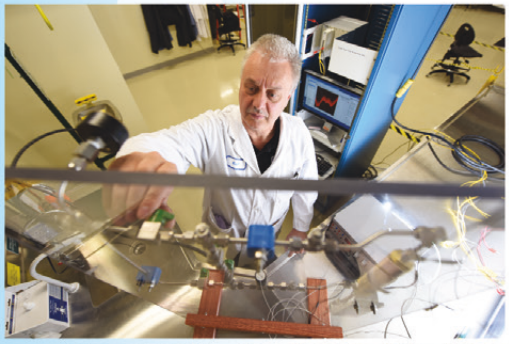
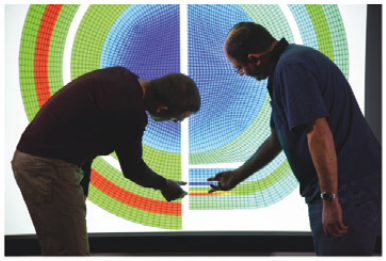
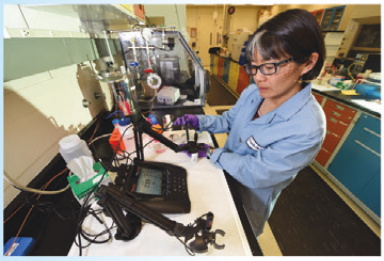
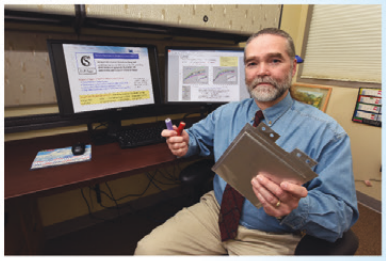
TECHNOLOGY TRANSFER

Annual Report Fiscal Year 2015

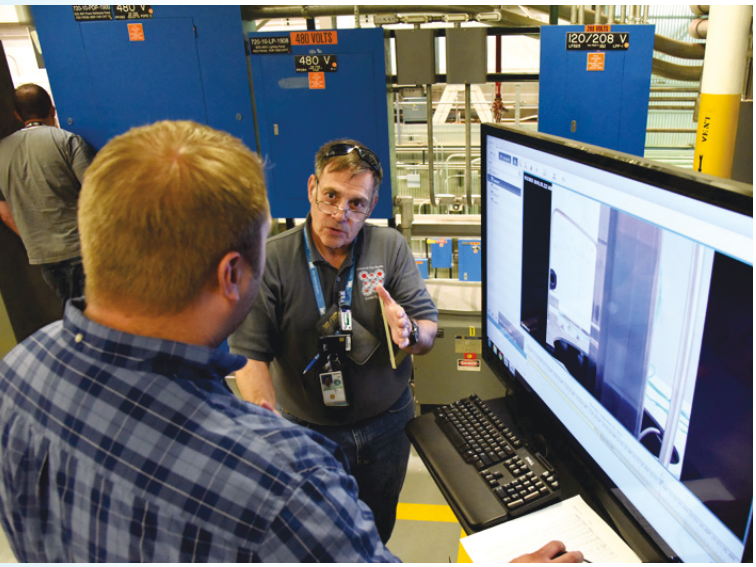
December





Idaho National Laboratory



Abstract

Idaho National Laboratory (INL) is a U.S. Department of Energy (DOE) multi-program national laboratory that conducts research and development in all DOE mission areas. Like all other national laboratories, INL has a statutory, technology transfer mission to make its capabilities and technologies available to federal agencies, state and local governments, universities, and industry. To fulfill this mission, INL encourages its scientific, engineering, and technical staff to disclose new inventions and creations to ensure the resulting intellectual property is captured, protected, and made available to others who might benefit from it.

As part of the mission, intellectual property is licensed to industrial partners for commercialization, job creation, and delivering the benefits of federally funded technology to consumers. In some cases, unique capabilities are made available to other federal agencies, international organizations, domestic and foreign commercial entities, or small businesses to solve specific technical challenges. INL employees work cooperatively with researchers and technical staff from the university and industrial sectors to further develop emerging technologies. In this global economy, INL is contributing to the development of the next generation of engineers and scientists by licensing software to educational institutions throughout the world.

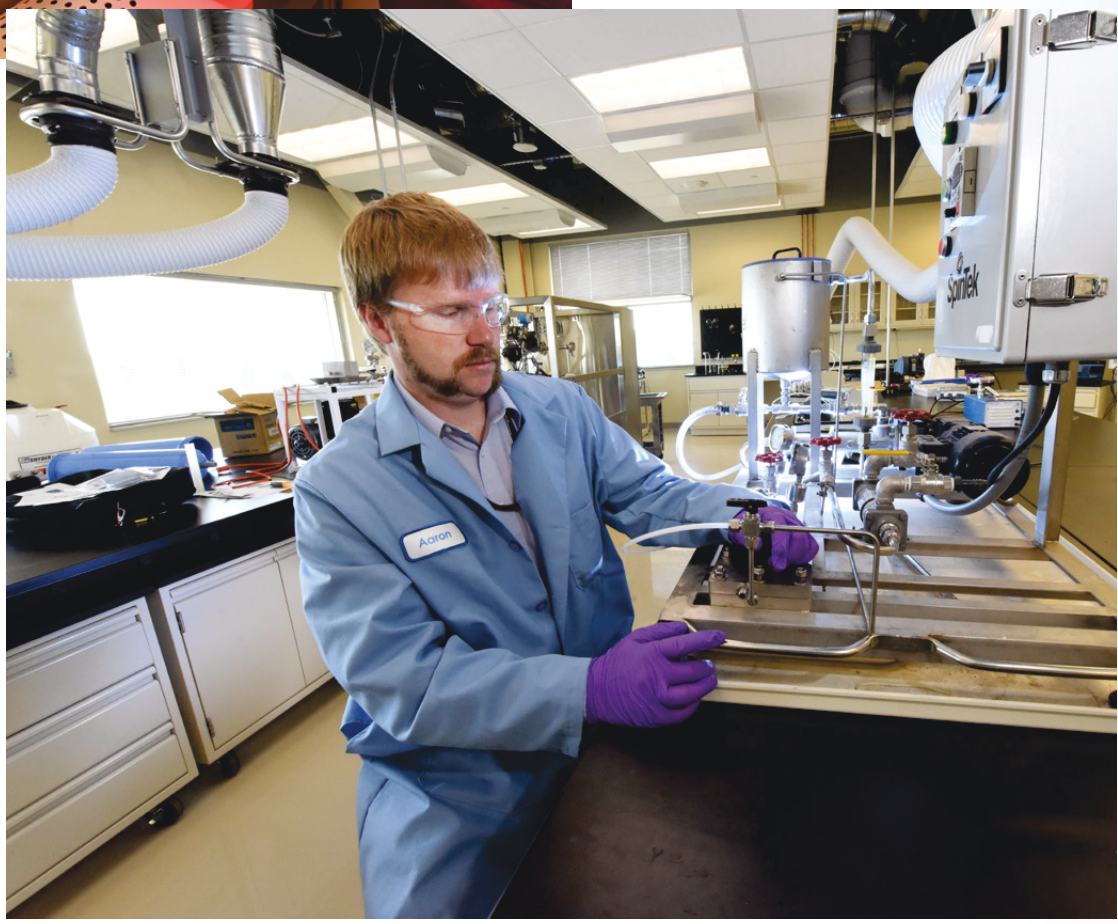
This report is a catalog of select INL technology transfer activities, including commercialization transactions and research agreements, executed during this past year. The size and diversity of INL technical resources, coupled with the large number of relationships with other organizations, virtually ensures that a report of this nature will fail to capture all interactions. Recognizing this limitation, this report focuses on transactions that are specifically authorized by technology transfer legislation (and corresponding contractual provisions) or involve the transfer of legal rights to technology to other parties.

This report was compiled from primary records that were readily available to the INL's Technology Deployment and Contracts Management offices. Accomplishments cataloged in the report reflect the achievements and creativity of the researchers, technicians, support staff, and operators of the INL workforce.

Prepared for the
U.S. Department of Energy
Under DOE Idaho Operations Office

Contract DE-AC07-05ID14517

Contents


Aaron

From the Laboratory Director

Industry engagement and commercialization of technologies developed at Idaho National Laboratory (INL) makes the world cleaner, safer, and better positioned to handle our greatest challenges, including climate change, water shortages, global security, and helping American industry become more competitive on a global scale.

Moreover, moving research and development from the Laboratory to market increases our impact and is a vital part of securing our critical infrastructure and demonstrating and deploying nuclear energy solutions and other clean energy options.

Fiscal Year 2015 featured a number of notable accomplishments at INL. It also was an exciting time for technology transfer within the U.S. Department of Energy (DOE) and at INL.

In 2015, DOE created the Office of Technology Transitions, which works closely with the national laboratories to expand the commercial impact of DOE research. The DOE Office of Energy Efficiency and Renewable Energy announced an initiative that will increase the impact of DOE research on the U.S. clean energy sector and accelerate the transition of innovation into the marketplace. The National Laboratory Impact Initiative contains three pilot programs:

1. The Small Business Voucher program provides small businesses access to laboratory capabilities. INL is partnering with Ames and Oak Ridge national laboratories to assist with outreach, merit interviews, and selection of proposals. The laboratories are working with small businesses in five technology areas: advanced manufacturing, bioenergy, geothermal, vehicles, and wind.
2. The Technologist-in-Residence program supports talent exchanges between national laboratories and industry, building on and extending existing partnerships.
3. The Lab-Corps program cultivates collaboration between researchers and industry with the goal of accelerating clean energy technology deployment and optimizing industry competitiveness. INL is one of seven laboratories participating in this pilot program with two teams. INL Team Advanced Renewable Aerial Inspections developed technology that allows use of unmanned aircraft to inspect wind turbine blades, which is safer, faster, and cheaper than sending people to do that job. INL Team Switchable Polarity Solvents is working on technology that could positively impact water purification and other applications.

INL's Technology Deployment will continue to support the teams as they pursue licensing and connect with industry.

Technology Deployment cooperates with INL's research directorates to deploy technologies that support the nation's energy and security missions. Over the past decade, INL has signed 697 new technology license agreements, executed 145 competitive research and development agreements and completed 417 agreements with federal agencies and private sector entities worth nearly $1.4 billion.

In 2015, Contracts Management expanded the Laboratory's work through agreements with organizations such as TerraPower, NuScale Power, the Canadian Nuclear Safety Commission, Korea Atomic Energy Research Institute, Japan Atomic Energy Agency, Cogent Energy Systems, Electric Power Research Institute, Wyle Laboratories, Northrop Grumman, Ford Motor Company, Ametek, WinSim Americas, NanoSteel, OneSubsea, P&G Utah, and Southern California Edison.

Other highlights from Fiscal Year 2015 include the following:

- INL received $1.8 million in royalty revenues from our technology licensing efforts, the second-highest royalty earnings in INL history. INL reinvested $1.3 million of royalties into ongoing research.
- An "Outstanding Technology Deployment" award was received for our integrated waste screening system from the Federal Laboratory Consortium for Technology Transfer. This system enables rapid segregation and processing of the nearly 40 million tons of drilling waste generated by fracking wells.
- A "How to Do Business with INL Guide" was published and posted on www.inl.gov, making it easier for our potential partners to better understand the variety of agreements under which we can work together and identifies points of contact.

Details of the above highlights and others can be found in this annual report. We are proud that INL, along with our partners at DOE, continue to deliver a significant return to the nation for the American taxpayers' investment in the nation's lead nuclear research, development, and demonstration laboratory.

Dr. Mark Peters

Director, Idaho National Laboratory

Introduction

Idaho National Laboratory (INL) promotes a broad approach to technology transfer, reflecting how research and development (R&D) efforts provide value to industry, government sponsors, academic partners, and the U.S. taxpayer. Fiscal Year (FY) 2015 was especially rewarding for INL and deployment of technologies as the Laboratory continued to focus on its mission in advancing nuclear energy, enabling clean energy deployment, and securing and modernizing critical infrastructure.

Licensing intellectual property (IP) and establishing a robust portfolio of various research agreements, including Cooperative Research and Development Agreements (CRADAs), Strategic Partnership Projects (SPPs), and User Facility Agreements (UFAs) are paramount to deploying technology. Through various deployment mechanisms, INL shares world class capabilities that include data, knowledge, user facilities, technical expertise, and IP in the form of patented inventions and copyrighted software. INL's Partnerships Directorate brings the academic, policy, and technology deployment expertise in IP licensing and management services that support the Laboratory's mission, while INL's Contracts Management organization enables R&D through development, negotiation, and management of Laboratory research agreements.

More innovation is occurring in INL's maturing deployment strategy. INL recognizes the importance of working early with its partners, as well as the researcher, to address party interests, align outcomes, and meet goals. Industry research agreements are coming together faster and questions are answered early. Public sharing of technology success continues to be extremely important through publishing and publicizing work in scientific journals, trade journals, media, awards, and events.

