Knowledge Foundation's International Conference

# Nuclear Power Safety 2011

December 8-9, 2011 • Washington, DC USA

## Advanced Technologies, Materials, & Engineering Approaches for Safe & Efficient Nuclear Power

*Distinguished Conference Faculty:*

Edward C. Abbott,
**ABZ, Inc**

Martina Adorni, PhD,
**University of Pisa, Italy**

Stephen L. Bump, CHP, CIH,
**Dade Moeller & Associates**

Leon Cizelj, PhD,
**Jozef Stefan Institute, Slovenia**

Herbert Feinroth,
**Ceramic Tubular Products**

William E. Gunther, PE,
**Brookhaven National Laboratory**

Donald J. Higson, PhD,
**Australian Radiation Protection Society & Institution of Engineers, Australia**

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**French Alternative Energies & Atomic Energy Commission - CEA, France**

Michael F. Keller,
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Yian Lei, PhD,
**Peking University, China**

Stuart A. Maloy, PhD, PE,
**Los Alamos National Laboratory**

Gail H. Marcus, ScD,
**Nuclear Power Technology and Policy**

Daniel S. McGarvey, CPCU, ARM, CEBS,
**Marsh**

Mohammad Modarres, PhD,
**University of Maryland**

Liviu Popa-Simi, PhD,
**LAVM LLC**

Susana Reyes, PhD,
**Lawrence Livermore National Laboratory**

Anthony Z. Roisman,
**National Legal Scholars Law Firm, P.C.**

Sean S. Roshan,
**Royal Institute of Technology, Sweden**

Ana Stanic,
**E&A Law Limited & University of London, United Kingdom**

Sabrina Tietze,
**Chalmers University of Technology, Sweden**

Georgy I. Toshinsky, DrSci,
**Institute for Physics and Power Engineering (SSC IPPE), Russia**

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## CONFERENCE AGENDA

### *Thursday, December 8, 2011*

8:00 *Registration, Exhibit Viewing/Poster Setup, Coffee and Pastries*

9:00 **Organizer's Welcome and Opening Remarks**

9:05 **KEYNOTE ADDRESS**
**Nuclear Power after Fukushima: Problems and Possibilities**

***Gail H. Marcus, ScD, Consultant, Nuclear Power Technology and Policy***

The speaker will provide an overview of how the Fukushima accident has altered nuclear power operations and development around the world. Some of the major safety issues raised by the incident will be identified, and likely impacts on operating plants will be explored. Special attention will be given to identifying possible technology options to help address longer term nuclear power development plans.

9:45 **Improvements Needed in Nuclear Power Plant Probabilistic Risk Assessments: Lessons Learned from Fukushima**

***Mohammad Modarres, PhD, Professor of Nuclear Engineering, Director of Reliability Engineering Program, University of Maryland***

The accident at the Fukushima-Daichii nuclear plant has led to public and regulator concerns about the safety of nuclear power and rejection of nuclear energy from Germany's energy mix. An important element of safety analysis of nuclear power plants has been Probabilistic Risk Assessment (PRA) used for estimating environmental risks and identifying critical scenarios and failure events in nuclear plants. In light of the Japanese accident, it is prudent to reexamine the strengths, weaknesses and improvements needed in the PRA techniques and tools. These improvements include estimation of risks of natural events, effect and treatment of all kinds of common cause failure events, unit-to-unit interactions and dependencies, human error assessment in multiunit plant sites, and new ways to assess vulnerabilities to station blackout.

10:15 **Comparative Radiological Impacts from Major Nuclear Reactor Accidents**

***Stephen L. Bump, CHP, CIH, Vice President, Dade Moeller & Associates***

Nuclear reactors at the Fukushima-Daiichi power station were severely damaged as the result of loss of cooling following an 8.9 magnitude earthquake and subsequent 14 meter tsunami. While this accident is somewhat unique since it is the result of natural forces, and not human operator error, it does have some similarity to previous accidents at Three Mile Island (TMI) and Chernobyl; notably all three accidents resulted in significant damage to the nuclear fuel, and all three resulted in atmospheric releases of radioactive material.

