May 28, 2010

MEMORANDUM TO: Michael R. Johnson, Director
Office of New Reactors

THRU: Thomas A. Bergman, Director/*RA/*
Division of Engineering
Office of New Reactors

Charles E. Ader, Director/*RA/*
Division of Safety System
and Risk Assessment
Office of New Reactors

FROM: Deanna Zhang, Electronics Engineer/*RA/*
Instrumentation Controls
and Electrical Engineering Branch 1
Division of Engineering
Office of New Reactors

Mohamed K. Shams, Technical Assistant */RA/*
Division of Engineering
Office of New Reactor

Shanlai Lu, Reactor Systems Engineer */RA/*
Reactor System, Nuclear Performance
and Code Review Branch
Division of Safety System
and Risk Assessment
Office of New Reactors

SUBJECT: COMBINED QUICK LOOK/FOREIGN TRIP REPORT TO PARTICIPATE IN THE 18TH 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, we attended the 18th 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.

CONTACT: Deanna Zhang, NRO/DE/ICE
(301) 415-1946

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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; Instrumentation and Controls; and Fusion Engineering. The Nuclear Regulatory Commission staff presented at several of the plenary, panel, and technical sessions.

The trip report from 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.

Enclosure:
As stated

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Name	DZhang	MShams	SLu	CAder	TBergman
Office	NRO/DE/ICE1	NRO/DE	NRO/DSRA	NRO/DSRA	NRO/DE
Date	5/27/2010	5/27/10	5/27/10	5/28/2010	5/28/2010

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NRC FOREIGN TRIP REPORT

Subject

Participation in the 18th 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 17-21, 2010, Xi'an, China

Author, Title, and Agency Affiliation

1. Deanna J. Zhang, Electronics Engineer, Instrumentation and Controls Branch 1, Division of Engineering, Office of New Reactors

2. Mohamed Shams, Technical Assistant, Division of Engineering, Office of New Reactors

3. Shanlai Lu, Senior Reactor Systems Engineer, Reactor System, Nuclear Performance and Code Review Branch, Division of Safety System and Risk Assessment, Office of New Reactors

Sensitivity

Official Use Only-Sensitive Internal Information

Background/Purpose

Ms. Zhang, Dr. Shams, and Dr. Lu attended 18th International Conference on Nuclear Engineering (ICONE 18) to deliver presentations and exchange information with conference attendees in the area of regulatory practices, digital instrumtation and control (I&C), and loss of coolant accident (LOCA) analysis in new reactor design on best-estimate LOCA methodology and confirmatory analysis.

Abstract: Summary of Pertinent Points/Issues

On May 17, 2010, the NRC staff attended the ASME Workshop and the Computational Fluid Dynamics seminar. During the ASME Workshop, Dr. Shams made two presentations, one on the overview of the global nuclear industry, and one on the overview of U.S. nuclear regulatory framework. Key points made on the two presentations include:

- key role that nuclear energy play in meeting future energy needs
- globalization supply chain issues with key nuclear components
- major international activities to support the development and regulation of nuclear energy
- roles and responsibilities of different nuclear energy stakeholders

Enclosure

On May 18, 2010, Dr. Shams 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

On May 20, 2010, Dr. Shams made a presentation at the panel session on NRC use of codes and standards. Key points of this panel session include:

- discussions on the framework for the use of codes and standard in the regulations and guidance documents
- NRC's participation in code development activities
- NRC's participation with international standard developers.

On May 20, 2010, Dr. Shams made a technical presentation on "How Regulators Make a Difference in New Reactor Safety." Key points of this technical presentation include:

- discussions on the NRC's regulatory framework for new reactor reviews
- review process and the level of detail in the applications
- examples where the NRC staff has identified issues in the designs under review that have resulted in revised analyses and changes in the designs that have resulted in safety enhancements
- examples on international regulatory collaboration through Multinational Design Evaluation Program (MDEP) where safety concerns have been identified resulting in revised analyses and design changes in the Advanced Passive (AP1000) and European Pressurized Reactor (EPR) designs

On May 21, 2010, Dr. Lu made a presentation on Pressurized Water Reactor (PWR) large break LOCA analyses and their applications to new reactor licensing process. Key points of this technical presenation include:

- new reactor licensing status in NRC
- general applications of regulatory confirmatory analysis to the new reactor licensing process
- demonstration of a four loop PWR Large Break Loss of Coolant Accident (LBLOCA) real time simulation using NRC's RELAP-5 and Symbolic Nuclear Analysis Package computer codes

In addition, on May 21, 2010, Ms. Zhang made a presentation on how to safely integrate cyber security into the design of nuclear power plant safety systems. Key points of her presentation include:

- importance of cyber security in protecting nuclear power plants
- methods for leveraging existing safety features to support cyber security
- integration of cyber security features that support confiditiality, integrity, and availability into the design of I&C systems
- cyber security in the design and development lifecycle of nuclear power plant

Discussion

ASME Workshop

On May 17, 2010, the NRC staff attended the ASME Workshop, where Mr. Amos Holt provided welcome remarks. Mr. Holt discussed the goals of AMSE in the continual support of providing codes and standards in the field of nuclear engineering. Mr. Holt also emphasized ASME's support for the global development of nuclear power by coordinating with the nuclear industry and regulators of different countries on the use and evolution of ASME's codes and standards.

