**CAES Associate Director Quarterly Report**
**Idaho State University, FY22Q2**
**January, February, March 2022**

**Section 1.        Publications on behalf of CAES**

Nasser, N.,  Z. M. Fadlullah, **M. M. Fouda,** A. Ali, and Muhammad Imran, "A Lightweight Federated Learning Based Privacy Preserving B5G Pandemic Response Network Using Unmanned Aerial Vehicles: A Proof-of-Concept," Elsevier Computer Networks, vol. 205, art. no. 108672, Mar. 2022.

Badr, M.M., M. I. Ibrahem, M. Mahmoud, **M. M. Fouda,** F. Alsolami, and Waleed Alasmary, "Detection of False-Reading Attacks in Smart Grid Net-Metering System," IEEE Internet of Things Journal, vol. 9, no. 2, pp. 1386–1401, Jan. 2022.

Wahlquist, S., Joshua Hansel, Piyush Sabharwall, **Amir Ali** "Review of Heat Pipe Experimental Efforts for Nuclear Applications" Accepted for publication in Nuclear Science and Engineering Journal.

He, Mingfu, **Amir Ali**, Minghui Chen "Experimental investigations of Critical Heat Flux re-occurrence on post-CHF surfaces" Progress in Nuclear Energy 148, 104211 (2022).

**Rodriguez, R**., Baek, D., Case, M. Fox, R. "Studies Toward the Use of Ionic Liquids and Supercritical $CO_2$ for the Recovery and Separation of Praseodymium from Waste Streams," *Catalysts* (2022) 12, 335. https://doi.org/10.3390/catal12030335

**Rodriguez, R.G**.; Baek, D. L.; Orme, K.; Case, M.E,; Fox, R.V.  "Electrochemical, thermodynamic, and physical properties of tetradecyltrihexylphosphonium ([P6,6, 6,14]+) and methyl-propyl piperidinium containing ionic liquids and their propylene carbonate solutions". *Journal of Molecular Liquids* (2022) 352*,* 118607

Khanal, Shisr, Uma Shankar Medasetti, **Mustafa Mashal, Bruce Savage**, Rajiv Khadka, 2022, Virtual and Augmented Reality in the Disaster Management Technology: A Literature Review of the Past 11 years:  Frontiers in Virtual Reality.   Vol 3. 11 April 2022. https://doi.org/10.3389/frvir.2022.843195

Mena, P.,  R. Borrelli, and **L. Kerby**, Expanded Analysis of Machine Learning Models for Nuclear Transient Identification Using TPOT, Nuclear Engineering and Design, in revision.

Mena, P., R. Borrelli, and **L. Kerby**, Survey of Markets for Nuclear Power in Western North America, International Journal of Energy, Environment, and Economics, in press (2022).

Mandell, D., Z. Ma, S. Zhang, **C. Pope**, C. Smith, Research to Develop Flood Barrier Testing Strategies for Nuclear Power Plants, NUREG/CR-7279, INL-EXT-19-56427 (2022).

Acharya, M., R. Khadka, and M. Mashal (2022). Preliminary Bond Testing and Splicing of Titanium Alloy Bars. Transportation Research Record: Journal of the Transportation Research Board. https://doi.org/10.1177/03611981211067785

Mashal, M., and S. Dhulipala (2022). Machine Learning-Aided Tools to Reduce INL's Concrete Emissions Using Recycled Products. In proceedings of the Battelle's Innovations in Climate Resilience Conference, Columbus, OH, United States.

**Section 2.       Conferences Attended on behalf of CAES**

Badr, M., M., M. Mahmoud, W. Alasmary, **M. M. Fouda,** K. H. Almotairi, and Zubair Md Fadlullah, "Privacy-Preserving Federated-Learning-Based Net-Energy Forecasting," Proc. of the 2022 IEEE SoutheastCon'22, Mobile, Alabama, Mar. 31–Apr. 3, 2022.

**Bodily, P**., et al, 2022, Visualizing the 3SAT to CLIQUE Reduction Process" Proceedings of the Intermountain Engineering, Technology, and Computing Conference

**Bodily, P.**, et al., 2022, KAMI: Leveraging the power of crowd-sourcing to solve complex, real-world problems: Proceedings of the Intermountain Engineering, Technology, and Computing Conference

**Bodily, P.**, et al., 2022,  Open Computational Creativity Problems in Computational Theory, Proceedings of the International Conference on Computational Creativity.