10:45 *Networking Refreshment Break, Exhibit/Poster Viewing*

11:15 **The Safety of Nuclear Power Generation**

***Donald J. Higson, PhD, Fellow of the Australasian Radiation Protection Society, Fellow of the Institution of Engineers, Australia***

In the years preceding the Fukushima disaster, most major nations in the world had come to the conclusion that, for reasons of energy independence and environmental responsibility, nuclear power must play a central role in their energy strategies for the 21st Century. It is not just a case of the benefits outweighing the risks. The risks are simply not what they are generally believed to be. We are particularly concerned that correct information should be available on the following points: (1) Routine operations of the nuclear industry do not expose workers or the public to dangerous levels of radiation; (2) Modern nuclear plants in proper containment structures present essentially no risk to the public, either from accidents or from terrorist attack; (3) Apart from being extremely safe, nuclear power plants have less environmental impact than other types of power station; (4) The nuclear industry generates minimal emissions of greenhouse gases; (5) Nuclear reactors and other nuclear fuel cycle plants in a commercial nuclear power programme would not use, handle or produce material suitable for making atomic bombs; (6) The safe disposal of radioactive waste is readily achievable technically.

11:45 **Protecting the Public Interest: The Self Help Model**

***Anthony Z. Roisman, Managing Partner, National Legal Scholars Law Firm, P.C.***

This presentation is focused on the role of the public in the decision-making processes of the NRC. Examples of the value of public participation are provided. Examples of serious failures by NRC to vigorously and effectively enforce nuclear safety standards are discussed. Only opponents of nuclear power have an un-compromised commitment to finding all safety problems at nuclear reactors. A carefully designed program to provide funds for their experts to better ferret out these problems, can become an essential safety net for nuclear reactors and can help create public confidence in nuclear reactor safety.

12:15 **Research and Education in Nuclear Safety: Perspective of the Smallest Nuclear Country**

***Leon Cizelj, PhD, Professor, Head of Department, Reactor Engineering, Jozef Stefan Institute, Slovenia***

Research and education are fundamental in the successful development and implementation of contemporary complex technologies, including peaceful utilization of nuclear energy. The national responsibility to organize and sustain appropriate research and education is clearly set forward in the IAEA Nuclear safety convention and in the EURATOM treaty. Recent regionalization and globalization of power markets provided new opportunities and challenges, which might be more pronounced in countries with rather limited resources. The research and education activities in nuclear engineering and safety pursued at the Jozef Stefan Institute and the University of Ljubljana are reviewed. Examples of integration within the European Union and OECD also include access to large experimental programs and exchange of students and teachers within the ENEN Association (European Nuclear Education Network).

12:45 *Luncheon Sponsored by the Knowledge Foundation Membership Program*

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2:15 **Accelerated Development of Advanced Fuels and Core Materials for Nuclear Power Applications**

***Stuart A. Maloy, PhD, PE, Program Manager, Advanced Nuclear Energy Programs, Co-Deputy Director FCRD Fuels Campaign, Core Materials Technical Lead, Los Alamos National Laboratory****

Abstract not available at time of printing. Please visit www.KnowledgeFoundation.com for the latest Program updates.*In collaboration with: Ken McClellan, Chris Stanek, LANL*

2:45 **Improved Removal of Volatile, Organic Iodides (Methyl Iodide, Ethyl Iodide) from Vented Containment Gas Streams with a Modified Wet-Scrubber Media for Light Water Reactors**

***Sabrina Tietze, Researcher, Nuclear Chemistry, Chalmers University of Technology, Sweden***

Safety systems in e.g. Swedish light water reactors volatile, radiotoxic iodine species in excess gas streams vented from the containment in case of a pressure increase are scrubbed off with an alkaline sodium thiosulfate solution. The removal efficiency for volatile organic iodides such as methyl iodide is about 20 times lower than for elemental iodine. In response to improve the removal efficiency a modified scrubber solution has been developed containing a nucleophilic organo-phosphorus compound to rapidly convert volatile organic iodides into non-volatile inorganic iodides maintaining in the scrubbing solution.

