

June 06, 2010

MEMORANDUM TO: Eric J. Leeds, Director  
Office of Nuclear Reactor Regulation

THRU: Patrick L. Hiland, Director /RA/  
Division of Engineering  
Office of Nuclear Reactor Regulation

FROM: Steven A. Arndt /RA/  
Division of Engineering  
Office of Nuclear Reactor Regulation

SUBJECT: COMBINED QUICK LOOK/FOREIGN TRIP REPORT FOR  
PARTICIPATION IN THE 18<sup>TH</sup> INTERNATIONAL CONFERENCE  
ON NUCLEAR ENGINEERING IN XI'AN CHINA,  
MAY 17-21, 2010

The purpose of this memorandum is to inform you on the subject foreign travel. On May 17-21, 2010, I attended the 18<sup>th</sup> International Conference on Nuclear Engineering. The conference was sponsored by China Nuclear Society, American Society of Mechanical Engineering (ASME), and Japanese Society Mechanical Engineering and held at Xi'an International Conference Center, Xi'an, China. The conference was organized by the School of Nuclear Science and Technology, Xi'an Jiatong University.

The conference consisted of an ASME Codes and Standards Workshop, Computational Fluid Dynamics seminar, VIP congratulatory remarks, plenary, panel, and technical sessions. The panel sessions and technical presentations were focused on leading global issues, research, and development of nuclear power. The panels consisted of topics on Newly Designed Plants-Issues and Challenges; Training, Education and Workforce of Nuclear Power Development; Sharing of Best Plant's Operation and maintenance Experiences; Regulation, Codes and Standards; and Gen-IV Program. The technical sessions consisted of the following tracks: Plant Operations, maintenance, Engineering, Modification, Life Cycle and Balance of Plant; Component Reliability and materials Issues; Structural Integrity; Nuclear Technology Applications and Innovations; Advanced Reactors; Safety and Security; Codes, Standards, Licensing, and Regulatory Issues; Fuel Cycle Decommissioning; Thermal Hydraulics; Reactor Physics and Transport Theory; Nuclear Education, Public Acceptance and Related Issues;

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Instrumentation and Controls; and Fusion Engineering. The Nuclear Regulatory Commission staff presented at several of the plenary, panel, and technical sessions. I presented my paper in the Instrumentation and Controls track and also chaired a session in that track.

The trip report for this activity is enclosed. This report serves as the "Quick Look" report and the formal "Trip Report."

The content of this report is not likely to be of interest to the Commission

Enclosures:

As stated

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NRC FOREIGN TRIP REPORT

**Subject**

Participation in the 18<sup>th</sup> International Conference on Nuclear Engineering, sponsored by the China Nuclear Society, American Society of Mechanical Engineers (ASME), and Japanese Society of Mechanical Engineers, held at the Xi'an International Conference Center, Xi'an, China

**Dates of Travel and Countries/Organization Visited**

May 15-21, 2010, Xi'an, China

**Author, Title, and Agency Affiliation**

Steven A. Arndt  
Senior Technical Advisor  
Division of Engineering  
Office of Nuclear Reactor Regulation

**Sensitivity**

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**Background/Purpose**

The objective of the travel was to attend and participate in the 18<sup>th</sup> International Conference on Nuclear Engineering (ICONE 18). Also, to deliver presentations and exchange information with conference attendees in the area of regulatory practices and digital instrumentation and control (I&C).

**Abstract: Summary of Pertinent Points/Issues**

The technical meetings were held at the Xi'an International Conference Center, Xi'an, China. The ICONE meeting is the leading ASME nuclear engineering conference. All aspects of current and future nuclear engineering technologies and applications were discussed. The meeting included more than 800 participants from more than twenty countries. The conference consisted of an ASME Codes and Standards Workshop, Computational Fluid Dynamics seminar, VIP congratulatory remarks, plenary, panel, and technical sessions. The panel sessions and technical presentations were focused on leading global issues, research, and development of nuclear power. The panels consisted of topics on Newly Designed

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Plants-Issues and Challenges; Training, Education and Workforce of Nuclear Power Development; Sharing of Best Plant's Operation and maintenance Experiences; Regulation, Codes and Standards; and Gen-IV Program. The technical sessions consisted of the following tracks: Plant Operations, maintenance, Engineering, Modification, Life Cycle and Balance of Plant; Component Reliability and materials Issues; Structural Integrity; Nuclear Technology Applications and Innovations; Advanced Reactors; Safety and Security; Codes, Standards, Licensing, and Regulatory Issues; Fuel Cycle Decommissioning; Thermal Hydraulics; Reactor Physics and Transport Theory; Nuclear Education, Public Acceptance and Related Issues; In and Controls; and Fusion Engineering. The Nuclear Regulatory Commission staff presented at several of the plenary, panel, and technical sessions.