Sudweeks, C.L., Raiden A. Hunter, Sophia Stolworthy, Kendal P. Olson, Carlyn, Osterhout, **Joshua J. Pak, Courtney Jenkins,** CHED: Irradiation and degradation study of polyurethane model compounds, , 263st ACS National Meeting, March, 2022.

**Pak, J.J.**, **Courtney Jenkins**, Sophia Stolworthy, Kendal P. Olson, Carlyn Osterhout, Canden Sudweeks, Raiden Hunter, CHED: Synthesis of polyurethane model compounds for degradation studies, , 263st ACS National Meeting, March, 2022.

Hasnaeen, N.,  **A. Chrysler**, "Detection of Malware in UHF RFID User Memory Bank using Random Forests Classifier on Signal Strength Data in the Frequency Domain," in *2021 IEEE International Conference on RFID* Las Vegas, Nevada, 2022.

**McBride, S**. Developing the Next Industrial Cyber Workforce. OT Cybersecurity Virtual Summit. March 23, 2022

Mashal, M., and S. Dhulipala (2022). Machine Learning-Aided Tools to Reduce INL's Concrete Emissions Using Recycled Products. Battelle's Innovations in Climate Resilience, Columbus, OH, United States. (Poster Presentation by Mashal).

Mashal, M., (Keynote Speaker). 2022 Idaho State University Graduate Research Symposium, Pocatello, Idaho, United States.

## Sections 3.  Submitted Proposals Related to CAES Activities, FY22Q2

| Lead PI | Admin Unit | Title | Sponsor |
| --- | --- | --- | --- |
| Amir Ali | Nuclear Eng/Health Physics | Fundamentals of Computational Analysis o... | BEA |
| Irene van Woerden | Community and Public Health | Trusted sources for nuclear news and inf... | BEA |
| Mustafa Mashal | Civil/Environmntl Engineering | Biodefense Collaboration | BEA |
| Mustafa Mashal | Civil/Environmntl Engineering | Emergency Operations Center Collaboratio... | BEA |
| Mustafa Mashal | Civil/Environmntl Engineering | Utilization of Waste Products from Agric... | BEA |
| Mustafa Mashal | Civil/Environmntl Engineering | Mobile Robot for Security Applications i... | BEA |
| Kendra Murray | Geosciences | Characterization of Olivine in Primitive... | BEA |
| David Rodgers | Division of Research | Idaho State University FALCON HPC Admini... | BEA |
| Mustafa Mashal | Civil/Environmntl Engineering | A Disaster Response Complex for Emergenc... | Idaho SBOE |
| Daniel LaBrier | Nuclear Eng/Health Physics | International Standard Testing Methods f... | UCalifornia |
| Joshua Pak | Chemistry | RII Track-2 FEC: Novel methods for upcyc... | NSF |
| Chad Pope | Nuclear Eng/Health Physics | Idaho State University support of CAES N... | BEA |
| Daniel LaBrier | Nuclear Eng/Health Physics | Implementing Scaling Analysis Techniques... | DOE |
| Amir Ali | Nuclear Eng/Health Physics | Experimental and Numerical Study on the ... | DOE |
| Daniel LaBrier | Nuclear Eng/Health Physics | High-temperature GAS cooLed reactor Irra... | UFlorida |
| Chad Pope | Nuclear Eng/Health Physics | Accelerating the Experimental Mission of... | OregonSt |
| Mostafa Fouda | Electrical Engineering | Towards Secure 6G Cell-Free Communicatio... | ORAU |

## Section 3.5.  Funded Awards related to CAES Activities , FY22Q2

| Lead PI | Admin Unit | Title | Sponsor |
| --- | --- | --- | --- |
| Kendra Murray | Geosciences | Characterization of Olivine in Primitive Eastern... | BEA |
| Mary Lou Dunzik Gougar | Nuclear Eng/Health Physics | NRC 2022 Fellowship | NRC |
| Mustafa Mashal | Civil/Environmntl Engineering | Sustainable and Green Concrete Mixes for INL's I... | BEA |
| Chad Pope | Nuclear Eng/Health Physics | Idaho State University support of CAES Nuclear S... | BEA |
| Mustafa Mashal | Civil/Environmntl Engineering | Experimental Validation of Repair Methods for Ea... | Idaho DOT |

**Section 4.  Patents, Licenses, other IP  -** None


**Section 5.  Other Awards**

Idaho State University 8th Annual Graduate Research Symposium: March 2022

    CEADS student Pepo Mena won Top Presentation in the Business, Economics, and Public Administration division; CEADS student Shovan Chowdhury won Top Poster Presentation in the Engineering, Physical, and Mathematical Sciences division.


