Winter Meeting and Technology Expo.
- A Review on Advanced Manufacturing for Hydrogen Storage Applications” to mdpi journal Energies. Authors = Zach Free, Maya Hernandez, **Mustafa Mashal** (ISU); Kunal Mondal (INL) (submitted)
- S. McBride**, J. Slay, C. Schou (2021). “A Vertically Integrated Pathway for Infusing Engineering Technicians with Industrial Cybersecurity Competencies”. Colloquium for Information Systems Security Education (CISSE).
- I. Ngambeki, **S. McBride**, J. Slay. (2021). “Knowledge Gaps in Curricular Guidance for ICS Security”. Colloquium for Information Systems Security Education (CISSE).
- Yeh, J.Y., Spencer, B.W., Sobhan Patnaik, S., Knight, T.W., **Dunzik-Gougar, M.L.**, “Coupled physics simulation of fracture in nuclear fuel pellets induced by resistive heating,” Journal of Nuclear Materials, Volume 553, 2021

Section 2. Conferences Attended on behalf of CAES

- Maya Hernandez, Kali Castle, **Rene Rodriguez**, 2021, Plasma Enhanced Chemical Vapor Deposition of Boron Nitride Thin Films; Idaho Conference for Undergraduate Research), July 2021
- B. Durtschi, **A.Chrysler** "Preliminary Analysis of RFID Localization System for Moving Precast Concrete," in ISU Undergraduate Research Symposium, Pocatello ID 2021
- J. Amir, B.Durtschi, **A.Chrysler**, P. Bodily "Radio Frequency Identification Vibration Detection Using Long Short-Term Memory," in National Conference on Undergraduate Research, 2021
- Amir Ali**, Piyush Sabharwall “ In-Plan Oval-Twisted Spiral Tube Heat Exchanger for Nuclear Applications,” American Nuclear Society Annual Meeting, Providence, RI, June 13-16, 2021.
- Scott Wahlquist, **Amir Ali** “ Heat transfer in randomly packed spheres for FHR reactors,” American Nuclear Society Annual Meeting, Providence, RI, June 13-16, 2021.
- Tanner Mauseth, **Mary Lou Dunzik-Gougar, Daniel LaBrier**, Scott McBeath, Isabella van Rooyen, “Development of an Innovative Sample Preparation Technique for Select Layers and Layer Interfaces of TRISO Particles,” American Nuclear Society, June 2021.
- Leibroek, L.**, PFIC advanced digital forensics tradecraft; Paraben (Park City, UT)
- Leibroek, L.**, Cyber threat intelligence for cyber physical professionals; American Petroleum Institute (Houston, TX)
- McBride, S.**, National Institute of Standards and Technology. National Initiative for Cybersecurity Education (NICE) Webinar: Securing Operational Technologies and Control Systems with a Skilled Workforce. Invited Presentation, July 2021.
- McBride, S.**, Fulbright Commission Program on Cybersecurity Education. “Foundations of Industrial Cybersecurity”. Invited presentation, June 2021.

Sections 3. Submitted Proposals Related to CAES Activities, FY21Q4

Lead PI	Admin Unit	Title	Sponsor	Status
Chad Pope	Nuclear Eng	Resonance Absorption Densitometry for Ma...	GElectric	Submitted
Chad Pope	Nuclear Eng	Faculty Development Program in Nuclear E...	NRC	Submitted
Daniel Dale	Physics	Three Neutron Correlations in the Sponta...	DOE	Submitted
Daniel LaBrier	Nuclear Eng	Implementing Scaling Analysis Techniques...	DOE	Submitted
Daniel LaBrier	Nuclear Eng	University Nuclear Leadership Programs (...)	DOE	Submitted
Mary Lou Dunzik-Gougar	Nuclear Eng	Nuclear Regulatory Commission Scholarshi...	NRC	Submitted
Mary Lou Dunzik-Gougar	Nuclear Eng	NRC 2022 Fellowship	NRC	Submitted
Mary Lou Dunzik-Gougar	Nuclear Eng	Reactor Time	Atomos Space	Submitted
Mostafa Fouda	Electrical Eng	Toward Online Energy-Aware Multi-Band Se...	Sony	Submitted
Mostafa Fouda	Electrical Eng	CAREER: Optimizing Green Cell-Free 6G Ne...	NSF	Submitted
Rene Rodriguez	Chemistry	Synthesis, Characterization, and Testing...	BEA	Funded

