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Benefits and Risks Associated with the Proposed Automated DAS

NRC / Industry Meeting

Digital I&C

March 21, 2008

Generation of Risk Insights
Benefits/Risks Associated with an Automated DAS

- Update of results since last TWG meeting
  - Modified assumptions regarding functionality of the NRC's proposed automated DAS
    - What the DAS actuates
    - What actuates the DAS
  - Summary of updated results
    - Fewer benefits resulting from the proposed automated DAS
    - Less risk resulting from spurious operation of the DAS
    - The proposed automated DAS continues to have
      - little benefit for the cost
      - a possible small negative impact on safety

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Generation of Risk Insights
Benefits/Risks Associated with an Automated DAS

- Modified what the proposed automated DAS actuates
  - Only low pressure injection and supporting systems (actuation of high pressure injection is not required to meet the ISGs)
    - Reduces the benefits of the proposed automated DAS
    - Reduces the risks of spurious actuation for some plants
  - Expanded the definition of Large LOCA break range to include all break sizes in which low pressure injection would be effective
- Modified what actuates the DAS
  - The DAS does not need to be actuated in the same way that ESFAS is actuated
    - e.g., rather than low pressurizer pressure OR high containment pressure, actuate low pressure injection on low pressurizer pressure AND high containment pressure
    - Further reduces the risks associated with the potential for spurious actuation of the proposed automated DAS

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Generation of Risk Insights
Benefits/Risks Associated with an Automated DAS

PWR results – automated DAS for LPI & SGI
(similar actuation logic as ESFAS actuation)

IE	IE Frequency NUREG/CR-1829	Time to 2200°F	HEP	W 2 loop	W 4 loop	CE #1	CE #2	B&W
				CDF resulting from digital CCF (P_{CCF} ~ 1E-4/dem)				
Large LOCA	2.8E-05/yr	-		2.8E-09				
Total				**2.8E-09**				

Benefits of a diverse LPSI actuation

		CCDP by plant type				
LOFW		1.3E-06	5.8E-06	5.0E-06	2.0E-06	4.0E-06
General Trans			5.6E-07			
Spurious SI				1.6E-05		3.1E-05

	IE Frequency NUREG/CR-6928 LERs		Spurious DAS CDF (per year) by plant type				
Spurious SI	0.007/year		9.1E-09	3.9E-09	1.1E-07	1.4E-08	2.8E-08
Spurious SGI	0.007/year		9.1E-09	4.0E-08	3.5E-08	1.4E-08	2.8E-08
Total			**1.8E-08**	**4.4E-8**	**1.4E-07**	**2.8E-08**	**5.6E-08**

Risks introduced by a diverse LPSI
diverse SGI

The benefits of the proposed automated DAS do not appear to be cost justified (per criteria of NUREG/BR-0058).

For the spectrum of plants considered, the proposed automated DAS may even have a negative impact on safety.

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Generation of Risk Insights
Benefits/Risks Associated with an Automated DAS

BWR results – automated DAS for LPI & MSIV
(similar actuation logic to ESFAS actuation)

IE	IE Frequency NUREG/CR-1829 NUREG/CR-6928	Time to 2200°F	HEP	BWR 2	BWR 3	BWR 4	BWR 5	BWR 6
				CDF resulting from digital CCF (P_{CCF} ~ 1E-4/dem)				
Large LOCA	1.5E-05/yr	-		1.5E-09/yr				
Transient/SORV	2E-3/yr	~30m	3E-3	6E-10/yr				
Med/Large SLB	1.0E-4/yr	>30m	3E-3	3E-11/yr				
Total				**2.1E-09**				

Benefits of a diverse
- ECCS initiation
- MSIV isolation

		CCDP by plant type				
MSIV Closure		2.6E-06	3.9E-06	6.0E-06	1.4E-06	1.8E-06
General Trans		7.0E-07	1.1E-06	1.6E-06	7.0E-07	7.6E-07

	IE Frequency NUREG/CR-6928 LERs		Spurious DAS CDF (per year) by plant type				
Spurious MSIV	0.007/year		1.8E-08	2.7E-08	4.2E-08	9.8E-09	1.3E-08
Spurious Rx Trip	0.007/year		4.9E-09	7.7E-09	1.1E-08	4.9E-09	5.3E-09
Total			**2.3E-08**	**3.5E-8**	**5.3E-08**	**1.5E-08**	**1.8E-08**

Risks introduced by a diverse
- MSIV isolation
- ECCS initiation

The benefits of the proposed automated DAS, even for an expanded set of events, do not appear to be cost justified (per criteria of NUREG/BR-0058).