Connecting with education partnerships, ranging from elementary to graduate research programs, has enhanced INL's reputation, while promoting the value of access to Laboratory research capabilities.

In FY 2015, INL began developing new tools to enable quicker access to the Laboratory's unique capabilities, facilities, and researchers. These tools will roll out during FY 2016 in support of INL's and DOE's technology transfer strategy.

This annual report details select efforts to deploy technologies during FY 2015. The report highlights IP actions, patent and copyright details, royalty earnings and investments in emerging technology, as well as showcasing key license agreements. Additionally, the report outlines impactful CRADAs and SPPs. Technology transfer has a strategic connection to economic development and a responsibility to assist in building a culture that fuels more innovation. Economic development is described as it relates to technology. Additionally, contributions made through the Technical Assistance Program (TAP) are highlighted.

Significant FY 2015 improvements enabled researchers to connect with more partners and made it easier for partners to do more business with INL. Contributions include: strategic re-investment of royalty funds to tie closer to Laboratory priorities; building a "How to Do Business with INL Guide" to assist the researcher and partners to the points of contact for the variety of mechanisms to conduct work; using a short form CRADA; and hiring a market and business intelligence specialist. The results of these changes are evident in this report and additional results anticipated in FY 2016.

Intellectual Property

The IP portfolio for INL includes disclosed invention records, filed patent applications, issued patents, and requested and granted copyright assertions. IP portfolios provide a basis for conducting work with national laboratories and federal agencies, commercial enterprises, academia, and other parties, both domestic and international. The extent of INL's science, engineering, and technical IP portfolios provide the foundation for the Laboratory to do creative, meaningful research.

Technology Deployment (TD) works closely with INL management and researchers to identify and pursue opportunities for technology commercialization and business development.

In 2015, INL inventors submitted 54 invention disclosure records (IDRs) to Battelle Energy Alliance, LLC (BEA). These include 18 from Nuclear Science and Technology (NST), 22 from Energy and Environment Science and Technology (EEST), 11 from National and Homeland Security (NHS), and three contributed by inventors supporting other mission work (Figure 1).

Twenty-seven U.S. patents were issued to either INL or to the DOE based on the inventions of INL scientists and researchers. These issued U.S. patents included four from NHS, 16 from EEST, and seven from NST (Figure 2).

In addition, INL filed 24 new patent applications, including nine from NHS, 13 from EEST, and two from NST.

Since the commencement of BEA's contract to manage INL, Laboratory researchers have generated 886 IDRs. These IDRs have led to more than 449 U.S. patent applications and have resulted in excess of 421 issued U.S. patents.

BEA has IP rights under its contract with DOE and can elect to retain title to inventions and seek patent protection, subject to some exceptions. The decision of whether or not to seek patent protection is based on market and technical assessments of the technology and its subsequent programmatic value. Market assessments are performed and a recommendation is presented to a committee comprised of department or project managers, assistant laboratory director or designee, market analysts, commercialization managers, and patent attorneys. These recommendations are presented to the committee and then a final decision is made to elect or decline the technology for patent protection by TD's director. Generally, if the invention is judged as commercially valuable, crucial to a primary mission, or valuable in terms of motivating further research funding, it is elected. If BEA decides to decline title, DOE chooses whether to seek patent protection in its own name. If DOE decides not to seek patent protection, the inventor(s) may petition to have the title assigned to them by DOE with the expectation that they will pursue patent protection using their own resources.

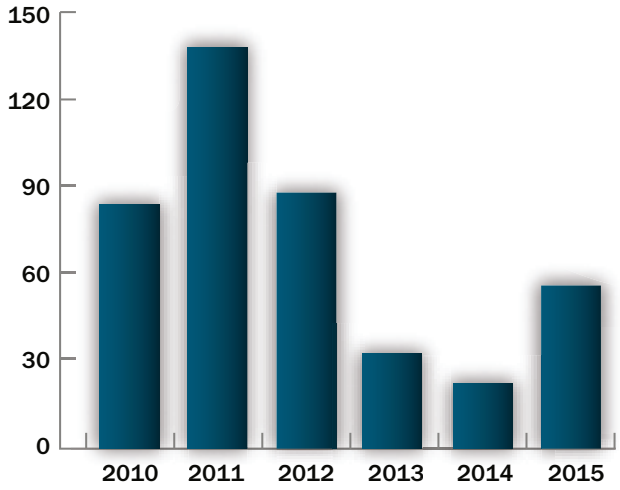


Figure 1. Invention disclosure records completed FY 2010–2015.

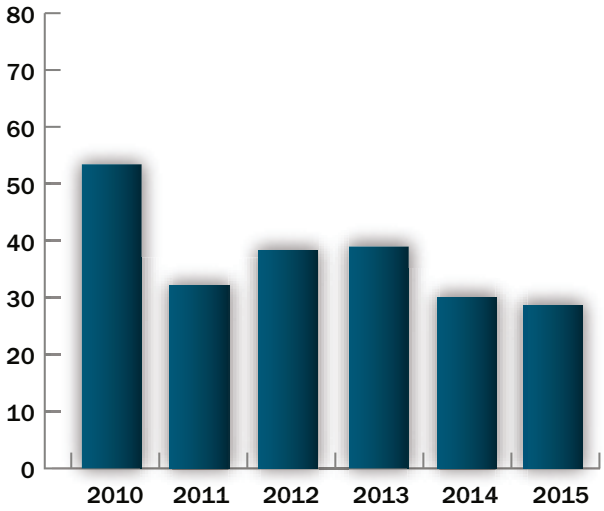
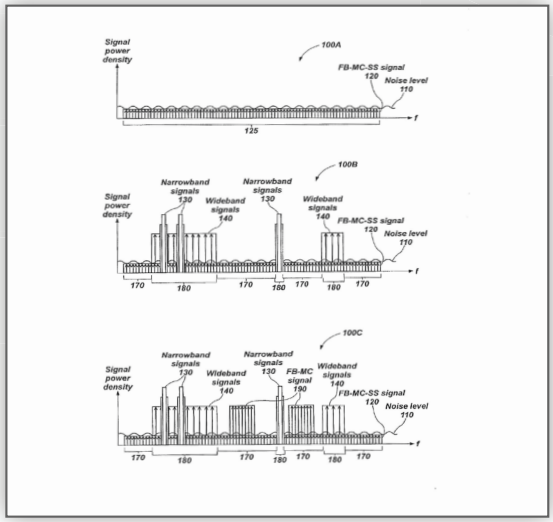


Figure 2. U.S. patents issued FY 2010–2015.

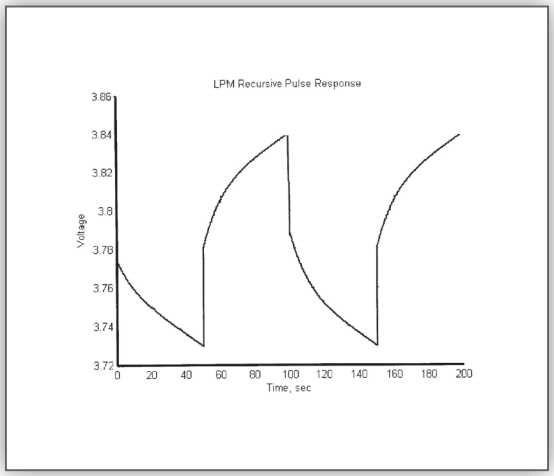
The following pages provide a brief description of the 27 patents issued to INL inventors during FY 2015 .



Methods and Apparatuses Using Filter Banks for Multi-carrier Spread Spectrum Signals

Hussein Moradi, Behrouz Farhang, and Carl A. Kutsche were issued this patent for their transmitter invention using a third type of spread-spectrum (SS), the Multi-Carrier Spread-Spectrum, to send a signal over a range of frequencies, improving bandwidth and decreasing interference. This method describes an SS technique that is often employed by wireless carriers and military to distribute wireless signal over a wider bandwidth, but the two most common types of SS are often susceptible to interference.

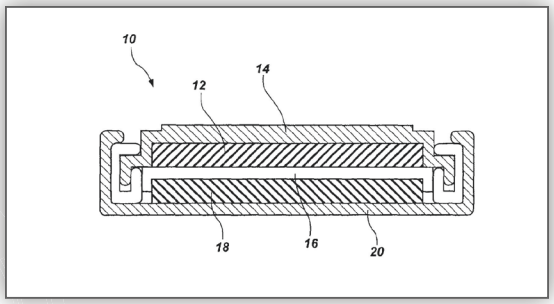
Patent Number: 8,861,571 Issued: October 14, 2014



Method of Estimating Pulse Response Using an Impedance Spectrum

Inventors John L. Morrison, William H. Morrison, Jon P. Christophersen, and Chester G. Motloch were awarded this patent for developing an in-situ method to measure impedance in energy storage devices, used to estimate parameters such as voltage. As the use of energy storage devices such as batteries, fuel cells, ultracapacitors, etc., increases, the need for systems that can monitor the lifespan of such devices is more relevant than ever before. This technology will help optimize performance and extend the life of energy storage devices.

Patent Number: 8,868,363 Issued: October 21, 2014



Electrodes Including a Polyphosphazene Cyclomatrix, Methods of Forming the Electrodes, and Related Electrochemical Cells

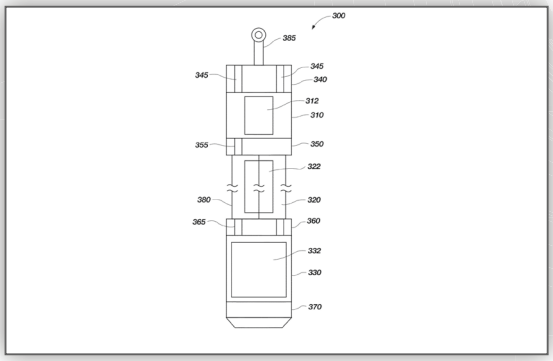
Kevin L. Gering, Frederick F. Stewart, Aaron D. Wilson, and Mark L. Stone were awarded this patent for developing a new battery electrode material. The patent describes an anode that is formed by a polyphosphazene cyclomatrix that is more cost-effective, efficient, and safer than existing commercially available materials. Though lithium-ion batteries are growing in popularity, safety concerns, storage limitations, and other issues have prevented some industries from fully embracing lithium-ion systems. This invention addresses some of these issues.

Patent Number: 8,871,385 Issued: October 28, 2014

Methods for Radiation Detection and Characterization using a Multiple Detector Probe

This patent was granted to Douglas W. Akers and Lyle G. Roybal. During environmental remediation, field operators are often unaware of the radiological contents in waste containers until the containers are exposed. This invention details the hardware and software for a multi-detector probe that can safely detect radiation within a closed container, which sends measurements and information about the type of radiation to a nearby computer, limiting potential exposure to field operators from radioactive material.

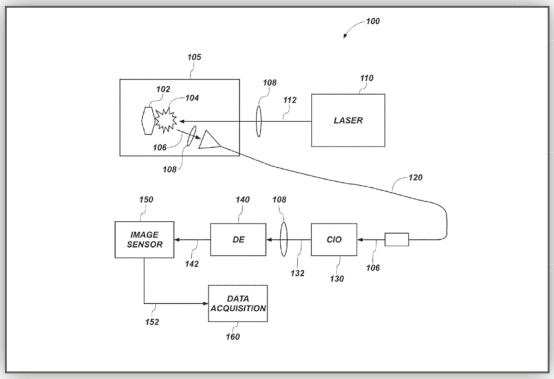
Patent Number: 8,878,140 Issued: November 4, 2014



Apparatus, System, and Method for Laser-induced Breakdown Spectroscopy

Awarded to Andrew J. Effenberger, Jill R. Scott, and Timothy R. McJunkin, this patent teaches a method and describes an apparatus to perform high-resolution laser-induced breakdown spectroscopy. Specifically, the key optical detection components for an inexpensive device are discussed along with the methodology to use them with pulsed, low-level light sources. This apparatus provides a low-cost, high-resolution alternative to existing portable isotope detection systems.

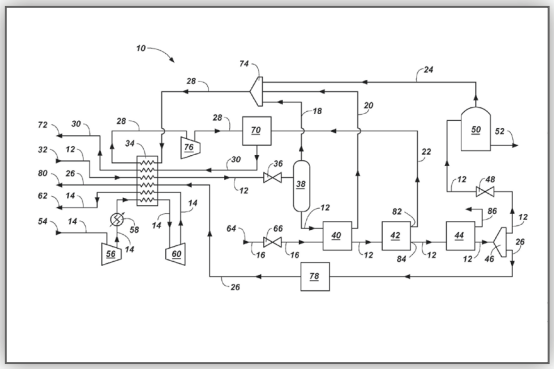
Patent Number: 8,891,073 Issued: November 4, 2014



Methods of Natural Gas Liquefaction and Natural Gas Liquefaction Plants Utilizing Multiple and Varying Gas Streams

This patent, issued to Bruce M. Wilding and Terry D. Turner, describes a new design for natural gas liquefaction plants that use multiple and varying gas streams to efficiently liquefy natural gas streams on a small scale and at low cost.

