

# **The Evolution of Digital Instrumentation and Control in the United States**

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**Keynote Address  
To the  
IAEA Technical Meeting on  
Integration of Analog and Digital Instrumentation and Control Systems in Hybrid  
Main Control Rooms at Nuclear Power Plants  
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Good Morning. We all know the important role of digital instrumentation and control systems in the safe operation of nuclear power plants, and the expansion of that role in new designs. NRC has been increasing our involvement with IAEA over the last few years and had the pleasure of hosting and co-sponsoring an IAEA Technical Meeting on Common Cause Failures in Digital Instrumentation and Control Systems of Nuclear Power Plants last summer. The large attendance at these Technical Meetings clearly demonstrates the importance of digital systems in the international nuclear community.

We are fortunate that many of the leading international experts in the area of nuclear power plant I&C are participating in this meeting, with representatives from nuclear power utilities, vendors, licensing bodies, research organizations and academic institutions. This should provide the opportunity for participants to learn from each other and generate new ideas for the safe deployment of nuclear I&C systems throughout the world.

I truly hope that you find this technical meeting and its information exchanges beneficial in helping us all to better achieve nuclear plant safety through the benefits of integrating digital and analog technologies as effectively, and efficiently, as possible.

Let me provide some NRC history that I have found to be insightful in understanding the evolution of I&C technology. For the early designs, we had what was thought to be a robust set of instrumentation and control systems, including adequate indications for the control room operators. Following the accident at the Three-Mile Island plant, a number of systems were mandated as add-ons that had human system integration or HSI implications, such as the safety parameter display system, post accident monitoring instrumentation, and bypassed and inoperable status indication. These tended to be separate and isolated systems whose technological implementation meant not following the conventions of the remainder of the human system integration in the control room. However, plant safety systems deployed in the U.S. in the 1980s, such as the Combustion Engineering Core Protection Calculators or CPCs, played a key role and were considered safe by the NRC largely due to being designed as a single digital component of an extended analog safety system. Thus, every safety function initiated by these CPCs had at least one analog backup.

The use of CPCs enabled more precise computations of plant operating parameters, thereby reducing uncertainties and allowing greater operational flexibility. Because the analog channel was diverse from the digital channel and could equally and redundantly fulfill the safety function when needed, the question of common-cause failure of the digital channels was not a significant concern. With I&C and human system integration modernization, better and more integrated approaches are possible in these areas.

Several years ago, the NRC began reviewing advanced reactor designs developed by General Electric, Combustion Engineering, and Westinghouse. At about the same time the U.K. regulator was reviewing the Sizewell B design. I understand that great debates took place among these regulators, their advisory committees, and the nuclear and computer software industries. These debates were far ranging across a wide spectrum of issues. Technical questions were debated such as whether “hard-wire” or analog backup instruments and controls were needed to implement the concept of diversity, or whether diverse digital systems would suffice. Answers surfaced which provided a backup system, either analog or digital, that established sufficient diversity.

The IAEA Technical Meeting held last June in Washington provided an excellent forum for discussing common cause failures in digital I&C systems. This provided us many valuable insights into how the international community is dealing with this issue. As we learned in the TM, international approaches to addressing common-cause failure in digital safety systems vary widely. But most are grounded in the application of varying degrees of diversity and independence to safety system components and functions. For those reasons, some of the new reactor license applications, to be submitted in the immediate future in the U.S., have plans to incorporate a diverse backup system to address common-cause failures of the primary digital safety systems.

In his keynote presentation at the June TM, NRC’s Commissioner Lyons spoke of the staff beginning a public dialogue on the potential benefits of a research, test and evaluation facility in the U.S. for safety system applications. Specifically, Commissioner Lyons hoped that “such an integrated facility would create synergies and efficiencies not evident in our current approach.” The NRC held a workshop of nuclear industry experts in Atlanta, GA, last September to gain their insights on the need for and uses of such a facility. We are currently evaluating the feedback we received and will be making a recommendation to the Commission.

Our Commission has consistently emphasized the importance of continual development of digital safety systems, with improved potential safety performance and operational flexibility. However, development of this important technology is not without technical as well as regulatory challenges.

Over the last several months, the NRC staff has been interacting extensively with various stakeholders to address persistent regulatory questions with regards to new approaches being taken in the use of the latest digital technology. This effort was to identify and resolve technical and regulatory issues that will result in more efficient licensing of digital I&C systems for new reactor applications and for retrofits at operating reactors and fuel processing facilities. To date the NRC staff has published position papers, characterized as Interim Staff Guidance, addressing four key areas, including highly-integrated control rooms. The staff’s effort is continuing and is expected to lead to further refinement of this guidance and its eventual incorporation into the Standard Review Plan or Regulatory Guides.

In summary, through the discussions with the industry and the staff's considerations of these new approaches and ideas, the benefits of an overall hybrid I&C system and control room often were considered and acknowledged. I believe that there are very real safety benefits that can be achieved through the integrated use of digital and analog systems in nuclear power plants. This is an extremely timely issue. Today's and tomorrow's, analog as well as digital, technology can be put to good use in improving the effectiveness of human system integration and the precision by which we monitor and control reactor parameters to maintain safety at all times. The control rooms in the next generation of plants will be fundamentally different and will not look the same as today's units.

A very big issue still facing the technical community is the need for gathering, sharing, and using hybrid system designs and operating experience at the international level. Useful insights can be obtained from experience with safety/non-safety analog and digital systems working closely with the international partners and non-nuclear industry. The U.S. stands to benefit from such international efforts as new plant deployment moves forward.

Finally, regulators should continue to improve the clarity and usefulness of regulatory requirements and standards for evolving technologies, in combination with existing technologies, and we must find better ways of evaluating these new designs, which will surely continue to evolve with hybrid systems.

I am pleased that the international community is taking an active role to ensure adequate attention is being paid to addressing these issues. We strongly encourage you to continue in this forum – that is to open the international body of knowledge and experience. We look forward to participating in this forum as this technology evolves.

I would like to take this opportunity to thank IAEA and AECL as well as co-sponsors, Bruce Power, Ontario Power Generation, and CANDU Owners Group, for all your efforts toward making this important TM possible.

Thank you for your attention and I hope you have a very informative and productive technical meeting.