For the spectrum of plants considered, the proposed automated DAS may even have a negative impact on safety.

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Generation of Risk Insights
Benefits/Risks Associated with an Automated DAS

PWR results – automated DAS for LPI & SGI
(modified logic from ESFAS actuation)

IE	IE Frequency NUREG/CR-6928	Time to 2200°F	HEP	W 2 loop	W 4 loop	CE #1	CE #2	B&W
				CDF resulting from digital CCF (P_{CCF} ~ 1E-4/dem)				
Large LOCA	2.8E-05/yr	-		2.8E-09				
Total				**2.8E-09**				

Benefits of a diverse SI

		CCDP by plant type				
LOFW		1.3E-06	5.8E-06	5.0E-06	2.0E-06	4.0E-06
General Trans			5.6E-07			
Spurious SI				1.6E-05		3.1E-05

	IE Frequency NUREG/CR-6928 LERs		Spurious DAS CDF (per year) by plant type				
Spurious SI	0.0018/year		2.3E-09	1.0E-09	2.9E-08	3.6E-09	7.2E-09
Spurious SGI	0.0018/year		2.3E-09	1.0E-08	9.0E-09	3.6E-09	7.2E-09
Total			**4.6E-08**	**1.1E-8**	**3.8E-08**	**7.2E-09**	**1.4E-08**

Risks introduced by a diverse SI
diverse SGI

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Generation of Risk Insights
Benefits/Risks Associated with an Automated DAS

BWR results – automated DAS for LPI & MSIV
(modified logic from ESFAS actuation)

IE	IE Frequency NUREG/CR-6928	Time to 2200°F	HEP	BWR 2	BWR 3/4	BWR 4	BWR 5	BWR 6
				CDF resulting from digital CCF (P_{CCF} ~ 1E-4/dem)				
Large LOCA	1.5E-05/yr	-		1.5E-09/yr				
Med/Large SLB	1.0E-4/yr	>30m	3E-3	3E-11/yr				
Total				**1.5E-09/yr**				

Benefits of a diverse
← ECCS initiation
← MSIV isolation

		CCDP by plant type				
MSIV Closure		2.6E-06	3.9E-06	6.0E-06	1.4E-06	1.8E-06
General Trans		7.0E-07	1.1E-06	1.6E-06	7.0E-07	7.6E-07

	IE Frequency NUREG/CR-5750		Spurious DAS CDF (per year) by plant type				
Spurious MSIV	0.0018/year		4.7E-09	7.0E-09	1.1E-08	2.5E-09	3.2E-09
Spurious Rx Trip	0.0018/year		1.3E-09	2.0E-09	2.9E-09	1.3E-09	1.4E-09
Total			**6.0E-09**	**9.0E-08**	**1.4E-08**	**3.8E-09**	**4.6E-09**

Risks introduced by a diverse
← MSIV isolation
← ECCS initiation

The benefits of the proposed automated DAS, even for an expanded set of events, do not appear to be cost justified (per criteria of NUREG/BR-0058).

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Risk Insights from PRA Related to D3 ISG on Credit for Operator Action

- What is the reason that the proposed automated DAS provides benefits that are so limited?
  - Frequency of initiating events for which it would be useful is small:
    - LOCAs
      - RCS is designed in accordance with consensus codes and standards (e.g., Section III of ASME B&PV Code)
      - Periodic examination of RCS components is performed in accordance with accepted codes and standards (e.g., Section XI of ASME B&PV Code
      - Frequent monitoring of the integrity of the RCS is performed and corrective action is taken when predefined limits are exceeded (e.g., leakage detection systems)
  - Reliability of ESFAS is high
    - Quality software life cycle processes
    - Functional diversity
    - Self testing, data validation, fault tolerance, procedural restrictions allowing changes to only one channel at a time, operating system 'blind' to plant transients, constant loading of communication and processing buses

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Risk Insights from PRA Related to D3 ISG on Credit for Operator Action

- **Consistency with defense-in-depth philosophy**
  - How is defense against common cause failures provided without additional diverse actuation?

    The ESFAS can be designed such that there is little potential for CCF between the causes of Large LOCAs/SLBs as initiating events and the ESFAS.
    - A source of diversity that is not acknowledged by BTP-19.

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Risk Insights from PRA Related to D3 ISG on Credit for Operator Action

- The ISG should be modified to limit the scope of D3 evaluations to anticipated transients, and remove the inconsistency with other regulations directed at addressing the effects of CCF, such as the ATWS Rule.

  Otherwise, the ISG's proposed automatic DAS

  - does not have sufficient benefit to justify the cost
  - may introduce more risk than it addresses.

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