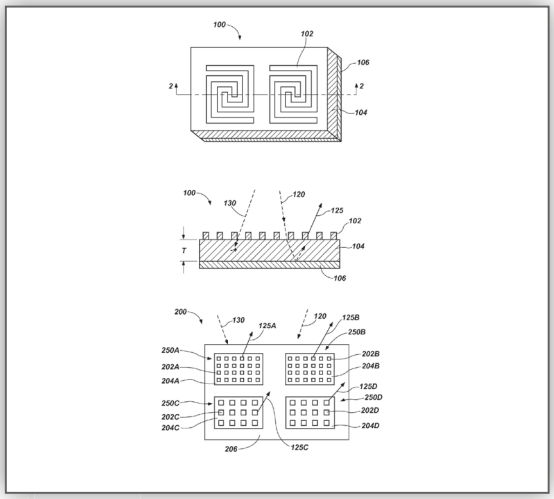
Patent Number: 8,899,074 Issued: November 18, 2014

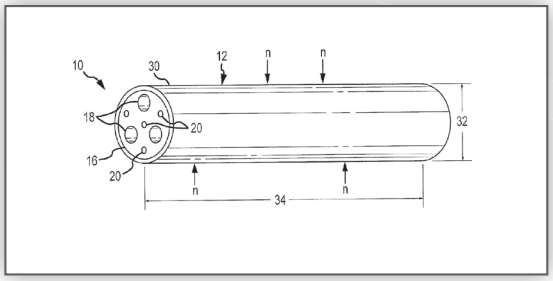


Radiation Sensitive Devices and Systems for Detection of Radioactive Materials and Related Method

This patent, awarded to Dale K. Kotter, describes a low-cost, radiation-sensitive device comprised of multiple resonance elements configured on a substrate, as well as system and method to use such a device for detecting the presence of special nuclear materials. This technology has relevancy in border protection and transportation security applications.

Patent Number: 8,901,507 Issued: December 2, 2014

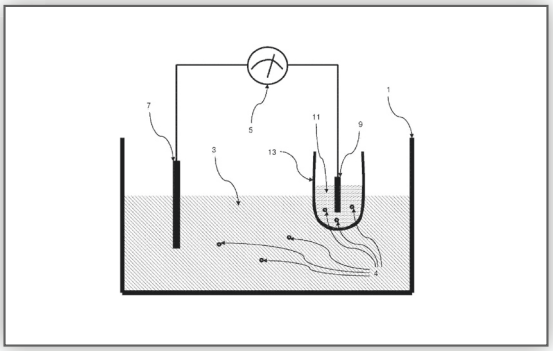




Neutron Absorbers and Methods of Forming at Least a Portion of a Neutron Absorber

Donna P. Guillen, Douglas L. Porter, W. David Swank, and Arnold W. Erickson were awarded this patent for their invention, using aluminum and hafnium to create a more effective neutron absorbing material. A thermal neutron absorbing material was developed to provide a domestic capability for fast flux materials and fuels testing in a pressurized water reactor. The patent describes a method for fabricating this new material.

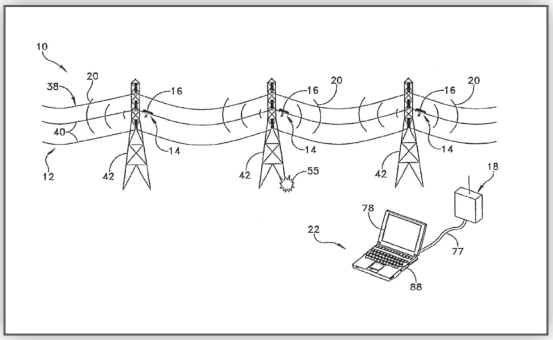
Patent Number: 8,903,035 Issued: December 2, 2014



Actinide-ion Sensor

The patent was issued to Shelly X. Li, Jan-Fong Jue, R. Scott Herbst, and Steven D. Hermann. A primary concern regarding the future of nuclear power is the management of radioactive waste. This invention describes an apparatus that can provide real-time monitoring of radioactive concentrations within waste. The apparatus pairs a working electrode and electrolyte inside the container with a reference electrode and electrolyte outside and then measures the difference with a voltmeter.

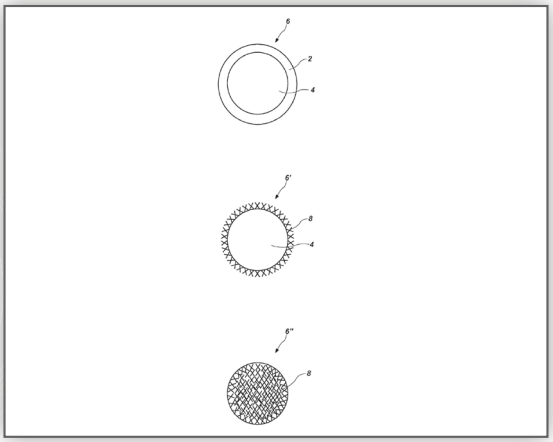
Patent Number: 8,932,446 Issued: January 13, 2015



Methods, Apparatus, and Systems for Monitoring Transmission Systems

Robert E. Polk, John M. Svoboda, Phillip B. West, Gail L. Heath, and Clark L. Scott were awarded this patent for their invention to monitor transmission systems. Pipelines, cell towers, power lines, and other transmission systems are all susceptible to damage via weather, accidents, or sabotage. Repairs are often costly and complicated and negatively affect large segments of the population when the systems unexpectedly go down. This invention provides advanced notice of problems to transmission system operators.

Patent Number: 8,941,491 Issued: January 27, 2015



Hybrid Particles and Associated Methods

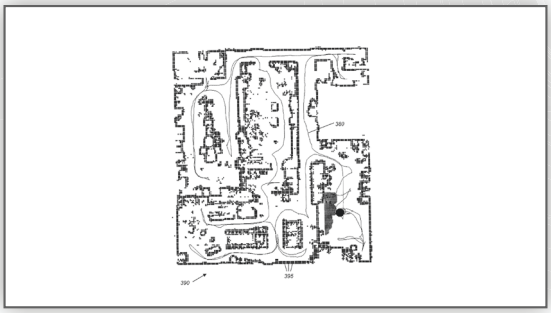
Robert V. Fox, Rene Rodriguez, Joshua J. Pak, and Chivin Sun were awarded this patent for their invention of hybrid particles used to create new semiconductor materials at lower costs. Semiconductor materials are found in light-emitting diodes, photovoltaic cells, microprocessors, and various other electronic devices. Some conventional semiconductor devices use lanthanide-based materials; as the need for these lanthanides increases, so does the cost. This technology may provide a low cost alternative to lanthanide based materials.

Patent Number: 8,951,446 Issued: February 10, 2015

Real Time Explosive Hazard Information Sensing, Processing, and Communication for Autonomous Operation

Roelof J. Versteeg, Douglas A. Few, Robert A. Kinoshita, Doug Johnson, and Ondrej Linda received this patent for developing a robot intelligence kernel allowing robots to autonomously detect, characterize, and map explosive hazards in a battlefield or other hostile environment. Remotely operated robots can be used for mine detection, but this requires skilled operators who may have to expose themselves in hostile environments. This invention protects the operators from dangerous situations.

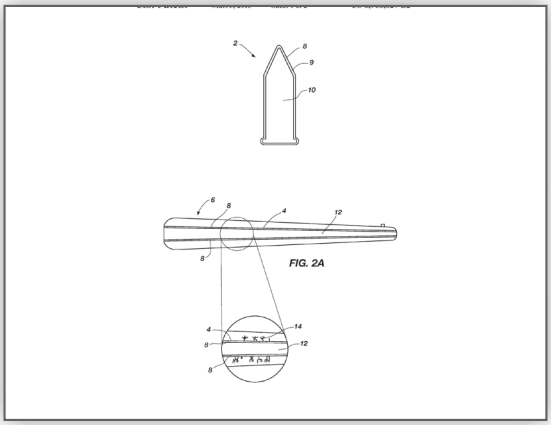
Patent Number: 8,965,578 Issued: February 24, 2015



Methods of Forming Boron Nitride

Tammy L. Trowbridge, Alan K. Wertsching, Patrick J. Pinhero, and David L. Crandall were awarded this patent for their invention, establishing a new method for forming boron nitride. New designs for ballistic weapons have resulted in projectiles that can travel faster, farther, and with greater accuracy, but these changes also increase temperature and friction within the barrel, causing greater damage. A boron nitride coating can condition and heal the weapon.

Patent Number: 8,968,827 Issued: March 3, 2015



Alteration and Modulation of Protein Activity by Varying Post-translational Modification

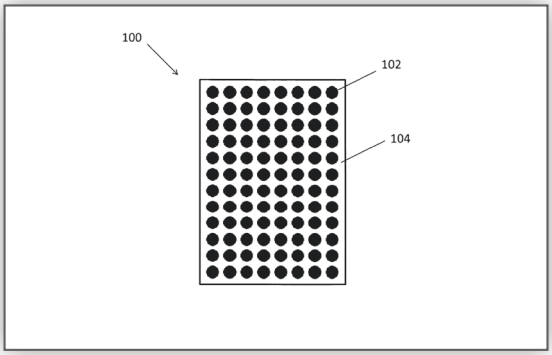
This patent was issued to David N. Thompson, David William Reed, Vicki S. Thompson, Jeffrey A. Lacey, and William A. Apel and teaches new methods of altering the enzymatic activity in a type of microorganism that thrives in extreme environments (an extremophile). The invention has potential to improve costs associated with converting biomass sugars into fuels and chemicals.

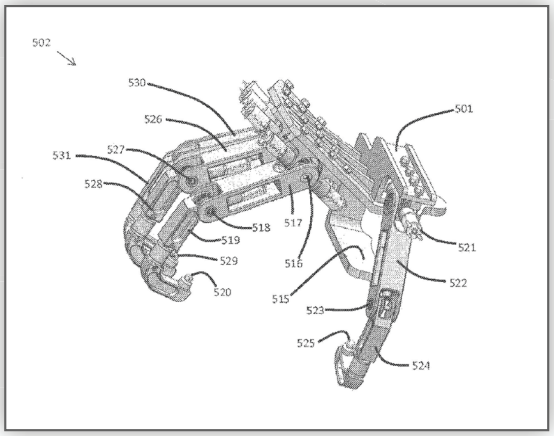
Patent Number: 8,969,033 Issued: March 3, 2015

Identification of Discriminant Proteins through Antibody Profiling, Methods and Apparatus for Identifying an Individual

This patent was awarded to Vicki S. Thompson, Jeffrey A. Lacey, Cynthia D. Gentillon, and William A. Apel and discusses how each person has their own unique antibody profile, which can be recovered from any biological sample more quickly and effectively than DNA tests. This patent describes a statistical analysis method that can take a protein array from a biological sample to positively identify a specific individual.

Patent Number: 8,969,009 Issued: March 3, 2015

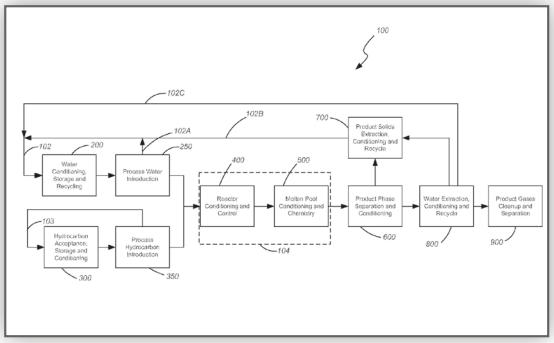




User Interface for a Tele-operated Robotic Hand System

Awarded to Anthony Louis Crawford, this patent describes an interface for a robotic hand that has a unique structure and associated algorithm to measure the size of the user's hand based on random fingertip movement. When working with dangerous materials and objects in settings such as hot cells, glove boxes, and explosives disarmament, operators need an interface that allows them the greatest levels of dexterity, range of motion, and accuracy. The interface allows the actual user's hand posture to be communicated to a robotic hand rather than just fingertip position lending itself to more intuitive movement despite the differences between the user's hand sizes.

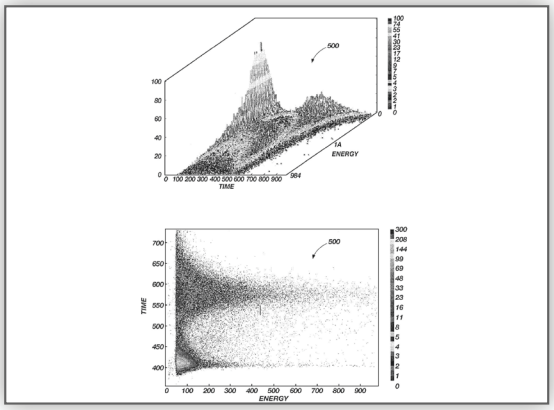
Patent Number: 8,989,902 Issued: March 24, 2015



System and Process for the Production of Syngas and Fuel Gasses

This patent was issued to Dennis N. Bingham, Kerry M. Klingler, Terry D. Turner, Bruce M. Wilding, and Bradley C. Benefiel for developing a new method of producing synthesis gas and hydrogen from a carbon feedstock. As the push for cleaner, renewable fuels grows stronger, researchers are looking at new ways to extract energy from alternative energy resources, as well as from energy reserves that have previously been overlooked.