**Section 6.  Graduated CAES-affiliated students -** None


**Section 7.   Continuing CAES-affiliated students (partial list)**

Ali:  Scott Wahlquist (MS) (graduating on May 22); Kyle Shredder (MS)

Bodily:  Alex Diviney (BS), Caleb Eardley (BS), Janita Aamir (BS), Daniel Igbokwe (BS), Garrett Stouffer (BS), Kaden Marchetti (MS)

Rodriguez:  Jacob Egbert (BS)

Weber:  Alyssa Farnes (BS)

LaBrier:  Morgan Robbins (MS), Jordan Harley (MS), Eslam Ali (MS), Sutapa Biswas (MS)

Chrysler:  Nehal Hasnaeen (MS), Suman Neupane (MS)

Leung:  Ted Pollack (PhD)

Kerby:  Pepo Mena (PhD), Patience Lamb (BS) - both graduating in May

Mashal:  Mahesh Acharya, PhD; Katie Hogarth, MS; Uma Shankar Medasetti, PhD; Jack Dunker, MS; Zach Free, MS; Josh Peck, BS; Sindi Banda, BS

Dale:  Jenna Devean (PhD)

**Section 8.  Incoming CAES-affiliated students -** None


**Section 9.  Joint Appointments (continuing)**

Chad Pope (nuclear engineering)

Sean McBride (cybersecurity)

Larry Leibrock (cybersecurity)

David Rodgers (CAES AD)


**Section 10.  New Equipment -** None


**Section 11.  Collaborative Research:**

(1) CAES Collaboration Grants - new in 2022

| INL PI | ISU co-PI | ISU Department | BSU/UI Co-PI | Project |
|---|---|---|---|---|
| Kunal Mondal | Mustafa Mashal | Civil Engineering | | Net Zero: Utilization of Waste Products from Agricultural and Biomass Industries to Reduce Concrete Emissions |
| Vaibhav Yadav | Mustafa Mashal | Civil Engineering | | Mobile Robot for Security Applications in Remotely Operated Advanced Reactors |
| Kingyue Yang Rajiv Khadka John Koudelka | Mustafa Mashal | Civil Engineering | | Investigation on Designing a Framework of Utilizing Sensor Data in Virtual Training for Disaster Response Preparedness and Response |
| Ryan Stewart | Leslie Kerby | Computer Science | | Using Artificial Intelligence to Guide the Run-In of a Pebble Bed Reactor |
| Joshua Fishler | Amir Ali | Nuclear Engineering | Lan Li | Fundamentals of Computational Analysis of Thermal Systems: Curriculum Development |
| Asef Redwan | Anirban Chakraborty | Biological Sciences | | Improving the electron shuttling efficiency of activated carbon in relation to biological nitrogen removal during water treatment |
| Md Riaz Kayser Ahmed Hamed | Mostafa Fouda | Electrical & Computer Engineering | | Developing Machine Learning Based Force Field for Predicting Radiation Resistance of High Entropy Alloys |

(2) ISU-CAES Seed Grant Program

**(Nearly completed Research in FY22Q2)**

| 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, TiO2, 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 |

| | | | | | Synthesis of Conformationally-Rigid Tetralkyl phosphonium based Ionic Liquids for extraction of critical element Cobalt |
|---|---|---|---|---|---|
| Pashikanti, Srinath | Pharmacy/ Chemistry | Rene Rodriguez | | Robert Fox Donna Baek | |
| van Woerden, Irene | Community & Public Health | | | Rae Moss | Perceptions of INL and Nuclear Energy in the local community |