3:15 **Emergency Battery Power Test Program Results and Future Plans**

***William E. Gunther, PE, Senior Research Engineer, Brookhaven National Laboratory***

In 2010, BNL established a battery testing laboratory to determine whether float current monitoring can be used as a suitable indicator for determining a vented lead-calcium battery's state-of-charge. This project involved the procurement and testing of three class IE battery types that are used in operating nuclear power plants. BNL completed active testing in May 2011 and is analyzing the data for a NUREG/CR report that will be issued later in 2011. Based on the recent Japanese experience, the NRC has determined that the existing test set up could be used to perform additional testing related to assessing the battery's capability to supply the necessary DC loads to support core cooling for as long a period as possible to determine if it can cope with longer periods of SBO like conditions. This testing will provide some indication of the amount of time available (depending on the actual load profile) for batteries to continue to supply core cooling equipment beyond the original SBO coping time. This will be helpful to manage the recovery of AC power to the battery chargers and/or AC power in general to maintain core cooling throughout the event. The test will also remove another point of contention to prove the real point of stabilizing current. The presentation will cover the results of the original testing program completed in May 2011, and the plans and preliminary test results from the beyond design basis testing being conducted in the fall of 2011.

*3:45 Networking Refreshment Break, Exhibit/Poster Viewing*

4:15 **SVBR-100 Modular Self-Protected Fast Reactor with Passive Safety**

***Georgy I. Toshinsky, DrSci, Professor, FSUE State Scientific Center, Institute for Physics and Power Engineering (SSC IPPE), Russia****

The natural properties of the lead-bismuth coolant ensure the self-protection of the reactor facility and make it possible to simplify and reduce the capital cost. The paper represents the main conceptual provisions of the innovative nuclear power technology based on modular fast reactors SVBR-100, justifies the highest safety level (mainly due to low value of potential energy stored in the coolant), analyzes the possibility of the multi-purpose use of these reactor facilities, including export availabilities with due consideration of the non-proliferation requirements.*In collaboratin with: O.G.Komlev, I.V.Tormyshev, SSC IPPE; V.V.Petrochenko, JSC AKME-Engineering*

4:45 **Passively Safe Commercial Nuclear Fuel**

***Herbert Feinroth, CEO, Ceramic Tubular Products***

The loss of coolant accidents at Three Mile Island in 1979, and Fukushima in 2011, led to severe core damage primarily because of the pyrophoric nature, and creep behavior, of the zirconium alloy used as fuel cladding. In the minutes after water was drained from the reactor core, the weak cladding expanded to block the flow channels, leading to rapid overheating, hydrogen generation, and subsequent core melt. A passively safe ceramic silicon carbide fuel cladding, under development since 1999, maintains its shape up to 1500˚C, and does not react exothermically with water during a LOCA. Had this cladding been used at TMI and Fukushima, the severe core damage would not have occurred, despite the Loss of Coolant Accident. The technology is now being tested in reactors at Oak Ridge and MIT.

5:15 **The Drastic Increase of Safety and Performances in Nuclear Power by Implementing Nano-Engineered Materials**

***Liviu Popa-Simi, PhD, President, LAVM LLC***

Our 30 years experience in nuclear materials and accelerator show that the implementation of nano-micro hetero-structured materials may bring the harmony between the nuclear power process and its technologic use by increasing safety and power production performances. The application of the micro-hetero-structures, drives to new nuclear fuel and reactor design, that reduces the nuclear waste, increases burnup and in some cases eliminates the need for enrichment. The continuous fission product processing units does not require fuel cooling in case of LOCA accident, and Fukushima type accidents are not possible. The nano-beaded fuel, may offer direct extraction of the transmutation products, and fuel breeding, producing high purity deficitary isotopes, safe and with minimal chemistry, making direct separation of the fission products from the transmutation products. Singular wave structures may directly burn Thorium or Depleted uranium, eliminating the need for enrichment, and reaching burnup factors over 50%, while nano-sintered cladding assures the needed structural materials resilience and safe-repairing properties making possible the reaching high burnup factors without recladding, in spite the new self separative process in micro-hetero structures makes the recladding process, easier, faster and cheaper, using mainly sequential distillation process. In order to become realities of tomorrow these concepts and incipient proof of principle experiments and computer simulations have to be seriously supported by DOE by developing a specialized research program.