Patent Number: 9,011,725 Issued: April 21, 2015



Apparatuses for Large Area Radiation Detection and Related Method

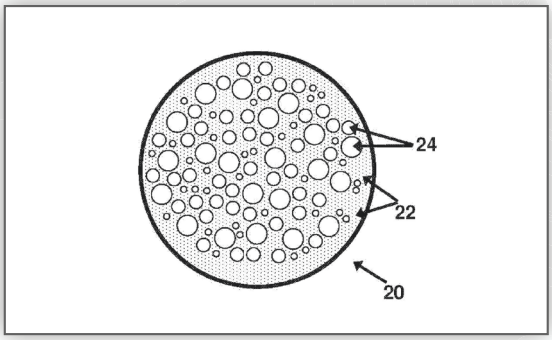
This patent was awarded to Douglas W. Akers and Mark W. Drigert for development of a radiation detector that uses scintillators to detect radioactive materials, such as Technetium-99 (Tc-99) and Carbon-14, which are difficult to measure in the environment with standard detectors. Tc-99 detection is of particular importance because the element has a long half-life and moves easily through the environment, especially in water.

Patent Number: 9,018,586 Issued: April 28, 2015

Method and Device for Fabricating Dispersion Fuel Comprising Fission Product Collection Spaces

This patent was issued to Eric L. Shaber and Randall S. Fielding. In traditional nuclear reactors, when neutrons interact with fissile material they create fission products that can build up and negatively impact the longevity and efficiency of the fuel. This invention describes a method for creating hollow micro-balloon spaces within the fuel element that will collect these fission products and improve the lifespan of the fuel.

Patent Number: 9,025,722 Issued: May 5, 2015



Type I Restriction Modification System Methylation Subunit of Alicyclobacillus Acidocaldarius

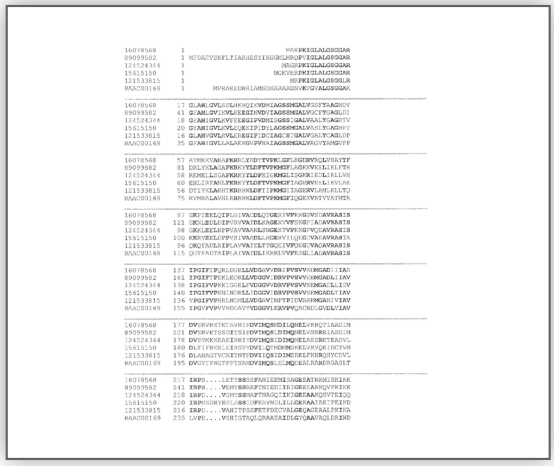
Brady D. Lee, Deborah T. Newby, Jeffrey A Lacey, David N. Thompson, Vicki S. Thompson, William A. Apel, Francisco F. Roberto, and David William Reed received a patent for developing "tools" that increase the successful genetic recombination of certain extremophiles. Certain strains of bacteria that thrive in hot or acidic environments (thermophiles and acidophiles), if genetically modified, show great potential for the production of chemicals critical to industrial processes.

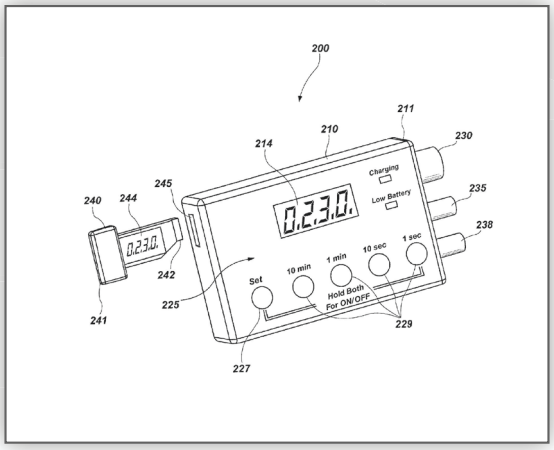
Patent Number: 9,029,114 Issued: May 12, 2015

Thermophilic and Thermoacidophilic Biopolymer-degrading Genes and Enzymes from Alicyclobacillus Acidocaldarius and Related Organisms, Methods

David N. Thompson, William A. Apel, Vicki S. Thompson, David W. Reed, Jeffrey A. Lacey, and Emily D. Henriksen were awarded this patent for their work identifying, isolating, and purifying enzymes and nucleic acid sequences from Alicyclobacillus acidocaldarius—a heat- and acid-loving bacterium. This work helps optimize biomass pretreatment for production of biofuels by removing and degrading the tough cell walls of plant material.

Patent Number: 9,045,741 Issued: June 2, 2015

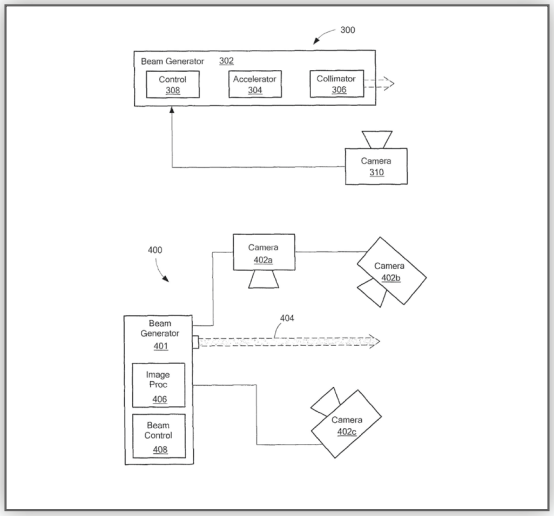




Methods for Synchronizing a Countdown Routine of a Timer Key and Electronic Device

This patent was awarded to Reston A. Condit, Michael Alan Daniels, Gregory P. Clemens, Eric S. Tomberlin, and Joel A. Johnson for their invention that synchronizes the countdown routines of a timer key and electronic device. Military, police, and some commercial situations call for explosives triggered by energetic initiation devices. The invention allows personnel to set a timer on the electronic initiation device while providing a separate timer key that displays the synchronized countdown time to the operator. This allows personnel continuous monitoring of the countdown time via the timer key at a nearby and safe location.

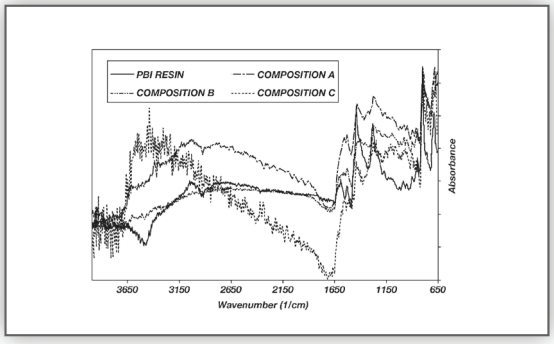
Patent Number: 9,046,268 Issued: June 2, 2015



Method and Apparatus to Monitor a Beam of Ionizing Radiation

This patent was awarded to Brandon Blackburn, David L. Chichester, Scott Marshall Watson, James T. Johnson, and Mathew T. Kinlaw for their methods and apparatus to capture fluorescent images to track an ionizing radiation beam. Radiation beams are useful in a variety of systems, including medicine and active interrogation systems. Inherent risks associated with the beams make it important to track their exact locations, but current methods are costly and labor-intensive.

Patent Number: 9,046,619 Issued: June 2, 2015



Precursor Polymer Compositions Comprising Polybenzimidazole (as Amended)

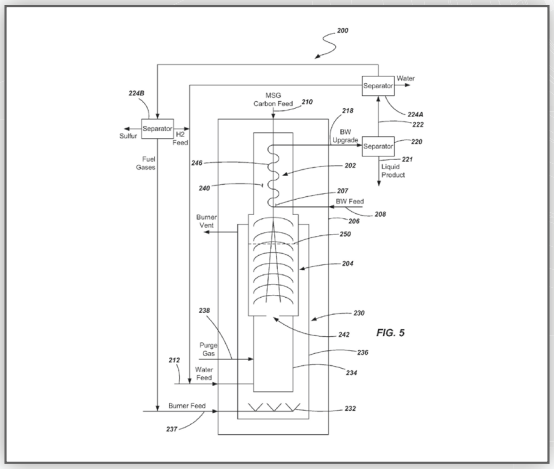
This patent was awarded to John R. Klaehn, Eric S. Peterson, and Christopher J. Orme. It describes stable, high-performance polymer compositions that include polybenzimidazole (PBI). PBI is a resilient polymer used to form materials such as membranes, conductive materials, fire-resistant materials, and ultrafilters. However, it can craze and crack when the hydrogen bonding has been disrupted. This invention improves the durability of PBI by combining it with another polymer.

Patent Number: 9,080,052 Issued: July 14, 2015

System and Process for Upgrading Hydrocarbons

Dennis N. Bingham, Kerry M. Klingler, Joseph D. Smith, Terry D. Turner, and Bruce M. Wilding were awarded this patent for their invention that upgrades hydrocarbon material using a black-wax upgrade subsystem and a molten-salt gasification system. Though hydrocarbon-based fuels are still a major source of energy production, growing energy needs also require the development of alternative fuel systems. One option is to upgrade low value hydrocarbon feedstocks.

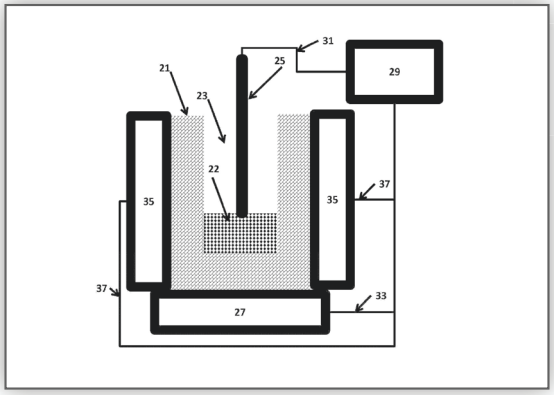
Patent Number: 9,114,984 Issued: August 25, 2015



Real-time Monitoring of Plutonium Content in Uranium-Plutonium Alloys

Shelly X. Li, Brian R. Westphal, and Steven D. Herrmann were awarded this patent for their method and device that allow for real-time, in-situ monitoring of plutonium content within uranium-plutonium alloys. As processing and preprocessing techniques for nuclear and spent nuclear fuel evolve, so must methods of monitoring and measuring the remaining plutonium contents within that fuel. This will help meet International Atomic Energy Agency safety standards, while decreasing proliferation risks.

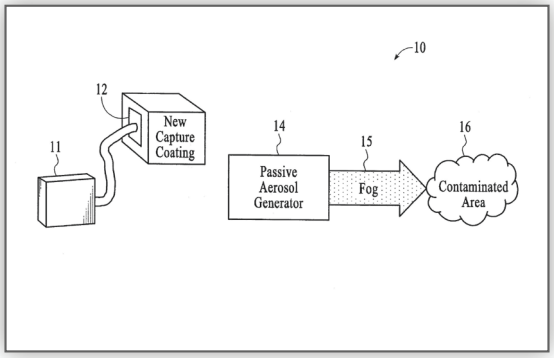
Patent Number: 9,121,807 Issued: September 1, 2015



Fogging Formulations for Fixation of Particulate Contamination in Ductwork and Enclosures

Radionuclides may contaminate dust, lint, and particulates throughout radiological buildings and ventilation systems. During decommissioning and dismantling of such facilities, it is difficult to contain these types of contamination. Joseph W. Maresca, Lori M. Kostelnik, James R. Kriskovich, Rick L. Demmer, and Julia Lynn Tripp received this patent for their invention of fogging formulations, which can easily penetrate particles, trapping and keeping them safely contained both during and after the decommissioning process.

Patent Number: 9,126,230 Issued: September 8, 2015

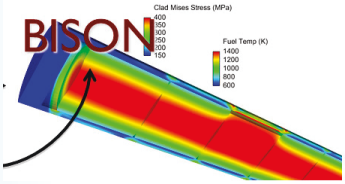


Copyrights Assertions

During FY 2015, INL received permission to assert copyright on seven software programs developed by INL authors, including one for NHS, two for EEST, and four for NST. Since FY 2005, INL has been authorized by DOE to assert copyright protection on more than 83 pieces of software.

Copyright is a legal right that grants the creator(s) of an original work, such as software, exclusive rights for its use and distribution. As a condition of employment, INL employees assign such rights to the company. In accordance with BEA's contract with DOE, all copyright rights are assigned to DOE, unless BEA specifically requests authority to "assert" copyright. BEA requests the permission to assert copyright on software it intends to license via open source and traditional agreements.