During the ASME Workshop, Dr. Mohamed Shams provided two presentations: "Overview of the Global Nuclear Industry," and "Overview of U.S. Nuclear Regulatory Framework." During the presentation on the overview of global nuclear industry, Dr. Shams discussed the important role that nuclear energy could play in meeting the future energy demands and environmental goals. Dr. Shams discussed the forces that affect growth of nuclear power, including forces that drive growth and those that constrain growth. Dr. Shams discussed the globalization supply chain issues, including having very few suppliers for key nuclear power plant components, and manufacturers that are unfamiliar with requirements for nuclear grade components. Dr. Shams also described the key international activities to support the development and regulation of nuclear energy, including MDEP, Nuclear Energy Agency, and International Atomic Energy Agency. During the presentation on the overview of U.S. Nuclear Regulatory Framework, Dr. Shams discussed how codes and standards are used in the NRC's review of new reactors applications. In addition, Dr. Shams explained the roles and responsibilities of different nuclear energy stakeholders, including the NRC which establishes regulatory requirements and issues related guidance, code organizations which establish the code requirements, and industry that develops programs and technologies to meet the pertinent requirements. Dr. Shams also discussed the Part 52 licensing process, and described how the design center approach enhances the licensing process.

Mr. Chris Sanna presented on the Global Use of Standards. Mr. Sanna discussed how a variety of nuclear reactor designs, regulations, and codes and standards, exists on the international market. Mr. Sanna stated that as a result of the many different regulatory requirements that exist for different countries, designers, builders, and manufacturers of nuclear power reactor components encounter challenges in meeting these different requirements. Mr. Sanna also compared the requirements within ASME Section III with other international codes and standards. One code that was mentioned was the French Code, *Design and Conception Rule for Mechanical Components of PWR Nuclear Islands* (RCC-M). He stated that these two standards both have similar technical requirements, but are notably different in approaches. For example, certification differs by countries for RCC-M, but not for ASME codes.

Dr. Zusheng Xu provided a presentation on the Overview of Chinese Nuclear Industry. During this presentation, Dr. Xu described the benefits of the AP1000 passive plant design as

compared to the Generation II plants and EPR. Dr. Xu emphasized how the modular design and construction of the AP1000 plant significantly reduces the construction time. Dr. Xu also provided an overview of the progress of the Sanmen AP1000 construction project. Dr. Xu described the three step strategy to China's nuclear industry: Step 1-give foreign priority to participate; 2-give priority for foreign support; 3-independent construction.

Mr. John Bendo provided a presentation on the Overview of ASME Codes and Standards.

Mr. Bendo provided a brief history of how ASME Boiler and Pressure Vessel Code was initiated. Mr. Bendo discussed the key characteristics of a standard, including requirements should be written with clear and consistent criteria, and be enforceable with well-defined scope of coverage. Mr. Bendo encouraged more participation on code committees. He also described the different section of the Boiler and Pressure Vessel Codes, with special emphasis on those sections that applied to the nuclear industry.

Mr. Ryan Crane gave a presentation on ASME Code Section XI-Codes for Inservice Inspection and Testing of Nuclear Power Plant. Mr. Crane discussed the organization of Section XI. Mr. Crane also described the organization of the committee on nuclear inservice inspection. In addition, Mr. Ralph Hill provided a brief overview of ASME code Section III.

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 NRO'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_2 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.

The technical sessions presented during ICONE 18 are described below:

"The Effect of Fuel Thermal Conductivity Degradation with Burn-up on PWR Licensing Limit" AREVA NP, Inc

A chief engineer from AREVA presented his evaluation of AREVA fuel performance codes in

response to NRC's Information Notice (IN) 2009-23 regarding thermal conductivity degradation due to burn-up. He compared the legacy thermal conductivity models with the most recent available models and evaluated the effect of thermal conductivity degradation on the PWR licensing limits, such as fuel enter line melt temperature, cladding strain, fuel rod internal pressure and LOCA peak cladding temperature (PCT). He concluded that legacy fuel performance codes need to be upgraded to accurately take into account degradation due to burn-up. His presentation demonstrated that IN 2009-23 has identified the right issue and is effective to push fuel vendors to take proper actions.