# Nuclear Power Safety 2011



## CONFERENCE AGENDA

5:45 **PANEL DISCUSSION**
**The Fukushima Effect: Nuclear Power at the Crossroads - Technological Advancement vs. Regulatory Issues**

***Moderator: Gail H. Marcus, ScD, Consultant, Nuclear Power Technology and Policy***

6:15 *End of Day One*

## *Friday, December 9, 2011*

8:15 *Exhibit/Poster Viewing, Coffee and Pastries*

9:15 **Building and Maintaining a Positive Safety Culture**

***Daniel S. McGarvey, CPCU, ARM, CEBS, Managing Director, Energy Mining and Power Practice, Marsh***

It is widely recognized that the presence of a positive safety culture is instrumental in assuring the safe operation of nuclear facilities. What are the essential elements of such a culture, and how can they be measured at your facility? What processes and procedures contribute to a safety culture, and how can they be leveraged to advance and improve job satisfaction and retention. Finally, what steps can management take to create an atmosphere that supports an active and self-sustaining safety culture as we experience a generational shift at our nuclear facilities?

9:45 **Hidden Obstacles in the Safety Landscape**

***Sean S. Roshan, Safety Analyst/Researcher, Center of Excellence in Deterministic Safety Analysis, Division of Nuclear Power Safety, Royal Institute of Technology, Sweden***

How is safety in nuclear power plants affected by lack of safety culture or incorrect conservative assumptions while performing safety analysis? 2006 loss of offsite power incident at Forsmark 1 and 1999 stability incident at Oskarshamn2 are two examples of incidents that could and should have been avoided if a healthy safety culture was in place and the correct conservative assumption had been made. Looking at these incidents, the initial events that triggered them and answering some "what-if" questions will act as a pedagogical tool to remind us about the importance of safety culture and correct conservative assumption.

10:15 **Reassessing Safety Rules after Fukushima**

***Ana Stanic, English Solicitor Advocate, E&A Law Limited, and Lecturer at the University of London, United Kingdom***

There is no doubt that the Fukushima accident has already brought changes to the nuclear power industry and has delayed the approval of the construction of new reactors. In the aftermath of the accident, most countries announced a review safety arrangements and procedure. In what was by many in the industry perceived as a knee-jerk reaction, Germany went further than any other country in the world announcing in May the phasing out of nuclear power in Germany by 2020. Other countries such as the UK and Finland have on the other hand concluded that there is no reason to shut down nuclear plants as a response to the Fukushima accident and instead have decided to reassess and strengthen their nuclear safety rules. This paper will review the new safety measures proposed by the nuclear regulatory authorities in England and Finland as well as the stress tests agreed by the European Commission and the European Nuclear Safety Regulators' Group (ENSREG) in May 2011 for a comprehensive risk and safety assessments of all 143 nuclear power plants in the EU.

10:45 *Networking Refreshment Break, Exhibit/Poster Viewing*

11:15 **Risk Analysis Implications of the Fukushima Reactor Accidents**

***Stephen L. Bump, CHP, CIH, Vice President, Dade Moeller & Associates***

This paper describes why the events at the Japanese facilities could change the methods used for safety analysis specific to identifying previously unrecognized vulnerabilities and risks, and proposes lessons learned to address how systems could be modified to improve post event accident responses.

11:45 **Fukushima: Causes and Implications**

***Edward C. Abbott, President, ABZ, Inc***

The accident at Fukushima resulted from a complex series of unlikely events beyond the mitigating capability of the safety systems. Errors in judgment and communication contributed to the accident's severity. Mr. Abbott will provide an introduction to BWR design. He will discuss the failure mechanisms that lead to the destruction of all four plants including management failures. Finally, he will discuss the implications for the US nuclear industry.

12:15 **Does Civilian Nuclear Power Have a Future in the United States?**

***Anthony Z. Roisman, Managing Partner, National Legal Scholars Law Firm, P.C.***

The history of nuclear power in the United States involves answering one central question: How safe is safe enough. Proponents believe that point was reached long ago. Opponents believe we are still far short of the goal. This presentation explores two issues - interim storage of nuclear wastes and the extent to which NRC functions as a vigorous regulator - and how these issues and their resolution will drive public perception of the safety question and influence the future of nuclear power.