BISON

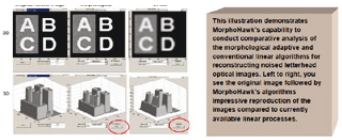


BISON is a finite element-based nuclear fuel performance code applicable to a variety of fuel forms, including light water reactor fuel rods, TRISO (Tristructural-isotropic) fuel particles, and metallic rod and plate fuel. It solves the fully coupled equations of thermomechanics and species diffusion and includes important fuel physics such as fission gas release and material property degradation with burnup. Based on the MOOSE (Multiphysics Objects Oriented Simulation Environment) framework, BISON can efficiently solve problems on 1-, 2- or 3-D meshes using standard workstations or large high-performance computers. Bison is also coupled to a MOOSE-based mesoscale phase field material property simulation capability. As described here, BISON includes the code library named FOX, which was developed concurrently with BISON. FOX contains material and behavioral models that are specific to oxide fuels. Authors include Jason Hales, Richard L. Williamson, Stephen R. Novascone, Benjamin Spencer, Giovanni Pastore, Cody Permann, David Andrs, J. C. Newman, Jr., Michael Tonks, Richard C. Martineau, Danielle Perez, Shane Stafford, Frederick Gleicher, J. W. Peterson, Andrew E. Slaughter, Pavel G. Medvedev, Thomas K. Larson, and Derek Gaston.

Grizzly

Grizzly is a simulation tool for assessing the effects of age-related degradation on systems, structures, and components of nuclear power plants. Grizzly is built on the MOOSE framework and uses a Jacobian-free Newton Krylov method to obtain solutions to coupled simulations of a variety of physics, including heat conduction, species diffusion, chemical reactions, and solid mechanics. Grizzly runs on a wide range of hardware, from a single processor to massively parallel machines. Authors include Andrew Slaughter, Benjamin Spencer, Cody Permann, Daniel Schwen, David Andrs, Derek Gaston, Hai Huang, Jason Miller, John Peterson, Pritam Chakraborty, and Xianming Bai.

MorphoHawk



MorphoHawk applies projectional mathematical morphology in a fundamentally new way. MorphoHawk extracts object information from digital images by filtering with simple geometrical figures such as rectangles or simple curves. Two core algorithms are used to accomplish this function. Authors include Michael V. Glazoff, Kevin L. Gering, and Yuri Petrovich Pytyev.

Reactor Application for Coaching Newbies

Reactor Application for Coaching Newbies (RACCOON) is a MOOSE-based reactor physics application designed to engage undergraduate and first-year graduate students. The code contains capabilities to solve the multi-group Neutron Diffusion equation in eigenvalue and fixed source form and will soon have a provision to provide simple thermal feedback. These capabilities are sufficient to solve example problems found in Nuclear Reactor Analysis by Duderstadt and Hamilton (the typical textbook of senior-level reactor physics classes). Authors include Sebastian Schunert, Javier Ortensi, Yaqi Wang, and Frederick Gleicher.

HFE-Trace

HFE-Trace (Human Factors Engineering) is an integrated method and tool for the management of human factors engineering analyses and related data. It supports coherent and consistent application of the nuclear industry's best practices for human factors engineering work and collects data on the design of new nuclear power plants. Information identifies potential system and functional breakdowns as well as system performance parameters, operating limits and constraints, and operational conditions. Human factors elements are added to each function, including intended operator role, function allocation considerations, prohibited actions, primary task categories, and primary workstation. HFE-Trace includes a computational method to assess factors such as system and process complexity, workload, environmental conditions, procedures, regulations, etc., that may shape operator performance and prevent potential operator errors. Jacques Victor Hugo is the author of this software.

Reservoir Temperature Estimator

The Reservoir Temperature Estimator (RTEst) is a program used to estimate deep geothermal reservoir temperature and chemical parameters such as CO_2 fugacity based on the water chemistry of shallower, cooler reservoir fluids. This code uses the plug-in features provided in The Geochemist's Workbench (Bethke and Yeakel 2011) and interfaces with the model-independent Parameter ESTimation Software (Doherty 2005) to provide for optimization of the estimated parameters. The author of RTEst is Carl D. Palmer.

Autonomic Intelligent Cyber Sensor Version 1.0.1

Resilient Control & Instrumentation Systems

Autonomic Intelligent Cyber Sensor (AICS)

The Autonomic Intelligent Cyber Sensor (AICS) provides cyber security and industrial network state awareness for Ethernet-based control network implementations. AICS utilizes collaborative mechanisms based on autonomic research and a service-oriented architecture to: (1) identify anomalous network traffic, (2) discover network entity information, (3) deploy deceptive virtual hosts, and (4) implement self-configuring modules. AICS achieves these goals by dynamically reacting to the industrial human-digital ecosystem in which it resides. Information is transported internally and externally on a standards-based, flexible two-level communication structure. AICS authors include Denis Todd Vollmer, Milos Manic, and Ondrej Linda.

Royalties

During FY 2015, U.S. businesses sold roughly $51 million in products, processes, and innovations based on INL patented technologies. Use of INL technologies in domestic and global markets has created jobs and increased U.S. global competitiveness.

Commercial markets have been very accepting of INL-developed technologies. From FY 2005 to FY 2015, INL signed 767 licenses to commercialize technologies developed within the Laboratory. This success is a result of excellent research and strong Laboratory support. INL's support strategy provides for necessary investments that will achieve optimal mission-related returns.

Since the inception of BEA's contract, INL has earned more than $16 million in royalties. It reflects a strong, expanding portfolio of IP, as well as increased attention to commercialization of INL discoveries, inventions, and current IP.

During FY 2015, INL received more than $1.8 million in royalty receipts. Although down from last year's record, the royalties earned in FY 2015 are impressive and represent the second-highest royalty earnings in INL history (Figure 3).

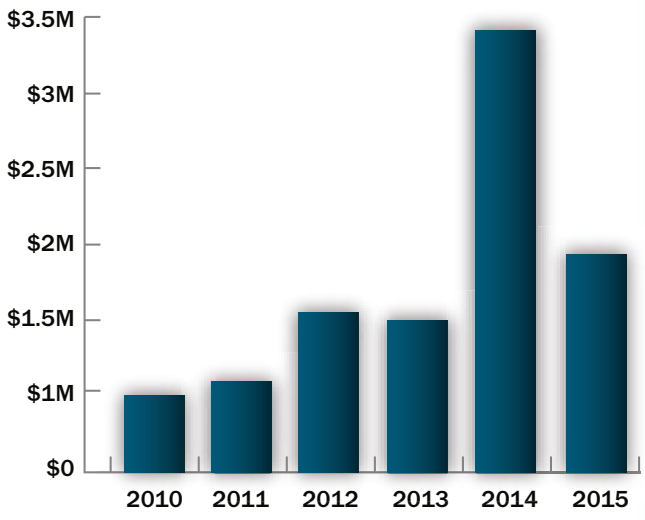


Figure 3. Royalties received FY 2010–2015.

Royalties are an important signal that INL innovations are meeting market needs. It should be noted that it takes time and persistence for inventions to mature into products that generate royalties. INL continues to encourage innovation and to reinvest a significant portion of the royalty revenues to promote development of promising new "early stage" technologies emerging from INL's ongoing R&D programs.

Expenditure of royalty funds is governed by federal regulations and must be used in ways that support technology transfer activities. Roughly 30% of royalty funds received by INL are shared with inventors of royalty generating technologies. Additional money is spent to recognize and reward inventors and other employees who have supported technology transfer activities throughout the Laboratory, independent of the technology having commercial applications. The remaining funds are reinvested in technology transfer activities throughout the Laboratory. Reinvestment is directed from two funds, the Science and Technology Strategic Investments Fund (SIF) and Innovation Development Fund (IDF).

SIF is focused on funding R&D capabilities that will lead to new technology development and increase the potential for INL to generate new business.

INL's IDF is a mechanism used for advancing the transfer of promising emerging technologies. A key to the success of these maturation investments will be INL's ability to engage industry whose own resources and expertise are essential in advancing future generations of INL technologies. IDF projects have permitted development of stronger relationships with industry, yielding exceptional return on investment to the U.S. public from INL research. Focusing on commercial results has enabled IDF's success.

In FY 2015, $1.3 million was reinvested into Laboratory technology transfer activities. A selected summary of projects is provided in Table 1.

Table 1. Select technologies supplemented with royalty funds.

IDF Projects	PI
Phosphoranimine Synthesis and Characterization (Safer non-flammable battery materials)	John Klaehn
Advanced Electrolyte Model (Improvement of tool used for screening battery electrolytes)	Kevin Gering
Control Area Network (CAN) Bus Network Safety and Security System (Prototype development of cyber device)	Ken Rohde
WSComm Wireless Communications (Support wireless standards)	Hussein Moradi
Super Tap Man-in-the-middle (MITM) Attack Analysis Tool (Development of tool to support cyber analysis)	Reston Conard
Switchable Polarity Solvent – Forward Osmosis (SPS-FO) Collaboration (CO_2 capture/water treatment process development)	Aaron Wilson
Telos Cyber Innovation Opportunity (Business case development)	Michael Glazoff
Cold Crucible Induction Melter (Design and testing of cold crucible drain system)	Bradley Benefiel
Autonomic Intelligent Cyber Sensor (Presentation materials to further licensing efforts)	Craig Rieger
Molten Salt (Expansion of capabilities)	James O'Brien
Well 142 Extension Drilling (Geothermal evaluation)	Rob Podgorney
Absolute Efficiency Calibration Detectors (Validate equations used for detection)	Troy Robinson
Nuclear and Radiological Activity Center (NRAC) Demonstration (Proof of concept to measure inventory in ducts, hoods, and gloveboxes)	David Chichester

License Highlights

INL negotiates license agreements with businesses or other organizations, that allows them to reproduce, manufacture, sell, or use IP owned by the Laboratory. INL licenses its IP on much of the same terms as universities, other research organizations, and industrial firms.

Since the initiation of BEA's contract, INL has signed 767 licenses that have earned more than $16.3 million in royalty fees. These include 58 patent licenses, 39 license option agreements, 96 copyright licenses with fees, and 574 copyright licenses without fees (Figure 4).

For FY 2015, INL signed 68 new licensing agreements, including two patent licenses, two patent license option agreements, eight copyright licenses with fees, and 56 copyright licenses without fees (Figure 5).

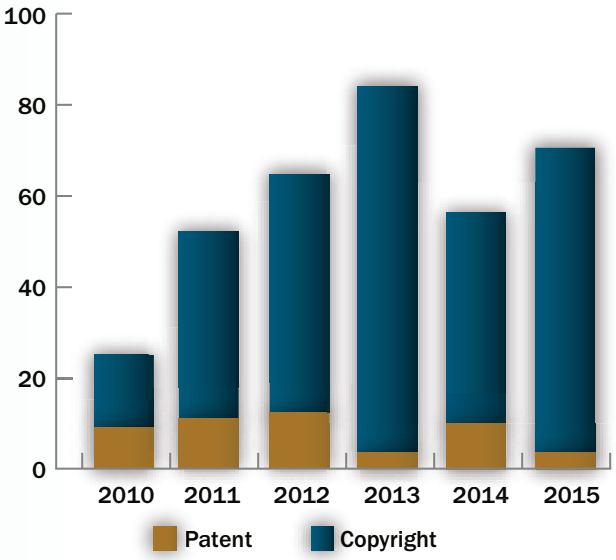


Figure 4. New licensing activities during FY 2010–2015.

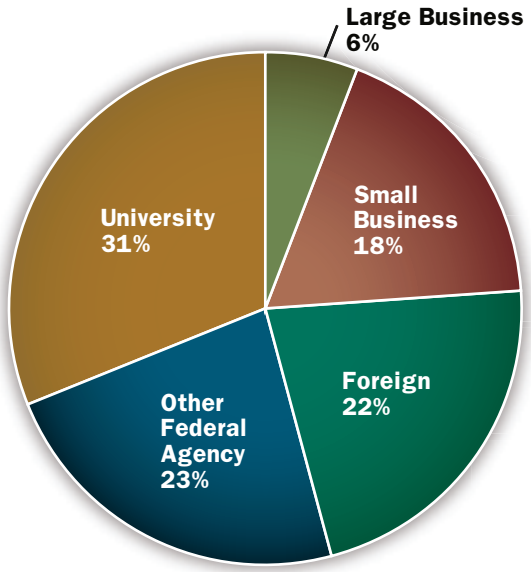


Figure 5. Licenses executed FY 2015.

Eunomic, Inc., and Investabode, LLC

INL executed two non-exclusive licenses for Autonomic Intelligent Cyber Sensor Version 1.0.1: AICS Beta Testing with Eunomic, Inc., and Investabode, LLC. AICS provides cyber security and industrial network state awareness for Ethernet-based control network implementations.

SOPHIA

INL issued four non-fee government use agreements for Sophia software. NexDefense, Inc., is licensed to provide Sophia software commercial licenses. INL issues non-fee government use licenses when requested by government agencies.