EPR - Related Test, "PKL TESTS ON HETEROGENEOUS INHERENT BORON DILUTION FOLLOWING SB-LOCA – APPLICABILITY TO REACTOR SCALE" AREVA

The PKL test facility was built and operated by AREVA to evaluate EPR's LOCA behavior. AREVA performed OECD PKL III test to understand the loop seal clearing, the onset of the natural circulation and boron dilution during a small break LOCA. During the test, the boron concentration of the fluid was measured and the following conclusions can be applied to reactor scale:

- The slug size volume is limited to the volume of the crossover leg plus the volume of the steam generator (SG) outlet plenum. No boron-depleted slug is formed on the hot side of the SGs.
- Natural circulation does neither start simultaneously in all loops nor isochronously in the U-tubes of a single SG. As circulation starts in one loop, the impetus is reduced for circulation to start in other loops.
- Overspilling before restart of natural circulation has an important impact on the mixing of the boron-depleted slugs with the Emergency Core Cooling System injection.
- NRC staff found that the information provided in this paper can be directly applied to EPR small break loss-of-coolant accident review and the relevant boron dilution evaluation.

BWR Dryer Flow Induced Vibration
"Fluctuating Pressure Generation in BWR Main Steam Lines Acoustic Excited by Safety Relief Valve Stub Pipes and Dead Legs," Hitachi

In order to evaluate the flow induced vibration in boiling water reactors (BWR) dryer region, Hitachi built a scaled vessel, dryer, main-steam line test facility. The tests were performed to identify the source of the flow induced vibration, the mode and frequency of the oscillation. The results showed that the sound waves source was located in the safety relief valve stub pipe and the dead legs. The magnitude and the frequency of oscillation were significantly affected by the stub pipe geometry.

"Numerical Evaluation of Fluctuating Pressure at Stub Pipes in Actual BWR Main Steam Lines"
Hitachi

Hitachi also developed computational fluid dynamics (CFD) model to capture the acoustic wave propagation through the BWR main steam line and the local impact on the steam dryer. The

actual safety relief valve stub pipe and the vessel internal structure are modeled. The developed model can be used to redesign the main steam line and safety relief valve orientation for new reactors.

"Quality Assurance in the ITER Construction," ITER Organization, Sungkook Park

Dr. Park presented on the quality assurance program for the International Thermo-nuclear Experimental Reactor (ITER) project. The ITER project is basically an engineering and construction project initiated in response to a French Quality Order to build the ITER machine, which is a scientific experimental fusion device. The ITER Organization has established a Quality Assurance Program for the construction of the ITER machine to meet the requirements of the order and to ensure the ITER activities are performed to achieve the safety and performance objectives of the ITER machine.

"A Review on Specific Features of Small and Medium Sized Nuclear Power Plants," College of Nuclear Science and Technology, 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, 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, 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.

"Utilizing Control Valve Diagnostic to Transform the Way you Maintain these Critical Assets," Fisher Controls, Bill Fitzgerald

Mr. Fitzgerald presented on the benefits of ensuring quality of process control on nuclear power plant performance, including increased production and efficiency, improved reliability, and improved maintenance and operations. Mr. Fitzgerald stated that most nuclear power plant control valves do not work optimally, and that by ensuring quality of process control of control valves results in more power output at lower costs. Mr. Fitzgerald also demonstrated the control valve diagnostic utility provided by Fisher Controls.

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

Class IE 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, 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., Ji Shi

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.

"US-APWR Human System Interface System Verification & Validation Program for Digital I&C Design," Mitsubishi Heavy Industries, Satoshi Hanada

Mr. Hanada described the I&C System and HSI system are applied to the US-Advanced Pressurized Water Reactor (US-APWR). He stated that the US-APWR digital I&C and HSI system (HSIS) utilizes computerized systems, including computer-based procedures and alarm prioritization, relying principally on an HSIS with soft controls, console based visual display units and a large, heads up, overview display panel. Mr. Hanada discussed the results of an extensive verification and validation (V&V) program that was completed with the objective of assessing U.S. operators' performance in this digital design environment. Mr. Hanada also presented the results of the follow up V&V activities tests that were conducted in 2009 to resolve human engineering discrepancies induced from the previous evaluation and the participants' comments and performance. He discussed the subjective and objective data were collected on each crew for each scenario and described the extensive convergent measures analysis that was performed, which resulted in the identification of both specific design as well as generic conclusions.

"Mitsubishi Digital I&C Design Features for PWR Plant," Mitsubishi Heavy Industries, Shunsuke Ishimoto

Mr. Ishimoto presented on Mitsubishi's digital safety I&C system. Mr. Ishimoto stated that Mitsubishi's digital safety I&C system has been developed and approved in Japan. The digital I&C system has been applied to many safety and non-safety system applications including full digital I&C system for new plants and digital upgrading for operating plants in Japanese PWR plants. Mr. Ishimoto discussed how defense-in-depth and diversity features for plant safety and control are integrated into the I&C systems design, and how these features also provide countermeasures against software common cause failures.