**(Ongoing Research awards in FY22Q2)**

| ISU PI | ISU Department | ISU co-PIs | University co-PIs | INL co-PI | Project |
|---|---|---|---|---|---|
| Ali, Amir | Nuclear engineering | | | Yasir Arafat | Performance optimization of MARVEL Microreactor power conversion system |
| Bodily, Paul | Computer Science | | | Rajiv Khadka | Application of Advanced Computational Theory to Facilitate Efficient Solutions to Real-World Combinatorial Problems |
| Forest, Tony | Physics | | | Chutiing Tan | A neutron Generator for Materials Testing |
| Fouda, Mostafa | Electrical & Computer Engineering | | | Ahmed Hamed | Smart Analytics of Biomass Images |
| Kalivas, John | Chemistry | | | John Koudelka | Virtual Reality for Dynamic Data Visualization of Analytical Chemical Data |
| Mashal, Mustafa | Civil Engineering | Dan LaBrier Jared Cantrell | | Som Duhlipala Amit Jain | Machine Learning-Aided Validation of a Sustainable and Highly Durable Construction Technology for the Containment Facility of Advanced Reactors |
| Pashikanti, Srinath | Biomedical and Pharmaceutical Sciences | Rene Rodriguez | | Robert Fox Donna Baek | Incorporation of Sterics in novel Phosphonium Ionic Liquid (PIL) and their Effect on Ligand Intermolecular Interactions and Chelation Properties |
| Savage, Bruce | Civil Engineering | Chikashi Sato Jim Mahar Mustafa Mashal | Karen Humes, UI Dakota Roberson, UI | | Water Storage Infrastructure Viability using Repurposed Tires for Pumped Hydro |
| Weber, Keith | GIS TReC | | Kathleen Araujo BSU Cassandra Koerner, BSU | Kelly Wilson Ryan Hruska Shiloh Elliot Chris Forsgren | The Power Grid/Wildfire Nexus: Using GIS and Satellite Remote Sensing to Identify Vulnerabilities |
| Xu, Danny | Biomedical and Pharmaceutical Sciences | | Kenneth Cornell, BSU | Eric Whiting | Hearing Loss Prevention through Integrative High Performance Computing, Data Science, and Experimental Biology |

(3) Other collaborations with INL Researchers

Chad Pope:
Developing a Digital Twin for the ISU AGN-201 Reactor with Representatives from INL (Chris Ritter), as part of a much larger Digital Twin proposal.

Leslie Kerby:
Cyber Attack and Defense of Autonomous or Remote Operations of Nuclear Reactors (collaboration with Christopher Spirito from INL)

Dan LaBrier
(1) ATR-C & ATR Gamma Tube - Student Engagement (Dave Schoonen, Ryan Little, Monica Dudenhoeffer – all INL; TBD – UI; Brian Jaques – BSU)
(2) Use of UHP Concrete in Nuclear Applications (Mustafa Mashal, Arya Ebrahimpour – ISU; Kunal Mondal, Drew Johnson, Elmar Eidelpes – INL)
(3) Investigation of Metal Hydride Distribution and Speciation (Mahmut Cinbiz, Chase Taylor – INL); INL LDRD FY21 Subaward

Amir Ali
(1) A Model-based Approach to an Optimal Net-Zero Framework for INL to achieve a 2029 Deployment, with MARVEL 2.0. Yasir Arafat (INL, PI), Amir Ali (ISU/CAES, Co-PI), Kostadin Ivanov, and David Holler (NCS, Co-PI), and Jeff Jones (Walsh Engineering, Co-PI) (LDRD preproposal accepted and full proposal submitted)
(2) Experimental and Numerical Study on the Impact of Fission Gas Ejection from Failed Fuel Rods on the Safety of Lead-Cooled Fast Reactors. Amir Ali (ISU/CAES, PI), Osman Anderoglu (UNM, Co-PI), Aydin Karahan (ANL, Co-PI), Jun Liao (WEC, Co-PI) (DOE-NEUP full proposal submitted)

Mustafa Mashal
(1) Emergency Operations Center Collaboration" (2022-2023). INL PI = Bryon Marsh, ISU PI = Mustafa Mashal, ISU Co-PI = Laurie Holien.
(2) Biodefense Collaboration" (2022-2023). INL PI = Bryon Marsh, ISU PI = Mustafa Mashal, ISU Co-PI = Laurie Holien.
(3) Leveraging Digital Twin, 3D visualization, and Model-Based Systems Engineering to Monitor Critical Community Health Infrastructure" (2022-2023). INL PI = Rajiv Khadka, ISU PI = Mustafa Mashal.
(4) Investigation on Designing a Framework of Utilizing Sensor Data in Virtual Training for Disaster Response Preparedness and Response" (2022-2023). INL PI = Xingyue Yang, ISU PI = Mustafa Mashal.

**Section 12:  Other Activities**

CAES-related courses (partial list)
Bodily: CS 4492, Special Problems: NP-Complete Reductions and Solutions
Fouda:  CS 4461 Secure Operating Systems
Leibrock - CS 4465/5565 Structure Analytical Techniques
McBride:
    CYBR 4481 Critical Infrastructure Defense
    CYBR 4487 Professional Development and Certification
    CYBR 4489 Capstone in Industrial Cybersecurity
    ESET 0181 IT-OT Fundamentals
    INFO 3310 Introduction to Information Assurance
Pope
    NE 4445 / 5545, Reactor Physics
    NE 4452 / 5552, Nuclear Criticality Safety
    NE 4488 / 5588, Nuclear Nonproliferation and Safeguards