Sophia is an INL-developed industrial control system fingerprinting software tool, which passively monitors infrastructure and informs management about anomalies for further investigation or protective actions. This innovative technology was made commercially available after extensive beta testing by dozens of enterprises. INL issued licenses to:

- Naval Ship Systems Engineering Station Philadelphia
- SPAWAR Systems Center Pacific
- Naval Surface Warfare Center Carderock – Philadelphia
- National Security Agency

Dynexus Technology, LLC

Dynexus Technology, LLC, was granted an option to execute an exclusive license for the Impedance Measurement Box and Battery Health Monitor technologies developed with funding from DOE's Vehicle Technologies Office. Dynexus is exploring a number of potential markets to apply this technology where improved visibility of battery health could result in substantial cost savings.

SiGNa Chemistry, Inc.

SiGNa Chemistry, Inc., exercised their option to exclusively license a technology that uses exothermic reactants in downhole environments for enhanced oil recovery. SiGNa plans to continue developing this technology for commercial application.

Waste Resource Recovery, Inc.

Waste Resource Recovery, Inc., executed a license granting exclusive rights to the R&D 100 Award winning Supercritical Solid Catalyst Biodiesel technology developed at INL. The technology does not have the same feedstock limitations as traditional biodiesel production methods. Up to 100% free fatty acid feedstocks are converted into biodiesel with the Supercritical Solid Catalyst process.

Illinois Rocstar, LLC

Illinois Rocstar, LLC, executed a government-use license to develop a standalone software module from the R&D 100 Award winning Advanced Electrolyte Model software developed at INL. The license is necessary to complete a Phase II National Aeronautics and Space Administration Small Business Innovation Research (SBIR) project awarded to Illinois Rocstar. The objective is to develop a set of computational tools that will accelerate the process of optimizing battery performance.

Reservoir Temperature Estimator

Former INL employee and subcontractor Carl Palmer executed a non-exclusive license, granting rights to the Reservoir Temperature Estimator (RTEst) software. RTEst is a program used to estimate deep geothermal reservoir temperatures and chemical parameters, such as CO_2 fugacity, based on conditions of shallower, cooler reservoir fluids.
Mr. Palmer plans to use RTEst to support evaluation of geothermal resources.

PHISICS

INL licensed Parallel and Highly Innovative Simulation for INL Code System (PHISICS) software to Japan Atomic Energy Agency. PHISICS is a software package intended to provide a modern analysis tool for reactor physics investigation. PHISICS is designed to maximize accuracy for a given availability of computational resources by using several algorithms and meshing options to optimize computational resources and desired accuracy levels.

RAVEN

INL issued nine licenses for RAVEN software. RAVEN is a software code that provides a graphical user interface for three principal applications. These include the pre- and post-processing of the RELAP-7 input and output, a capability to model nuclear power plants control logic for RELAP-7 code and dynamic control of the accident scenario evolution, and a general environment to perform probability risk analysis for RELAP-7, RELAP-5, and any generic MOOSE-based applications. Licensees include:

- Texas Engineering Experiment Station of the Texas A&M University System
- Oak Ridge National Laboratory
- University of California – Berkeley
- University of Utah
- UChicago Argonne, LLC
- University of Idaho
- Politecnico Di Milano – Energy Division
- Politecnico Di Milano – Nuclear Division
- Purdue University

BISON

INL licensed BISON software to more than 25 universities and commercial entities. BISON is a finite element-based nuclear fuel performance code applicable to a variety of fuel forms, including light water reactor fuel rods, tristructural-isotropic fuel particles, and metallic rod and plate fuel. It solves the fully coupled equations of thermo-mechanics and species diffusion, and includes important fuel physics such as fission gas release and material property degradation with burnup. The BISON application is based on the MOOSE framework. Licensees include:

- Kansas State University
- UChicago Argonne, LLC
- The Ohio State University
- University of South Carolina
- University of Tennessee
- The Regents of the University of California - Berkeley
- University of Wisconsin - Madison
- University of Michigan
- Los Alamos National Security, LLC
- ANATECH
- National Nuclear Laboratory, Ltd.
- Massachusetts Institute of Technology
- Oregon State University
- Canadian Nuclear Laboratories
- Virginia Commonwealth University
- Politecnico Di Milano - Department of Energy, CeSNEF Nuclear Engineering Division
- Department of Chemistry & Chemical Engineering, Royal Military College of Canada
- Electric Power Research Institute (EPRI)
- Oak Ridge National Laboratory
- Bechtel Marine Propulsion Corporation / Bechtel Bettis, Inc.
- Sandia National Laboratories

BISON, continued

- Battelle Pacific Northwest Laboratories
- The Pennsylvania State University
- UT Battelle, LLC
- Texas Engineering Experiment Station of the Texas A&M University System
- Institutt for energiteknikk
- Centre for Energy Research, Hungarian Academy of Sciences (MTA EK)

RELAP5-3D

Industry and universities continued to request access to the RELAP5-3D code. In FY 2015, more than 16 new license agreements were executed. RELAP5-3D is widely used in the international nuclear community to support research and nuclear studies, safety analysis, and evaluation of innovations. As it has for decades, INL continues to cooperate with the International RELAP Users Group, and last year released the latest in the RELAP5-3D code series to analyze transients and accidents in water-cooled nuclear power plants and related systems. Immediately prior to this year's annual International RELAP Users Group meeting in Idaho Falls, ID. 31 individuals participated in an advanced training class conducted by INL. This training assists utilities and other companies using RELAP5-3D in performing systems safety analyses. Licensees include:

- University of Nevada Las Vegas
- Waseda University
- TerraPower, LLC
- BWX Technologies, Inc.
- Department of Nuclear Safety, Taiwan Power Company
- Nuclear Regulation Authority, Japan
- Iowa State University of Science & Technology
- Japan Atomic Energy Agency
- SHINE Medical Technologies, Inc.
- U.S. Naval Academy
- Wolf Creek Nuclear Operating Corporation
- AMEC Nuclear UK Limited
- Professur für Thermofluiddynamik, Technical University of Munich
- Bangladesh University of Engineering & Technology
- Nooter Erickson, Inc.
- McMaster University

Cooperative Research and Development Agreements Highlights

INL uses CRADAs to meet the R&D needs and resources of the participating parties. INL's CRADA portfolio includes agreements with shorter periods of performance to agreements lasting several years; all of which is necessary to align mission objectives and deliver outcomes. The number of agreements executed and commitments made vary considerably from year-to-year based upon INL objectives, the readiness of the participants to invest in collaborations, and the Laboratory's ability to identify the right participants and negotiate satisfactory collaborative partnerships.

INL continued to successfully seek and capture opportunities for greater impact to the Laboratory's overall mission. Figure 6 highlights the booked value of CRADAs executed by FY. During FY 2015, five new CRADAs were executed and 17 existing CRADAs were modified. The total CRADA value during the year was more than $22.6 million, including $17.1 million of funds-in, $2.7 million of in-kind contributions from participants, and approximately $2.6 million in government contributions.

Looking beyond the value and quantity of CRADAs, it is important to recognize and understand INL's partnership demographics. In FY 2015, the new and modified agreements varied from foreign participant to small businesses. Figure 7 highlights the diversity of INL's CRADA portfolio.

The following executed and modified CRADAs in FY 2015 brought future collaboration and research opportunities to INL Mission Directorates: NST, EEST, and NHS.

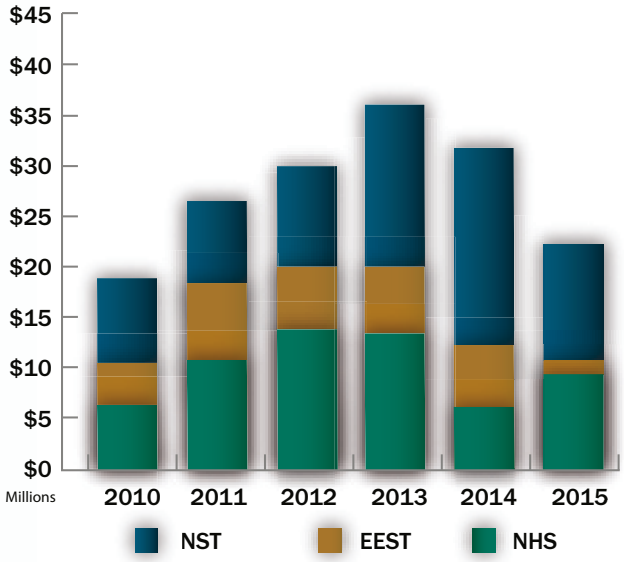


Figure 6. New and modified CRADAs supporting mission directorates FY 2010–2015.

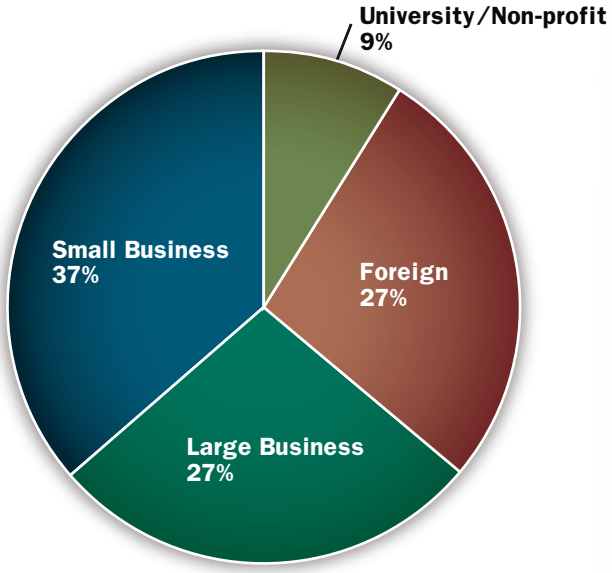


Figure 7. FY 2015 executed CRADAs by stakeholder.

AltaLink, L.P.

Aligning with mission objectives of DOE Office of Energy Efficiency and Renewable Energy Wind and Water Power Technology Office research project, INL is performing research activities to monitor wind and other data parameters along certain electrical transmission corridors. This real-time and historical data is used for modeling and validation, and to determine possibilities for dynamic transmission operation. The anticipated use of this research will determine if partial upgrades to certain areas/sections of the transmission lines are feasible to limit or postpone the need for full line upgrades or new transmission lines in certain cases.

WindSim Americas, Inc.

INL and WindSim are researching, developing, and demonstrating a software solution for integrating computational fluid dynamics into a dynamic line rating modeling system that can significantly increase capacity of existing power transmission infrastructure. This collaboration falls within the grid integration and renewable energy business development and resource integration to meet the nation's energy demands. This effort includes refinements to the calculated wind data near transmission lines as well as entire transmission line simulations. Optimization algorithms may also be explored for future transmission line construction.

Idaho Transporation Department

The purpose of this CRADA is to inspect, review, and integrate technologies supporting vehicle-to-vehicle and vehicle-to-infrastructure communication with the goal of establishing the capability and related infrastructure to reduce accidents and generally improve safety and efficiency on a site, state, and national scale. The Idaho Transportation Department will make snowplows available to INL. In support of planned research, the snowplows will be retrofitted with sensors and other devices to enable vehicle-to-vehicle and vehicle-to-infrastructure communication. This work will benefit national fuel efficiency initiatives.

IGE Energy Services, Limited

Through a period of performance extension, INL continues to provide collaborative efforts to identify and develop mitigation solutions for International General Electric (IGE) ENAMCTM system vulnerabilities in the wake of advancing technologies. IGE and INL continue to participate in this collaboration to enhance infrastructure robustness and security to benefit the United Kingdom and also to facilitate international collaboration between the U.S. and the United Kingdom electrical distribution system. INL is currently in discussions with IGE to perform an additional observation assessment on a new IGE system, PowerONTM.

Porifera, Inc.

Under Phase 2 of an SBIR grant, Porifera and INL are developing waste-water treatment technologies. INL has conducted research into SPS-FO for water purification and has partnered with Porifera to evaluate the use of SPS-FO in treating waste water using carbon dioxide (CO_2). This collaboration advances development and deployment of an integrated low-energy water treatment and carbon capture technology.

Korea Atomic Energy Research Institute (KAERI) and UChicago Argonne, LLC

An electrochemical recycling study between INL, UChicago Argonne, LLC, and KAERI is 10 years in duration and is divided into three phases. In FY 2015, a modification was executed to enact Phase II-B. Under this phase, the parties will perform the installation of equipment and initiate the process to produce one or more transuranium-bearing fuel slugs. This work is part of the Joint Fuel Cycle Study between the U.S. and Republic of Korea.

Ametek, Inc.

INL and Ametek, Inc., an ORTEC Business Unit, continue to combine resources to develop a robust portable instrumentation that can accurately determine the presence of chemical agents or energetic materials in military munitions or storage containers. This collabortive relationship began in 1993 and continues beyond 2015 with an extension for another five years to continue the development of the Portable Isotopic-Neutron Chemical Assay System.