Mr. Ishimoto stated that the digital I&C system will also be applied for the US APWR in the U.S. plant. He stated that the US APWR is one of the candidate reactor of future nuclear power plants in U.S., which has been developed by Mitsubishi Heavy Industries, Ltd. by modifying Japanese APWR design to comply with U.S codes and standards. The I&C system HSIS, Protection and Safety Monitoring System Plant Control and Monitoring System, and Diverse Actuation System. Mr. Ishimoto also discussed the potential use of digital I&C design features and application within the US APWR design to both new plants and digital upgrading for operating PWR plants.

"Safety System and Control System Separation Requirements for ACR-1000TM and Operating CANDU Reactors," Atomic Energy of Canada Ltd., Sunsil Tikku

Mr. Tikku presented on the key principles for CANada Deuterium Uranium (CANDU) nuclear reactor technology, including complete functional and physical separation between control and safety, and also between the safety systems. Mr. Tikku described the historical evolution of these principles that make CANDU reactors one of the safest technologies in the world today. He stated that the original Generation II CANDU 6 reactors started with complete separation of

control from safety and the division of safety systems into two groups having strong physical separation such as opposite sides of the reactor or reactor building. In addition, within each group a more moderate distance separation was employed. Mr. Tikku stated that these key separation principles are maintained with the introduction of digital technology.

"Integrating Cyber Security into Nuclear Digital I&C Safety Systems," US NRC, Deanna Zhang

Ms. Zhang provided an overview of why cyber security is important to the protection of nuclear power plants. She discussed methods that can be employed to safely integrate cyber security into the design and development process of digital safety systems. Ms. Zhang discussed various cyber security features that ensure confidentiality, integrity, and availability that may be integrated into the design of these systems. In addition, Ms. Zhang presented on the importance of implementing a robust information security program to secure the development environment of these digital systems to prevent malicious manipulation of the system while under development.

"How Regulators Make a Difference in New Reactor Safety," US NRC, Mohamed Shams

Dr. Shams made this presentation in Technical Track 7 Codes, Standards and Regulatory Topics of New Reactors. The presentation included discussions on the NRC's regulatory framework for new reactor reviews, the review process and the level of detail in the applications. The presentation provided specific examples where the NRC staff has identified issues in the designs under review that have resulted in revised analyses and changes in the designs that have resulted in safety enhancements. Examples were discussed on international regulatory collaboration through MDEP where safety concerns have been identified resulting in revised analyses and design changes in the AP1000 and EPR designs.

"PWR Large Break LOCA Analyses and Their Applications To New Reactor Licensing Process," US NRC, Shanlai Lu

During this presentation, Dr. Lu briefly discussed U.S. new reactor licensing status, the general applications of regulatory confirmatory analysis to the new reactor licensing process and gave a demonstration of a four loop PWR LBLOCA real time simulation using NRC's RELAP-5 and Symbolic Nuclear Analysis Package computer codes. Based on the demo, Dr. Lu explained the need of the accurate treatment of fuel pellet thermal conductivity and the initial core stored energy. Then, Dr. Lu discussed NRC IN 2009-23 "Nuclear Fuel Thermal Conductivity Degradation" and its implication to LBLOCA analysis. With the anticipation that the upgrade of legacy fuel performance code may result in higher peak cladding temperature prediction, Dr. Lu pointed out a potential future analysis improvement to reduce PCT uncertainty. The improvement is associated with the core decay heat calculation. Currently, most licensees perform statistical sampling of decay heat only once at the beginning of the LOCA transient. This simplified approach results in significantly large uncertainty band of the calculated peak cladding temperature. Employing more frequent sampling at a time interval of 1/10 of fuel conduction time constant may significantly reduce the uncertainty band of PCT. This concept was proved by a staff confirmatory analysis which shown a factor of two reduction of PCT uncertainty.

Panel Sessions

"Regulations, Codes and Standards"

Dr. Mohamed Shams participated in a panel discussion on regulations, codes and standards. In addition to the NRC representative, the panelists included representatives from China (Panel Chair), Japan, France, and ASME. Dr. Shams delivered a presentation on the NRC use of codes and standards including discussions on the framework for the use of codes and standard in the regulations and guidance documents, the staff participation in code development activities, and the NRC's participation with international standard developers. The representative from Japan provided remarks on codes and standards organizations in Japan, while the French representative discussed the development of nuclear codes and standard in France. The Panel Chair provided a presentation on the regulations of nuclear safety in nuclear power plants in China.

Key Discussions with Conference Participants

AP1000 Pump Issue

(b)(4)

Pending Actions/Planned Next Steps for NRC

None

Points for Commission Consideration/Items of Interest

None

"On the Margins"

N/A