On May 18, 2010, Dr. Shams, of the Office of New Reactors made a presentation at the plenary session on perspectives of new reactors program. Key points of this presentation include:

- activities at Nuclear Regulatory Commission (NRC) for new plant licensing
- initiation of the new construction and inspection program
- progress of NRC's review for recent Combined Licensing (COL) applications
- NRC's cooperation in international activities
- creation of the Advanced Reactors Program

Staff from the Offices of New Reactor, Nuclear Regulatory Research and Nuclear Reactor Regulation also made technical presentations on the topics of NRC use of codes and standards, regulation associated new reactor safety, large break LOCA analyses and their applications to new reactor licensing process, cyber security, and boiling reactor stability analysis. My presentation on lessons learned from the review of the first few digital I&C licence amendments for operation reactors included a discussion current issues facing NRR in its review of digital I&C systems, lessons learned from recent reviews and current challenges including the review of software tools.

### Discussion

#### Opening Ceremony and Plenary Session

On May 18, 2010, the NRC staff attended the opening ceremony, congratulatory remarks, and plenary sessions for the ICONE-18. Mr. Qin Sun, the conference chair provided opening remarks. The vice-provincial governor of Shaan Xi, China, Jinzhi Zhu, provided congratulatory remarks for the organizers of ICONE-18. Ms. Zhu welcomed everyone to Shaan Xi province and briefly described the history of Xi'an. Ms. Zhu also discussed the state of China's nuclear power industry, with 11 plants currently in operation, 23 plants in construction currently, and 30

additional units approved. Before 2015, China's plan is to have more than 50 units in operation. By 2020, China plans to have more than 100 units in operation. Mr. Shirong Zhou, Deputy Administrator of China's Nuclear Regulatory Agency, provided a presentation on China's nuclear industry. Mr. Zhou discussed the benefits of use of nuclear power to China since operation of nuclear plants has no major impact to the environment. Mr. Zhou discussed plans for making improvements in the area of rules and regulation, as well as on inspection. China plans to start nuclear engineering programs in 60 universities beyond the existing 4 nuclear engineering programs. In order to strengthen the Chinese nuclear regulatory agency, China intends to add 1500 staff members before 2020. Mr. Zhou also discussed development of methods to employ probabilistic risk assessment in China's nuclear power regulatory review process. Mr. Amos Holt provided opening remarks on the role that ASME codes play in the manufacturing of components, and how components are certified by ASME. Mr. Toshiaki Enomoto, the Executive Advisor of Tokyo Electric Power Company provided an overview of the status of nuclear power industry in Japan, including use of diversity and defense-in-depth and the restoration of the Kashiwazaki-Kariwa Nuclear Power Plant. Mr. Enomoto discussed the need for improvement of Japan's nuclear power plant capacity, citing that Japan's nuclear power plant has the lowest capacity (at 58%) whereas the U.S. has the highest (above 90%). Mr. Enomoto states that Japan's nuclear power plants have the lowest average number of unplanned scrams per year. However, once a scram occurs, recovery takes a lot longer than the plants of other nations.

Following the opening ceremony and VIP congratulatory remarks, the plenary session started with Mr. Osmau Oyamada's, Commissioner of Japan's Nuclear Safety Commission (NSC), presentation on the overview of Japan's regulatory framework. Mr. Oyamada discussed the organizational structure of the regulatory body, the roles and responsibilities of the regulatory body, and the key chronology for the formation of the regulatory commission. Mr. Oyamada discussed the NSC's relationship with the Ministry of Economy, Trade, and Industry, and Nuclear and Industrial Safety Agency. He stated that NSC is not the regulatory body of Japan's nuclear industry, but the administrative body that makes recommendations to the Ministry of Economy, Trade, and Industry. Mr. Oyamada discussed the need for improvement in the area of seismic guidance and research due to recent large seismic events causing significant issues in Japan's nuclear industry. Mr. Oyamada stated that research has been initiated and an investigatory advisory board has been created to resolve this issue.