Strategic Partnership Projects Highlights

DOE believes Strategic Partnerships Projects (SPP), by virtue of exposing the laboratories to the needs of other agencies and industry, strengthens the laboratories' core capabilities and assists them in remaining at the forefront of their fields, which supports the Department's mission. To align that mission, DOE renamed what was formally known as "Work for Others (WFO)" to "Strategic Partnership Projects (SPP)" in FY 2015. The transition from WFO to SPP was communicated to the INL research community and procedures are being aligned to meet the revised focus on engaging partners through an integrated research agreement mechanism.

In FY 2015, 12 new federal SPP agreements and 120 modifications were executed. INL's FY 2015 non-federal SPP agreements included 23 new projects and 46 modifications to existing agreements. The combined federal and non-federal SPP portfolio included 201 active agreements resulting in an estimated booked value of $294 million. While the overall FY 2015 non-federal agreement volume was relatively flat, there was a significant increase in federal SPP agreement values. The increase can be tied directly to key federal SPP funding. Figure 8 highlights the booked value of SPPs executed by FY.

INL's SPP allows universities, private entities, and federal agencies access to INL's immense and specialized R&D capabilities on a full-cost recovery basis. In FY 2015, the new and modified agreements varied from other federal agencies to small businesses. Figure 9 highlights the diverse nature of INL's FY 2015 SPP portfolio.

The following are examples of executed SPPs in FY 2015 that furthered collaboration and research within INL Mission Directorates: NST, EEST, and NHS.

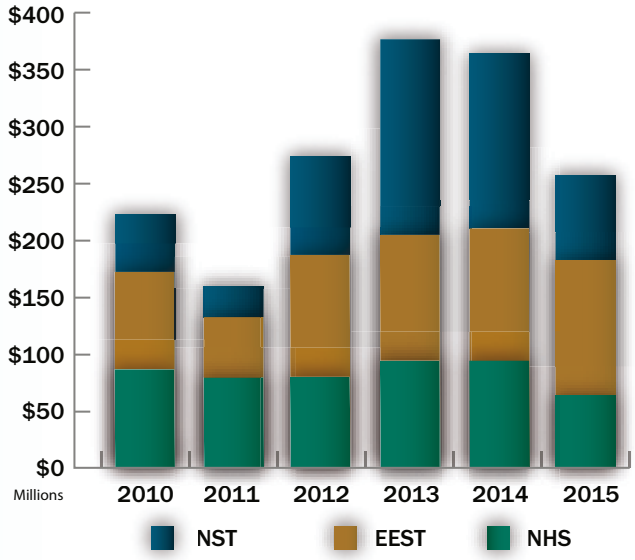


Figure 8. New and modified SPPs supporting mission directorates FY 2010–2015.

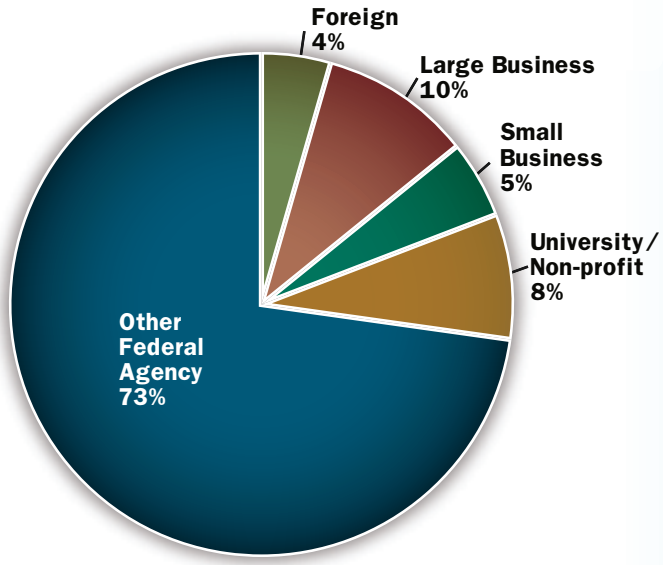


Figure 9. FY 2015 executed SPPs by stakeholder.

OneSubsea

OneSubsea is a one of a kind company created by two subsea leaders: Cameron and Schlumberger. INL negotiated and executed a multi-phase SPP with OneSubsea to perform research on two specific areas of interest. The first area is development of new technology and methodology that will identify and arrest corrosion in remote and harsh environments, using delivery technology conceived and customized for the purpose. Volatile corrosion inhibitors have excellent potential for mitigating or halting altogether, the progress of corrosion occurring in pipelines. Preliminary research has revealed several classes of compounds that could achieve this outcome, and in addition could provide a "report back" function that would remotely signal the existence and the extent of corrosion. The second area of research includes identifying the best technologies and future battery testing technologies.

Alliant Techsystems Operations, LLC

Alliant Techsystems (ATK) Operations Missile Products Division partnered with INL to improve the technology of propellant-based fracturing for hydrocarbon recovery in shale reservoirs. INL's unique analytical and simulation capabilities are well suited to analyze propellant-based well stimulation effects and optimization. Propellant-based fracturing is currently performed largely based on empirically derived relationships between reservoir response and propellant characteristics, including mass, deflagration rate, and fluid pressure used to direct gas flow. This work supports the EEST mission through advancing technology useful for well stimulation for geothermal energy recovery and fossil energy recovery.

Southern California Edison

Southern California Edison is partnering with INL to implement a risk analysis process for evaluation of cyber threat advisories, as well as research to pursue a "Machine-to-Machine Automated Threat Response" capability. INL will conduct a one-year risk analysis pilot project to demonstrate a viable operational risk analysis process and to spiral the development of a prototype software tool suitable for operational use. This research will educate and support the members of the California Energy Systems for the 21st Century (CES-21), who are striving for a proactive and agile response to today's dynamic threat environment characterized by the targeting of critical infrastructure with exploits, vulnerabilities, and malware.

Radiation Monitoring Devices, Inc.

Three SPPs were executed with Radiation Monitoring Devices, Inc. (RMDI). Through a Small Business Innovative Research grant, RMDI requested that INL provide consultation support in the development of a new neutron/gamma detector and testing with small quantities of uranium and plutonium. This work is part of the continuing testing regimen of vendor and agency-funded nonproliferation-based instrument testing. This test campaign utilizes the NRAC, Materials Fuel Complex Zero Power Physics Reactor facility and nuclear material to provide a realistic testing campaign.

Northrop Grumman Corporation – Aerospace Systems

The SPP with Northrop Grumman Corporation – Aerospace Systems allows INL to continue to support of the Electronic Warfare Common Component with specific focus on the Miniature Air Launch Decoy Jammer component previously developed under a prior SPP agreement. INL is in a unique position as the authors of this software to provide the most cost-effective solution for the U.S. Government.

Electricity de France

Électricité de France (EdF) partnered with INL to access world-class expertise in probabilistic modeling and mechanistic modeling for reactor pressure vessels. INL has a long history of probabilistic risk assessment applications, including pressurized thermal shock sequence analysis. EdF desires an independent third-party evaluation of their safety calculations, which enables their ability to obtain U.S. nuclear industry sector expertise. EdF also needs access to current research topics related to reactor pressure vessel modeling, which is underway within INL and the Oak Ridge National Laboratory.

Electric Power Research Institute

Electric Power Research Institute conducts research, development, and demonstration relating to the generation, delivery, and use of electricity for the benefit of the public. Ballistic resistance of electrical transformers, especially their critical components, are of interest to the electrical industry in the wake of recent physical attacks on the grid. EPRI partnered with INL because of its expertise and history in armor research, protective materials, and ballistic testing. Under the SPP, INL will conduct ballistic testing on critical components to quantify the vulnerability and then calculate the effectiveness of different ballistic mitigation panels.

Strategic Partnerships Projects Retention and Growth

The numbers of non-federal SPPs modifications increased during FY 2015. This increase is a positive reflection of the unique and quality work performed by INL. The following partners extended their relationship with INL.

- Canadian Nuclear Safety Commission
- EPRI
- Wyle Laboratories, Inc.
- Cumming Investment Company, LLC
- NuScale Power, LLC
- Japan Atomic Energy Agency
- Northrop Grumman Information Systems Sector, Defense Systems Division
- Ford Motor Company.

"SPP enables DOE to deliver its mission of technology transfer and research partnerships that result in commercialization and deployment, thus becoming a logical extension of programmatic work and enhancing the impact of the science and technology discoveries made at DOE facilities."

Source: DOE P 481.1, DOE's Policy Regarding Laboratories, Plants and Sites Engaging in Strategic Partnership Projects with Other Federal Agencies, Independent Organizations, and the Private Sector, Approved: 12/17/14

Technology-Based Economic Development Highlights

The Technology-Based Economic Development (TBED) program is providing value by proactively impacting Idaho and the surrounding regional economy, igniting innovation, and strengthening regional workforce and partnerships.

Proactively Impacting Idaho and the Surrounding Regional Economy

As one of the largest employers in Idaho, INL provides a significant economic impact on Idaho's economy. Based upon a study managed by INL's TBED, conducted by Grow Idaho Falls in conjunction with the Idaho Department of Labor and the Eastern Idaho Entrepreneurial Center, employment for INL during FY 2014 was over 3,500 making it Idaho's fifth-largest private employer and tenth-largest employer when compared to all public and private businesses.

The economic impact identified in the study only included INL operations managed by BEA and thus, are R&D focused. The study did not include impact of other DOE contractors, the DOE itself, or the Naval Reactors Facility.

The following bullets include highlights from the FY 2014 INL R&D Economic Summary:

- INL adds more than $1.4 billion to total industrial output and more than 8,600 jobs to Idaho
- INL increased personal income in the state by more than $661 million
- Average base salary of an INL employee is $87,542 annually
- INL subcontracted more than $125 million to Idaho subcontractors
- INL's corporate office contributed $682,565 to charitable giving
- INL directly employed 3,513 workers in Idaho
- Secondary effects in Idaho accounted for an additional 5,102 jobs for a total of 8,615 jobs
- INL accounted for more than 2.3% of statewide economic output.

Switchable Polarity Solvent – Forward Osmosis Lab-Corps Team: (Pictured Left to Right) Aaron Wilson and Carter Fox, INL researchers, along with Shawn Perkins and David Noack with the Idaho Small Business Development Center.

Igniting Innovation - INL Wins Department of Energy, Energy Efficiency, and Renewable Energy Competitive Grant Award for Lab-Corps Entrepreneurial Teams

INL is one of seven laboratories participating in the DOE, Energy Efficiency and Renewable Energy Lab-Corps pilot program. INL has two entrepreneurial teams consisting of three people each: a principal investigator, entrepreneurial lead, and an industry mentor. Each team focuses on one new technology.

For one INL team, researchers Aaron Wilson and Carter Fox are proposing a SPS-FO technology that could make a big impact in water purification as well as a host of other applications. For the other team, researcher Matthew Balderree developed an application to use unmanned aircraft to inspect wind turbine blades—a safer, faster, and more economical approach than sending humans.

DOE announced the Lab-Corps pilot program in the fall of 2014. The program aims to strengthen entrepreneurial culture at national laboratories by focusing on private sector needs and immersing researchers in the commercialization process. By cultivating small-team collaboration between researchers and private entrepreneurs, Lab-Corps' goal is to accelerate clean energy technology deployment and catalyze industry competitiveness. The Lab-Corps team was managed and directed by EEST. Program level coordination, training, project management, and contracts support was provided by TBED.

Autonomous Renewable Aerial Inspections Lab-Corps Team. Pictured Left to Right: Wendolyn Holland, Holland Consulting, LLC; Matthew Balderree, INL researcher; and Corey Smith, Research and Business Development Center.

Strengthening Regional Workforce and Partnerships

INL's TBED program targets projects aimed at spurring regional economic development, technology-based economic development, entrepreneurship, and innovation in the region using BEA corporate funds for grants.

In FY 2015, a new strategy was implemented to focus the grant awards on larger, higher impact projects with industry cluster development and closer alignment to the laboratory's mission space. TBED grant recipients included:

- Idaho Technology Council with E-Center, BYU-Idaho. The Idaho Technology Council is a broad-based statewide organization with a mission to help technology companies in Idaho start, grow, and thrive. They focus on three key areas: energy, agriscience, and software. Projects funded through the TBED grant included a voice for Idaho technology companies, Idaho technology map, identifying Idaho wireless technology companies for potential INL Wireless User Facility, Idaho Deal Flow Report, and Idaho Technology-based Talent/Workforce Flow Report. The information gathered for the reports will benefit the entire state and drive industry cluster growth in the technology space.

- Regional Economic Development Corp for East Idaho is a newly formed, two county (Bingham and Bonneville), five-city region to support key cluster development strategy including R&D in physical, engineering and lab sciences, food-related and value-added manufacturing, hazardous waste treatment, chemical manufacturing, machinery manufacturing, and heavy and civil engineering construction.

