



Digital Instrumentation and Control

February 1, 2011

Agenda

- **Steering Committee activities**
- **Operating reactor licensing**
- **New reactor licensing**
- **Research support**
- **International activities**

Steering Committee Activities

- **Steering Committee established in 2007**
- **Project Plan developed with input from all stakeholders**
- **Communication enhanced with stakeholders**
- **Seven ISGs issued**

Steering Committee Activities

- **ISGs used to support new and operating plant licensing reviews**
- **ISGs have improved predictability, consistency and effectiveness**
- **Incorporating ISGs into regulatory infrastructure**
- **Sunsetting Steering Committee and Task Working Groups**

Operating Reactor Licensing Accomplishments

- **Infrastructure**
 - **Improved review process**
 - **Updating current platform topical reports and reviewing new topicals**
- **New technology**
 - **Wolf Creek**
 - **Oconee**

Status of Operating Reactor Reviews

- **Ongoing reviews**
 - **Grand Gulf**
 - **Crystal River**
 - **Columbia**
- **Watts Bar Nuclear Plant Unit 2**
 - **Review includes 3 safety-related digital platforms and 3 balance of plant digital platforms**

Digital I&C System Platforms and Applications

- **New Platforms**
 - **HFC-6000**
 - **Advanced Logic Systems**
 - **Spinline 3**

Digital I&C System Platforms and Applications

- **Update to topical reports**
 - **Common Q**
 - **Tricon**
- **Software validation tool**
 - **SIVAT V&V**

ISG-6 Pilot for Diablo Canyon

- **ISG-6 and Oconee lessons learned**
- **Digital to digital replacement of RPS and ESFAS**
- **Amendment request expected Spring 2011**
- **Will use pilot to further improve review process**

Operating Reactor Challenges

- **Operational issues**
 - **50.59**
 - **Maintenance Rule**
 - **Inspection of start-up testing and other site reviews**
 - **Technical Specifications**

New Reactor Licensing Accomplishments

- **Completed review of GEH's ESBWR Design Certification application**
- **Completed review of WEC AP1000 Design Certification Amendment**

Status of New Reactor Reviews

- **Design certification and COL application reviews**
- **ISG documents being used**
- **Stakeholder interactions on I&C DAC**

I&C DAC/ITAAC Inspections

- **Submitted draft I&C inspection procedure to ACRS**
- **Test of inspection procedures with South Texas applicant**
 - **Scheduled for March 2011**

New Reactor Challenges

- **Quality and completeness of I&C submittals**
- **Nexus between complexity and safety**
- **Design approaches and schedule expectations**

Research Support

- **Digital I&C research guided by the Digital System Research Plan**
- **Research divided into four areas:**
 - **Safety Aspects**
 - **Security Aspects**
 - **Advanced Nuclear Power Concepts**
 - **KM and Research Collaboration**

DI&C Research at National Labs

- **I&C Research requires both digital expertise and knowledge of nuclear technology**
- **ORNL, SNL, PNNL, BNL, INL provide extensive expertise**
- **Diverse Lab work includes D3, FPGAs, Cyber, FMEA, EMP**
- **University research and international interactions complement National Labs**

Research Products

- **NUREG/CR – 7007, Diversity Strategies for Nuclear Power Plant Instrumentation and Control Systems**
- **NUREG/CR – 7006, Review Guidelines for Field-Programmable Gate Arrays in Nuclear Power Plant Safety Systems**

Research Products

- **NUREG/CR – 6991, Design Practices for Communications in Highly Integrated Control Rooms**
- **Digital Platform Cyber Assessments & Regulatory Guide 5.71, Cyber Security Programs**

Software Failure Mode Identification and Analysis

- **Goal: Assess analytical methods to support licensing of software including FMEA techniques**
- **FMEA may be useful for system hazard review**
- **KAERI has one successful limited scope case of using FMEA for software assurance**