12:45 *Lunch on Your Own*

2:15 **LIFE: A Sustainable Solution for Developing Safe, Clean, Fusion Power**

***Susana Reyes, PhD, Nuclear Engineer, LIFE Licensing and Tritium Systems Lead, Lawrence Livermore National Laboratory***

The starting point for the LIFE project is the requirement to deliver commercial fusion power soon enough to make a difference. A LIFE plant is intrinsically safe due to the nature of fusion, which requires continuous delivery of laser energy to drive the operation's in contrast to fission, where the reaction can occur without

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intervention. Runaway reaction or meltdown is not possible, and no cooling, external power, or active intervention is required from a safety perspective in the event of system shutdown. In this talk, we provide an overview of LIFE's attractive safety characteristics and present a summary of the results from preliminary accident analysis of the LIFE power plant.

2:45 **Nuclear Power Strategy on the Premise of Fusion Power**

***Yian Lei, PhD, Professor, School of Physics, Peking University, China***

Advances in fusion energy research show a strong possibility that fusion energy could become economically feasible in 100 to 200 years. The world energy demand in this period has to be meet largely by nuclear fission power. Even the quantity is huge, and the time span is long, fission power should be considered as a transient strategic energy as the safety concerns are severe. Conservative tactics should be taken in the development of fission power.

3:15 **A New Direction for Nuclear Power**

***Michael F. Keller, President and CEO, Hybrid Power Technologies LLC***

The once bright promise of American nuclear power has dimmed considerably, with the recent events in Japan creating even more uncertainty. A new approach is required. Hybrid nuclear energy is a fail-safe and evolutionary new direction for nuclear power. The nuclear fuel cannot explode or burn-up, the reactor can not explode or burn-up, and radiation releases to the environment are extremely unlikely. No operator actions are necessary to keep the public safe.

3:45 *Networking Refreshment Break, Exhibit/Poster Viewing*

**4:15 Prototypic Corium Experiments: An R&D Aimed at Understanding the Severe Accidents and Designing the Mitigation Solutions**

***Christophe Journeau, PhD, CEA International Expert, Laboratoire d'Essais pour la Matrise des Accidents Graves, DEN, DTN, STRI/LMA, French Alternative Engergies and Atomic Energy Commission - CEA, France****

After TMI2 and Chernobyl accident, several experimental facilities have been built to study severe accidents. An important aspect is to perform out-of-pile experiment with depleted uranium, since uranium dioxide has very peculiar chemical and physical properties that cannot be satisfactorily simulated. These experiments are useful to identify the major contributors in scenario coupling at very high temperatures heat transfer, physical chemistry, fluid and structural mechanics, neutronics, to validate codes and models in order to extrapolate results to the reactor scale and also to qualify engineered solutions (such as corium spreading, top flooding core catchers, etc.) to mitigate the consequences of a severe accident.**In collaboration with: P.Piluso, CEA*

4:45 **NUTEMA: A Tool for Supervising Nuclear Technology and for the Transfer of Knowledge**

***Martina Adorni, PhD, Coordinator, Fuel BEHAVIOR Division, San Piero a Grado Nuclear Research Group, University of Pisa, Italy***

An innovative informatics science system is discussed in this paper which deals with the nuclear technology. The concerned system is called NUTEMA (i.e. either Nuclear Power Plant Technology Knowledge Management System or Nuclear Technology Master). The system aims at having virtually available in one room whatever is concerned with a NPP (Nuclear Power Plant) unit. Namely, nuclear fuel is modeled starting from nuclear properties, as well as the turbine and any heat exchanger; in relation to each individual component, e.g. a valve, the designer is identified together by the construction drawings and the last maintenance. A large variety of computational tools is installed in NUTEMA; they allow the design optimization of the concerned unit as well as the evaluation of safety margins. The NUTEMA system assembles all together the competences needed for the construction, the design, the management of a NPP and allows the training of nuclear industry staff. The concept of Design Authority introduced by the IAEA (International Atomic Energy Agency) inspired the thoughts at the basis of the NUTEMA design. The NUTEMA system is primarily devoted to utilities, but any industry like regulatory authorities and research institutes concerned with nuclear technology, may take benefits from its use. At the end, it is discussed that NUTEMA works as an integrated transportation system in a big city: three networks for the transportation (of the information in the case of NUTEMA) are distinguished, where the same nodes (i.e. the train stations) can be used by each of the networks.

5:15 **Exhibitor Showcase Presentations and Selected Oral Poster Highlights**

5:45 *Concluding Remarks, End of Conference*

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