Sean McBride	ESTEC	Industrial Cybersecurity Education and T...	SBOE	Funded
Sean McBride	ESTEC	McBride - MSU NSF	Montana State	Submitted

Section 3.5. Funded Awards related to CAES Activities , FY21Q4

Lead PI	Title	Sponsor
Chad Pope	U.S-Brazil Joint Study to Assess Market and Comm...	BEA
Rene Rodriguez	Synthesis, Characterization, and Testing of Cata...	BEA
Vince Bowen	Nuclear Operations AGN-201 reactor	Idaho Career & Technical Education
Vince Bowen	NuScale SMR simulator	Idaho Career & Technical Education

Section 4. Patents, Licenses, other IP

None

Section 5. Other Awards

None

Section 6. Graduated CAES-affiliated students

Jason Jones (BA), Nick Wiles (BS) (Chemistry) **Josh Pak / Cori Jenkins**

Kali Castle, BA, Philomon Bileng, BS (Chemistry) **Rene Rodriguez**

Zach Free (Civil Engineering) **Mustafa Mashal**

Casey Steinman, (M.S.), Tanner Mauseth, (M.S.) Nuclear Science and Engineering **Mary Lou Dunzik-Gougar**

Section 7. Continuing CAES-affiliated students

Meesha Iqbal, Anne McDonald, Grace Dehner (MPH program) **Irene Van Woerden**

Dallin Felsted (Physics) **Dan Dale**

Lexee Bair, Kendal Olson, Canden Sudweek (Chemistry) **Josh Pak / Cori Jenkins**

Scott Wahlquist (Nuclear Engineering) **Amir Ali**

Morgan Robbins, Jordan Harley, Eslam Ali (Nuclear Engineering) **Dan LaBrier**

Uma Shankar Medasetti (PhD), Zach Free (MS), Jack Dunker (MS) (Civil Engineering) **Mustafa Mashal**

Tanner Mauseth (PhD), Scott McBeath (PhD), Austin Tam (PhD), Malwina Wilding (PhD), Todd Sherman (PhD), and

Kofi Tuffour-Achampong (M.S.) Nuclear Science and Engineering **Mary Lou Dunzik-Gougar**

Section 8. Incoming CAES-affiliated students

Carlyn Osterhout, Sophia Stolworthy, Raiden Hunter (Chemistry) **Josh Pak / Cori Jenkins**

Nehal Hasnaeen, Suman Neupane (Electrical Engineering) **Andrew Chrysler**

Kyle Schroeder (Nuclear Engineering) **Amir Ali**

Abby (Abigayle) Hargreaves, John Stenkoski, Sutapa Biswas (Nuclear Engineering) **Dan LaBrier**

Pawan Acharya (BS), Claire Haupt (BS), Lwin Htun (BS) (Civil Engineering) **Mustafa Mashal**

Section 9. Joint Appointments (continuing)

Chad Pope (nuclear engineering)

Sean McBride (cybersecurity)

Larry Leibrock (cybersecurity)

David Rodgers (CAES AD)

Section 10. New Equipment

0.5 milliCurie californium-252 fission source (**Dan Dale**)

Tektronix RSA 306B Spectrum Analyzer, 9 kHz – 6.2 GHz (**Andrew Chrysler**)

Com-Power AL-130R Active Loop Antenna, 9 KHz – 30 MHz (**Andrew Chrysler**)

A 30kW heater, Omega thermocouple calibrator block, Multiple flow pumps, and thermal-hydraulic instrumentation (thermocouples, and pressure transducers) (**Amir Ali**)

High-speed camera and other accessories for the Gaming and Visualization Laboratory at ISU (**Mustafa Mashal**)
 Advanced visualization tools donated by ISU staff for the Gaming and Visualization Lab (**Mustafa Mashal**)
 Transferring a “Drop Hammer” and accessories from INL to ISU (**Mustafa Mashal**)
 CyberCore laboratory used for special projects (**Larry Leibrock**)

Section 11. Collaborative Research:

(1) CAES Visiting Faculty Program, Summer 2021

Idaho State University	INL Collaborators
Mostafa Fouda	Kurt Derr
Andrew Chrysler	Lloyd Landon
Justin Wood/Marcus Burger (withdrawn)	Ron Fisher
Mustafa Mashal	Chandu Bolisetti, Som Dhulipala
Irene van Woerden	Rajiv Khadka

