



## EVALUATING DIVERSITY IN DIGITAL I&C SAFETY SYSTEM DESIGNS

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### REGULATORY FOCUS ON DIVERSITY

- 10 CFR 50 Appendix A, GDC 22, requires design techniques such as **functional diversity or diversity in component design and principles of operation to be used to the extent practical** to prevent loss of protection functions
- SRM for SECY 93-087 directs the NRC staff to **verify adequate diversity has been provided**
- NUREG/CR-6303 and SRP Ch. 7 BTP 7-19 provide guidance for **identifying the need for diversity** in safety systems

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### ISSUE

- Regulatory requirements and guidance **DO NOT** define **what constitutes ADEQUATE diversity** in a safety system design
- This has led to licensing uncertainty caused by different interpretations of the term, "**ADEQUATE**"
- TWG #2 Issue #1 identified this licensing uncertainty issue by asking,
  - **If diversity is needed** to mitigate the consequences of potential CCFs, **how much diversity is enough?**
- A research effort has been addressing this question

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### RESEARCH APPROACH ASSUMPTIONS

- Diversity positions and designs in other agencies, industries and countries are based on operating experience and engineering judgment
- NUREG/CR-6303 guidance can be combined with this experience and engineering judgment to develop a diversity evaluation process
- The evaluation process can be used to evaluate other diversity approaches independent of technology
- Operational experience can provide insights for developing diversity guidance

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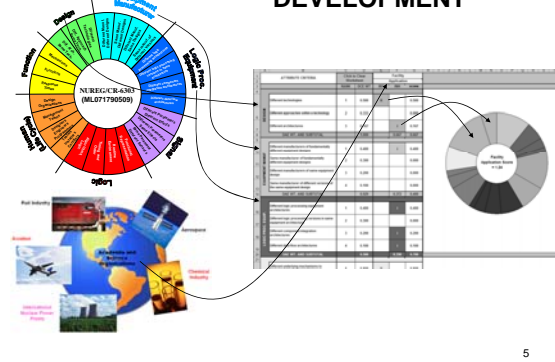
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### EVALUATION METHOD DEVELOPMENT



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### METHOD DEVELOPMENT SUMMARY

- Developed an Excel spreadsheet using NUREG/CR-6303 guidance as a framework to capture diversity designs and positions from other agencies, industries and countries
- The data and NUREG/CR-6303 guidance was then used to develop weights
- The weights were used to score the designs and positions

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### DIVERSITY WEIGHTING AND SCORING

- Diversity Criterion Effectiveness (DCE) weight
  - Criterion effectiveness relative to other criteria within the same Attribute
- Diversity Attribute Effectiveness (DAE) weight
  - Frequency of use for each diversity Attribute
- Used DCE and DAE weights to calculate scores
  - $Score = DCE * DAE$  for Attributes and Criteria used in a design
- Scores were normalized by the average of the scored designs used to develop the weights

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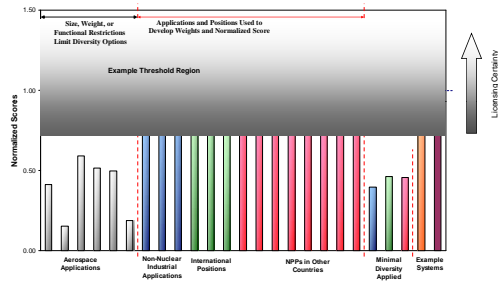
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### I&C SYSTEM DIVERSITY SCORING



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### IMPLEMENTATION CONSTRAINTS

- Potential CCFs should be identified using operational experience, NUREG/CR-6303 evaluations, and BTP 7-19 analyses
- The diverse design should address the CCFs
- All credited diversity criteria should be in the design
- The resulting diversity score should fall within a yet-to-be determined range of acceptable scores
- Information justifying the design should be provided to the NRC for subsequent verification

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## NEXT STEPS

- Stakeholder feedback
  - A draft version of the NUREG/CR is available in ADAMS – ML090510111
- Review and incorporate comments into the NUREG and the evaluation method
- Incorporate the evaluation method into NRC processes for reviewing I&C designs
  - Revise NRC guidance to reference the method
  - Incorporate the evaluation method into the SRP

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## SUMMARY

- Experience and engineering judgment have been correlated with NUREG/CR-6303 diversity attributes
- The correlated data was used to develop a method for evaluating diversity in I&C system designs
- Spreadsheet-based tool is available (ADAMS ML083440387)
- Draft report is available for review and comments (ADAMS ML090510111)

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