Software Failure Mode Identification and Analysis

- **Traditional FMEA contribution to software assurance is limited**
 - **Too many potential fault modes in software**
 - **Software faults driven by systemic causes**
- **Research products - NUREG/IA and Research Information Letters**

Digital System Operational Experience

- **Goal: Factor digital OpE into regulatory practices**
- **Digital OpE limited in US NPP safety systems**
 - **Quantification not currently meaningful**
 - **Collaboration via the EPRI MOU provides access to event details**

Digital System Operational Experience

- **Obtaining international and non-nuclear OpE**
 - **COMPSIS, EDF & Korean via EPRI MOU**
 - **Non-Nuclear Digital OpE**
- **Compiling inventory, classification and data for analysis**

Digital System PRA Research

- **Goal: Identify methods and data needed to quantify the reliability of digital I&C systems for PRAs and support risk-informed licensing process**
- **Five completed NUREG/CRs on reliability models for digital systems**
 - **Identified a set of desirable characteristics**
 - **Applied modeling methods to an example system**

Digital System PRA Research

- **Additional research is needed to**
 - **Improve current methods**
 - **Augment existing data**
 - **Principal focus at present is the quantification of software reliability**
- **Long term significant research effort**

International Activities

- **Active international cooperation**
 - **Multi-lateral programs**
 - **Bi-lateral exchanges**
 - **Support development of international standards (IAEA, IEC)**

International Activities

- **Multi-lateral programs**
 - **Multinational Design Evaluation Program (MDEP)**
 - **NRC Leads digital working group**
 - **AP1000 working group**
 - **EPR working group**
 - **European I&C (7 Country Project)**

International Activities

- **Bi-lateral exchanges:**
 - **Finland**
 - **France**
 - **Canada**
 - **China**
 - **Korea**
 - **Japan**
 - **Others**

International Activities

- **Support development of international standards**
 - **IAEA Safety Guide**
 - **IEC Standards**
 - **Inputs from multi-lateral exchanges**
 - **New and updated standard**
 - **Interactions with IEEE**
 - **Other standards**

International Activities

- **NRC international cooperation in the digital I&C area has**
 - **Improved operating experience and lessons learned sharing**
 - **Improved knowledge of and coordination of regulatory positions (MDEP and other activities)**
 - **Increased research collaboration**

Acronyms

ACRS	Advisory Committee on Reactor Safeguards
BNL	Brookhaven National Laboratory
COL	Combined License
COMPSIS	Computer Systems Important-to-Safety
DAC	Design Acceptance Criteria
D3	Diversity and Defense-in-Depth
EDF	Electricité de France
EMP	Electromagnetic Pulse

Acronyms

EPR	Evolutionary Power Reactor
EPRI	Electric Power Research Institute
ESFAS	Engineered Safety Features Actuation System
ESBWR	Economic Simplified Boiling Water Reactor
FMEA	Failure Modes and Effects Analysis
FPGA	Field Programmable Gate Arrays
GEH	General Electric Company, Hitachi Nuclear Energy

Acronyms

HFC	Doosan HF Controls
I&C	Instrumentation and Control
IAEA	International Atomic Energy Agency
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
INL	Idaho National Laboratory
ISG	Interim Staff Guidance

Acronyms

ITAAC	Inspections, Tests, Analyses and Acceptance Criteria
KAERI	Korea Atomic Energy Research Institute
KM	Knowledge Management
MDEP	Multinational Design Evaluation Program
MOU	Memorandum of Understanding
NPP	Nuclear Power Plant
OpE	Operational Experience

Acronyms

ORNL	Oak Ridge National Laboratory
PNNL	Pacific Northwest National Laboratory
PRA	Probabilistic Risk Assessment
RPS	Reactor Protection System
SIVAT	Simulation Validation Test Tool
SNL	Sandia National Laboratory
V&V	Verification and Validation
WEC	Westinghouse Electric Company