Mr. Qin Sun, President of China National Nuclear Corporation, provided an overview of the challenges that China's nuclear power industry is facing in the safe operation, construction, materials, and staffing of nuclear power plants. Mr. Sun stated that China is developing nuclear power very fast, so increasing safety is critical. In addition, it is important for China to enhance its nuclear codes and regulation. Mr. Sun stated that China is developing a fuel production facility and increasing mining capabilities of nuclear materials. In addition, China is increasing its research in next generation reactors (Gen IV), enhancing training of operators, and

increasing coordination with universities to develop technical programs focused on nuclear energy and operation.

Dr. Mohamed Shams provided a presentation on the perspectives of the new reactors programs. Dr. Shams discussed the activities at NRC for new plant licensing. He described the formation of the Office of New Reactors within NRC, and the hiring of staff to support new reactor licensing and design certification applications. Dr. Shams also described the initiation of the new construction and inspection program. He also discussed Title 10, of the Code of Federal Regulations (10CFR), Part 52 licensing process, with a description of the design center approach. Dr. Shams discussed the progress of NRC's review for recent COL applications, and NRC's goals for this year. Dr. Shams also discussed NRC's cooperation in international activities, such as MDEP, and the start of the advanced reactor program.

Mr. Jun Wang, Chief Engineer of China's State Nuclear Power Technology Corporation, provided a presentation on the development and application of AP1000 technology in China. Mr. Wang stated that China has successfully built Gen I and Gen II plants, and with the cooperation with France, built additional plants at the Da Ya Wan site. Mr. Wang discussed the technical features of the AP1000 plant, including the benefits of having the passive design. Mr. Wang stated that Sanmen and Haiyang site both have 6 units planned, with an initial investment of 80 billion Yuan for 4 units of AP1000. Mr. Wang stated that the goal is to have grid connection by August of 2013, for the Sanmen unit and grid connection by February of 2014, for the Haiyang unit. For the Sanmen AP1000 construction project, China has mastered the mass concrete monolithic pouring process, and AP1000 main pipe forging. In addition, China has finished the conceptual design for the AP1400.

Ms. Kathryn Jackson, Senior Vice-President and Chief Technology Officer of Westinghouse Electric Company, provided a presentation on innovation, simplification, and standardization in the global nuclear future. Ms. Jackson emphasized that critical decisions need to be made to address the growing energy needs and providing CO<sub>2</sub> friendly solutions. Ms. Jackson stated that there is a need to affect and coordinate with policy makers to ensure that nuclear power can keep up with energy demands in the future. Therefore, the government's role to facilitate the nuclear renaissance is critical. She stated that new designs have to provide cost basis that can compete with other energy sources. Ms. Jackson also described Westinghouse's design philosophy for nuclear power.

Some insights from the technical sessions are described below:

**"A Review on Specific Features of Small and Medium Sized Nuclear Power Plants,"  
College of Nuclear Science and Technology, by Salah Ud-din Khan**

For the growing nuclear power industry small and medium sized nuclear reactors are instrumental for the development and demonstration of nuclear reactor technology. Due to the enhanced and outstanding safety features, these reactors have been considered globally. Dr. Khan compared the designs of various small and medium sized reactors. Dr. Khan reviewed the design and safety aspects of auxiliary building ventilation, Simple Small Portable Proliferation Resistance Reactor, Multi-Application Small Light Water Reactor, Fixed Bed Nuclear Reactor, Marine Reactor and Deep Sea Reactor, Space Reactor Passive Safe Small Reactor For Distributed energy supply system, System integrated modular Advanced Reactor, Super, Safe, Small and Simple Reactor, International Reactor Innovative and Secure, Nu-Scale Reactor, Next Generation nuclear power plant, etc.