- Region IV Development for the Investing in Manufacturing Community Partnerships designation for Twin Falls, Idaho as a new manufacturing community. In July, U.S. Secretary of Commerce Penny Pritzker announced the award and INL's BEA corporate funding was used as a matching grant for the designation. The program aims to accelerate the resurgence of manufacturing and create a competitive climate for communities to attract manufacturing jobs and investment. Communities with the Investing in Manufacturing Community Partnerships designation are provided elevated consideration for federal assistance across 10 agencies.

Jan Rogers, Regional Economic Development Corporation for East Idaho newly appointed chief executive officer.

Connecting to the Community with Outreach and Event Sponsorships

The following community outreach and events were sponsored during FY 2015.

- INL's TBED sponsored the Eastern Idaho Entrepreneurial Center and Founders Forum, spring 2015 Entrepreneurs Platform on June 23, 2015 at Eastern Idaho Technical College. The platform allows entrepreneurs who have started their own company to present their business ideas and find resources to help expand their business.
- INL's TBED participated in the governor's Idaho Rural Partnership, Community Review for the town of Fairfield, Idaho, June 24–25, 2015. The review consisted of a team of 12 local, state, and federal representatives who toured the community, met with community leaders and citizens, and evaluated different aspects of the economy such as local economic development, infrastructure, community design, and health care. The aim of a Community Review is to empower the community and provide objective information to help strengthen the economy, create jobs, and connect the community with statewide resources.
- Last fall the Eastern Idaho Entrepreneurial Center hosted east Idaho's first ever startup weekend. Startup weekends are 54-hour events where startup enthusiasts from every industry come together to share ideas and skills, form teams, and launch startups. INL's TBED and TD teams participated as startup weekend coaches.

Startup Weekend
powered by the Kauffman Foundation

- INL's TBED program sponsored, coordinated, and hosted the 2015 Business + Innovation + Growth (BIG) event on February 12–13, 2015 at the Energy Innovation Laboratory. BIG is an educational business pitch competition designed to educate entrepreneurs, inventors, and students in eastern Idaho about early-stage financing. Twelve teams presented their BIG idea to a panel of judges in the community and diversity track. First and second place awards were announced during the awards ceremony.

Fairfield Idaho residents share their vision for their community during the Idaho Rural Partnership Community Review.

INL's Director of Partnerships, Amy Lientz presented her new organization to the eastern Idaho ConnectShare group of business and community leaders.

Mark Jaster, Business + Innovation + Growth finalist stands with the 3D printer he showcased during the entrepreneurial educational competition.

Technical Assistance Program

INL's TAP works to enhance the entrepreneurial climate for emerging high-technology enterprises by broadly deploying laboratory capabilities and technologies. TAP's contribution to strengthening and growing the region is to offer technical assistance for up to 40 hours of support that is not available from the private sector in the region. TAP offers highly skilled experts and laboratory resources to the region.

Between 2005 and 2015, TAP has sponsored 8,860 hours of assistance to entrepreneurs, small businesses, and rural communities. During the past year, INL has dedicated more than 304 hours to nine TAP projects focused on increasing INL's goodwill and community outreach through projects that intersect and support the Laboratory's mission areas.

Select TAP projects from FY 2015 include:

- Proximate and ultimate analysis was performed by INL's Biomass Feedstock Characterization team on Owahyee County Juniper to potentially turn an invasive species into an economic product. Juniper is an invasive species that is encroaching on the rangelands of southern Idaho, destroying natural habitat of the sage grouse, and impacting the available grazing areas.
- Grand Teton National Park received 40 hours of support from INL's Mitchell Plummer to work with park service staff and software developers to share glacier simulator and climate change impact over large time steps. The animated video will be used educate visitors to Jenny Lake in Grand Teton National Park.
- Hydrocore, Inc., received 40 hours of support from INL's Nick Soelberg to provide a technical feasibility review. The review focused on Hydrocore's novel method of generating a syngas with a submerged electric arc furnace from waste materials such as municipal solid waste with the potential benefit to enhance the commercial deployment rate of the technology.

Juniper sample being ground up using Vermeer HG 200 horizontal hammermill grinder by INL's Biomass Feedstock Characterization team.

Technology Transfer Success Stories

Often technology transfer successes are not measured in numbers of patents or agreements, but in impacts made by people and informal collaborations. The following highlights demonstrate some of the past year's successes.

Anomaly Detection Solution for Industrial Networks Obtains Funding

An important tool developed by INL researchers has obtained $2.4 million in private venture funding to support the recently announced commercial rollout and product development of Sophia, an industrial network anomaly detection system. The firm NexDefense commercialized Sophia following a successful research collaboration between INL and industry. Sophia empowers engineers as well as security and control system operators in critical infrastructure to detect anomalies that may signify an attempt to intrude or discover system communications as they happen. It then alerts defenders before an adversary can have an impact.

Employee Honored with USCAR Research Partner Award

The U.S. Council for Automotive Research (USCAR) has announced that INL Battery Test Center group leader, Dr. Jon Christophersen was selected to receive the 2014 Research Partner Award for "Excellence in Leadership and Innovation." As a collaborative organization involving automakers Ford, General Motors, and Chrysler, USCAR was created to leverage precompetitive government partnerships with the U.S. auto industry. Christophersen has been a critical researcher supporting the USCAR DOE U.S. Advanced Battery Consortium Technical Advisory Committee. He collaborates with the committee to develop and deploy advanced energy storage technology across the industry in support of DOE's technology development goals for advanced vehicles.

INL Receives Award for Outstanding Technology Development

INL's Integrated Waste Screening System has received an award for 2015 Outstanding Technology Development from the Federal Laboratory Consortium Far West Region. INL researchers Doug Akers and Lyle Roybal developed the technology to efficiently assess the nearly 40 million tons of drilling waste generated by fractured wells. These wells often produce significant amounts of Technologically Enhanced Naturally Occurring Radioactive Material, which must be characterized, segregated, and disposed of properly. The system can conduct rapid (three-minute) onsite analyses, reduce costs, and both document and certify recommendations for proper environmental disposal.

Critical Materials Institute Announces License of New Technology

DOE's Critical Materials Institute (CMI), led by Ames Laboratory, held its annual meeting at INL August 4–6, 2015. On August 10, a joint news release announced that the institute had licensed a new technology to U.S. Rare Earths, Inc. The membrane solvent extraction system, invented by CMI partners Oak Ridge and Idaho national laboratories, is the first commercially licensed technology developed through the CMI. It aids in the recycling, recovery, and extraction of rare earth minerals. Established in 2013 as an Energy Innovation Hub, CMI explores ways to assure supply chains of materials critical to clean energy technologies such as wind turbines, electric vehicles, efficient lighting, and advanced batteries.

Teamwork Enables Software Success

BEA frequently subcontracts with industry, universities, and other government agencies to help make improvements to products originally developed by BEA. Subcontracting mechanisms have allowed BEA to establish teams of the best talent from around the world. BEA's long history of successful collaboration with subcontracted partners has led to developing some of the best software in the industry.

These relationships have been very successful for R&D, but not without confusion concerning ownership rights and licensing. Historical subcontracting language allowed subcontractors to request permission from DOE to assert copyright to their own contribution regardless of the funding source.

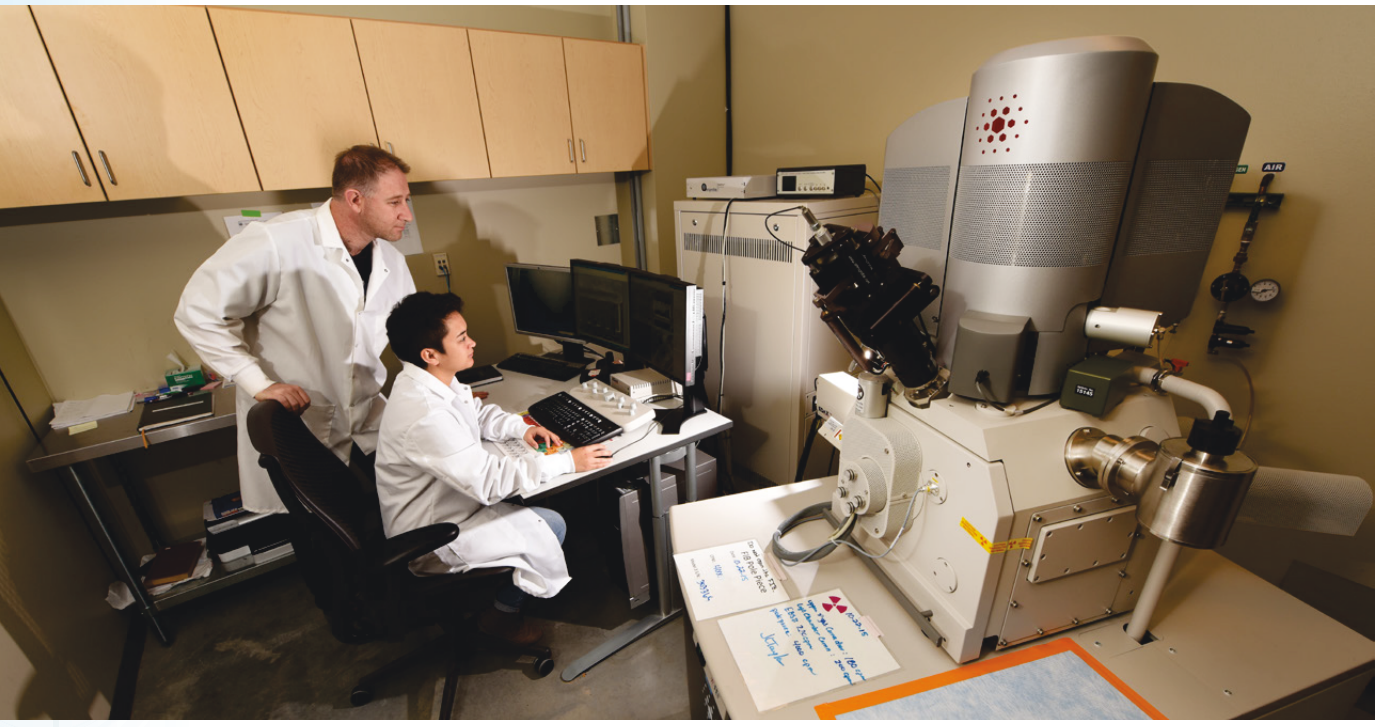
Typically, most employment agreements assign ownership rights to the employer. However, when copyrighted works are involved, BEA must request permission from DOE to assert copyright and obtain those rights.

BEA respects authors' contributions and strives to reward them appropriately when software is licensed and royalty income is generated. Before commercializing software, BEA must determine legal ownership of the code. When multiple entities share ownership in software, it is sometimes:

- Difficult to obtain ownership rights necessary to commercialize software.
- Difficult to control product version, quality, and the INL brand.
- Expensive to manage the commercialization process, whether through traditional licensing or open source deployment.

These difficulties and expenses can have a negative impact on BEA's proposed licensing strategies and sometimes render the software undesirable by potential licensees. In discussing the problem with DOE-Chicago legal counsel, the Special Works Clause (SWC) from the Federal Acquisition Regulations was suggested as an alternative contracting clause. The purpose of the SWC is to preserve INL's ownership rights, when non-employee authors are involved in modifying existing functional code on a tangential basis.

Gary Smith, Beth Jaggar, and Mark Kaczor (TD) worked with IP Counsel from DOE-Chicago, Bob Crowton (Service Acquisitions), John Anderson (Strategic Sourcing and Procedure Support), and Craig Hunsaker (Legal) to implement a process that will screen future subcontracts and include SWC as appropriate. Implementation of SWC (when appropriate) will provide BEA with a stronger position when it comes to commercializing software developed at the Laboratory. This innovative process has provided a significant contribution to the licensing of NST nuclear codes, including MOOSE applications such as Grizzly, Raven, Rattlesnake, and BISON.



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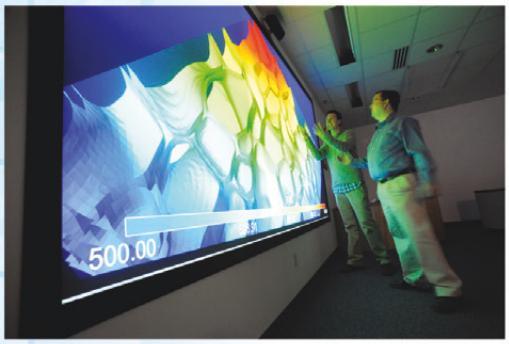


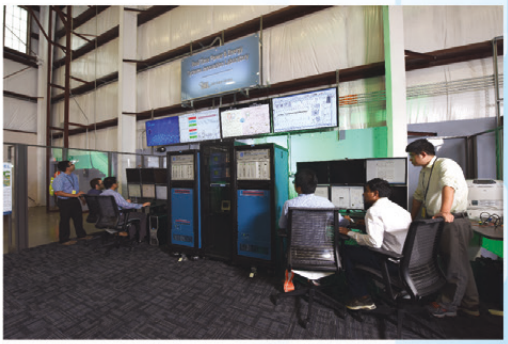


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