(2) INL Collaboration Fund Program, Spring/Summer 2021

INL Investigator	ISU Investigator	Research Topic
Joshua Hansel	Amir Ali	Nuclear Microreactor Heat Pipe Modeling and Simulation Database
Kunal Mondal	Mustafa Mashal, Bruce Savage, Rene Rodriguez, Kavita Sharma	Bulk Storage of Hydrogen Energy
Bryon Marsh	Mustafa Mashal	Radiological Dispersal Device Training
Som Dhulipala	Leslie Kerby	Randomized Computing for Multiphysics Modeling and Simulations

(3) Idaho I-Corps Summer 2021 (co-sponsored by CAES)

Name	Affiliation	Venture/Initiative
Donna Delparte	Geosciences	Potato Crop Virus/Imaging
Jared Barrott	Pharmacy	Hydrogen therapy/CPAP
Amir Ali	Nuclear Engineering	Heat Exchanger
Nirajan Bhattarai	Pharmacy	Hearing Loss
Anish Sebastian	Mechanical Engineering	Automated Rouging

(4) ISU-CAES Seed Grant Program (Ongoing Research in FY21Q4)

ISU PI	ISU Department	ISU co-PIs	University co-PIs	INL co-PI	Project
Ali, Amir	NE		David Arcilesi (UI)	Piyush Sagharwall	Small-Scale Heat Exchanger Thermal Performance Facility
Jenkins, Cori	Chemistry	Josh Pak		Chris Zarzana Brittany Hodges	Urethane degradation analysis for upcycling and designing sustainable plastics
Leung Solomon	CE		Yaqiao Wu (BSU MaCS)	Don Wood	Sorption Removal of Gaseous Fission Products in Nuclear Fuel Reprocessing by MCM-41, TiO ₂ , and their Functionalized Derivatives
Mashal, Mustafa	CE	Bruce Savage Jared Cantrell Roy Dunker		Rajiv Khadka Xingue Yang John Koudelka Maya Redden Bryon Marsh Shad Keele Michael Shurtliff	The Use of Emerging Technologies for Training of Emergency Responders
Murray, Kendra	Geosciences		Nick Bulloss (BSU MaCS)	Xiaofei Pu	Olivine phenocryst evolution in the Snake River Plain basalt flows that underlie the INL
Pashikanti, Srinath	Pharmacy/ Chemistry	Rene Rodriguez		Robert Fox Donna Baek	Synthesis of Conformationally-Rigid Tetralkyl phosphonium based Ionic Liquids for extraction of critical element Cobalt
van Woerden, Irene	Community & Public Health			Rae Moss	Perceptions of INL and Nuclear Energy in the local community

(5) Other collaborations

"Perceptions of different types of nuclear reactors:" **Irene Vane Woerden** (ISU), Rae Moss (INL) and Rajiv Khadka (INL)

"In situ positron annihilation spectroscopy for characterizing irradiation induced defects:" **Tony Forest** (ISU), Chuting Tan (INL-MFC), Jagoda M. Urban-Klaehn (INL-EES&T), Chase N. Taylor (INL-NS&T)

"Far-Field Detection of Rogue and Malicious Hardware using EM Fingerprinting (Research and Internship):" **Andrew Chrysler** (ISU) and Konstantinos Koliass (UI). Funded by the Idaho Cybersecurity Education Initiative, State of Idaho.

Heat Treatment and Autoclave Testing for Novel Hydraulic Loop Coupling; BEA Subcontract 154652-62 (**Dan LaBrier** (ISU), Nate Oldham, Tom Maddock, Nic Woolstenhulme, all INL) – completed 8/31/21

Integrated Sensor Development for Used Fuel Storage Canisters; BEA Subcontract 154652-79 (**Dan LaBrier** (ISU), Evans Kitcher, Phil Winston, Michael Fanning, Nancy Johnson - all INL) – completed 9/30/21

Chemical Interactions between Molten Sodium & Standard Insulation Types; (start-up and ISU CAES Seed Grant funding), collaborative project w/INL, **Dan LaBrier** (ISU)

ATR-C & ATR Gamma Tube - Student Engagement (**Dan LaBrier** (ISU), Dave Schoonen, Ryan Little, Monica Dudenhoeffer – all INL; Rich Christensen – UI; Brian Jaques – BSU)

Use of UHP Concrete in Nuclear Applications (**Dan LaBrier** (ISU), Mustafa Mashal, Arya Ebrahimpour – ISU; Kunal Mondal, Drew Johnson, Elmar Eidelpes – INL)

The collaborative proposal “Advanced Manufacturing for a Sustainable Energy Future” (PI = David Estrada from Boise State University) has been recommend for funding. **Drs. Mashal, Savage, and LaBrier** are research mentors for this project from the ISU side.