**"Validations of CFD Code for Density-Gradient Driven Air Ingress Stratified Flow," Idaho National Laboratory, by Chang Oh**

Air ingress into a very high temperature gas-cooled reactor is an important phenomenon to consider because the air oxidizes the reactor core and lower plenum where the graphite structure supports the core region in the gas turbine modular helium reactor design, thus jeopardizing the reactor's safety. Validating the CFD code used to analyze the air ingress phenomena is therefore an essential part of the safety analysis and the ultimate computation required for licensing. Dr. Oh presented on the results from the experimental data exchange using seven different sets of gases with various density ratios. These results were compared to the output of CFD calculations. The results showed that the experimental axial velocities agreed very well with the predicted velocities from CFD calculations.

**"A Study on Fault Diagnosis Technology of Nuclear Power Plant Based on Decision Tree," College of Nuclear Science and Technology, Harbin Engineering University, by Yu Mu**

The technology of real-time fault diagnosis for nuclear power plants has great significance to improve the safety and economy of reactor. At present, expert system, artificial neural network (ANN) and support vector machine (SVM) algorithms are most widely used in the field of nuclear power plants (NPP) fault diagnosis. However, due to the shortcomings of ANN and SVM, Ms. Mu presented on use of decision tree algorithm in the field of NPP fault diagnosis. Ms. Mu demonstrated that the diagnostic results as compared with the SVM method showed that decision tree has the advantage of much faster training speed and a little higher accuracy. In addition, decision tree can obtain rules from the sample set, so it has good explanatory ability for the diagnostic results.

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**"Condition Assessment of Class 1E electric Cables through Indenter Modulus and Break-elongation Test," Suzhou Nuclear Power Research Institute Company, by Tao Liu**

Class 1E electric cables can generally withstand 40 years of degradation from predicted operational environments and still perform safety-related functions even during and after accidents. These cables degrade through deterioration of insulation material, possibly leading to mechanical and electrical failure after decades of operation. The elongation at break is usually used as the critical parameter. However, elongation testing is destructive and requires relatively large specimens, making it undesirable for analyzing installed cables. Mr. Liu presented methods and results of using indenter modulus and break-elongation test for condition assessment of NPP cables after accelerated aging under heating and radiation. Mr. Liu stated that the test results demonstrated the relationship between break-elongation and indenter modulus, and concluded that indenter modulus can be effectively used for condition assessment of NPP cable aging degradation.

**"Design of Wireless Heterogeneous Framework for Radiation Monitoring in Nuclear Power Plant," School of Mechatronics engineering and Automation, Shanghai University, by Shouwei Gao**

Radiation monitoring plays a vital role in the safe and efficient operation of the NPP. The current radiation monitoring system (RMS) generally uses cable monitoring network with distributed radiation monitors. Mr. Gao stated that using cable monitoring can introduce various compatibility issues when more detector nodes are added to the existing cable monitoring network. In addition, the original RMS has to be shut down for rewiring and reconstruction. Mr. Gao presented on the proposed design of a heterogeneous framework that is based on the wireless sensor network (WSN) technology for monitoring environmental conditions around and inside NPP, specifically, radiation levels. Mr. Gao showed that the proposed full-scope RMS has a no-wiring and no-construction upgraded scheme based on the WSNs, which forms a heterogeneous multi-networks fusion control system, and does not affect the existing NPP radiation monitoring facilities.

**"Study on Technical Improvements for Human System Interface in the Main Control Room of Ling Ao 3 & 4," China Nuclear Power Design Co., Ltd., by Ji Shi**

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Mr. Shi presented on technical improvements for Human System Interface (HSI) implemented to manage normal and accidental situation of the NPPs at the Ling Ao (LAO) 3&4 site under construction in the South of China. Mr. Shi described the operation principles of the NPPs, and presented on two major improvements on the LAO 3&4 NPP, including the implementation of a Digital Control System combined with a computerized HSI that is backed-up with a conventional control mean Back-up panel. In addition, Mr. Shi discussed some of the technical improvements implemented for the HSIs, such as State Oriented Procedures, Large Display Panel, Computerized-base procedures, advanced alarm system, Safety Parameter Display System.

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Pending Actions/Planned Next Steps for NRC

None

Points for Commission Consideration/Items of Interest

None

"On the Margins"

N/A