RFI response in collaboration with INL (Som Duhlipala), ISU (**Mustafa Mashal** and **Leslie Kerby**), and the University of Wyoming (Lars Kotthoff) titled “AI/UAV/Digital Twin Approaches for the Condition Assessment of Biological Concrete” was submitted to Legacy Concrete Assessment and Repair Using Biology (RFI-DARPA-SN-21-34).

Pre-application to NEUP under Spent Fuel and Waste Disposition – Disposal, titled “Experimental and Uncertainty Quantification-Aided Numerical Assessments of Ultra- High Performance Concrete as a Buffer Material for Deep Geological Spent Fuel Repositories” PI = **Mustafa Mashal** (ISU), Co-PIs = **Dr. Dan LaBrier** (ISU); and Dr. Som Dhulipala, Dr. Drew Johnson, Dr. Amit Jain, and Dr. Ben Spencer (Advisor) from INL

"Transient Reactor (TREAT) Experiments to Validate MBM Fuel Performance Simulations", **Mary Lou Dunzik-Gougar**, Benjamin Spencer (INL), Sean McDeavitt (A&M), and Travis Knight (South Carolina State)

"Enhancing Irradiation Tolerance of Steels via Nanostructuring by Innovative Manufacturing Techniques", **Mary Lou Dunzik-Gougar**, Haiming Wen (Missouri University of S&T), James Cole (INL), Yipeng Gao (INL)

"Measuring Mechanical Properties of Select Layers and Layer Interfaces of TRISO Particles via Micromachining and In-Microscope Tensile Testing", **Mary Lou Dunzik-Gougar**, Subhashish Meher (INL) and Fei Teng (INL)

Section 12: Other Activities

Cybersecurity Training (Sean McBride)

Idaho Cybersecurity Education Initiative

Industrial Cybersecurity Education and Training Community of Practice

Cybersecurity Certificates (David Beard):

Lead advisor for two new ISU Computer Science cybersecurity certificates (Undergraduate and Graduate) developed in collaboration with INL. Over 20 ISU students have signed up for the cybersecurity certificates so far and a number have already applied to INL for internships and jobs.

ESTEC (supported in part by INL Collaborations) (Vince Bowen, Sean McBride)

Graduated students: 56 AAS students, 2 BS students

Continuing students: 57 AAS students

Newly arrived students: 40 AAS students

Disaster Response Complex (Mustafa Mashal)

Completed nearly a dozen training events in collaboration with INL’s National and Homeland Security with members of National Guard from over 20 states, were hosted at the Disaster Response Complex at ISU between late April - October, 2021.

Hosted a workshop titled “Acute Disaster Response Training” in the Disaster Response Complex on August 24, 2021 in collaboration with the Department of Community and Public Health in the College of Health, ISU Continuing Education and Workforce Training, Southeastern Idaho Public Health, Idaho National Laboratory (Applied Visualizations Team), and other partners.

Presented a lightening talk at the INL Collaboration with NUC and CAES titled “Disaster Response, High-Performance Concrete, Hydrogen Storage, Industry 4.0: Where Civil Engineering Crosses Other Disciplines” on July 28, 2021.

Presented an INL webinar on the “Disaster Response Complex for the INL Resilience Optimization Center” on July 14, 2021.

CAES Annual Pitch Event 2021: Pathways to INL Net Zero (Mustafa Mashal)

“Sustainable and Green Concrete Mixes for INL’s Infrastructure.” Winner of Track C “Open Submission”

Section 13. Research Highlight:

Chad Pope (Nuclear Engineering)

I worked with INL and a team of ISU students to assemble a "Risk Repository". The idea is a location where benchmark risk models and risk analysis reports and papers can be easily found. The folks at INL were working with the NRC on a probabilistic risk analysis (PRA) model of a pressurized water reactor. After some very significant reviews and approvals the generic model was finally released by INL and the NRC. The problem was that nobody had a place to share the model.

I created a [public box folder](#) where the model could be housed. We spent much of the spring and summer finding as many risk analysis papers and reports that we could find. We categorized the paper topic and created a folder strategy for the risk repository. I added a link to the [ISU/NE web page](#) (scroll to the bottom of the page) for the repository along with a separate email account for communications.

Next up, I (with help from the NE CPIs) will create an annotated bibliography of the papers and add more benchmark models. I have two generation (power generation focused instead of safety) risk models that will be added shortly.

I have already gotten some positive feedback from the INL and NRC folks and the INL folks are identifying additional models that they can share.