

Crediting Mitigating Strategies in Regulatory Decision Making

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OUTLINE

- Background-Regulatory Drivers
- Background-Industry Response
- Maximizing Risk Reductions from Plant Systems
- Potential Risk Reductions from FLEX
- Importance of “Synchronizing” FLEX with Existing Systems
- Areas for Crediting FLEX
- Some Completed & Ongoing Regulatory Activities
- Challenges
- Conclusions

BACKGROUND REGULATORY DRIVERS

Issued Order EA-12-049, “*Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events*” (NRC ADAMS Accession Number ML12054A735).

- Order requires a three-phased approach to mitigating BDBEE.
- Initial phase requires the use of installed equipment and resources to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling capabilities.
- Second phase requires providing sufficient portable onsite equipment and consumables to maintain or restore these functions until they can be maintained with offsite equipment and support.
- Final phase requires obtaining sufficient offsite resources to sustain those functions indefinitely.

US NRC Response to Fukushima Dai-ichi Accident (Continued)

- Issued 10 CFR 50.54(f) letters to all licensees to request that they reevaluate the seismic and flooding hazards at their sites using updated seismic and flooding hazard information and present-day regulatory guidance and methodologies. (NRC ADAMS Accession No. ML12053A340).
- Evaluated NRC actions regulations against the observations and lessons learned by the IAEA.
- Followed up with audits, inspections, and safety evaluations to ensure that licensees have complied with NRC orders and appropriately responded to 50.54(f) letters.

Background

Industry Response

US Industry Response to Fukushima Dai-ichi Accident

Implemented three major modifications.

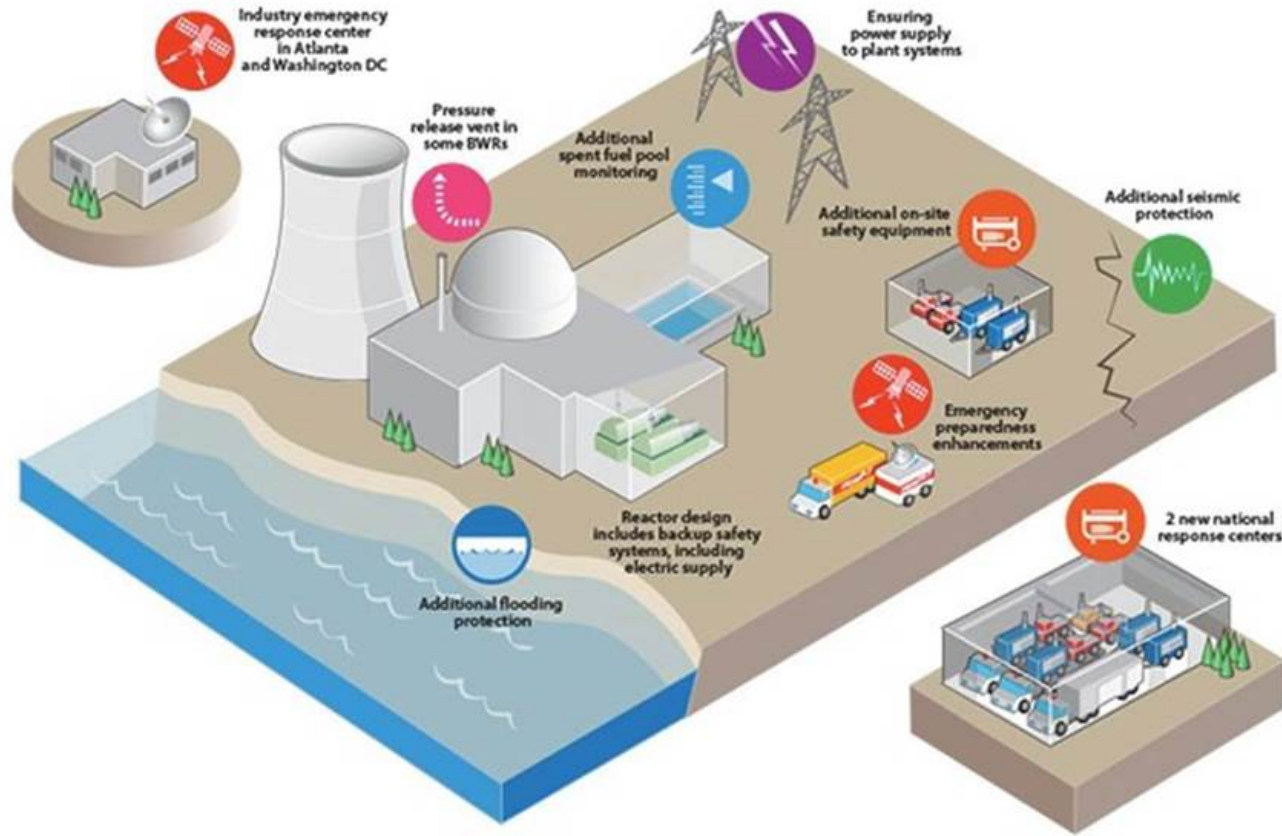
- Installing hardware in spent fuel pools to measure the water level from the surface to the top of the fuel stored in the pool.
- Installing hardened vents capable of withstanding a severe accident at some BWRs.
- **Implementing the FLEX Strategies to mitigate BDBEE**

US Industry Response to Fukushima Dai-ichi Accident (Continued)

- The safety enhancements of FLEX strategies are deployed in three phases.
- Using installed plant equipment that is independent of AC power which could survive the external event.
- Using portable equipment stored onsite that can provide power and water to the plant through various connection points.
- Using an offsite resource that will be made available within 24 hours.

US Industry Response to Fukushima Dai-ichi Accident (Continued)

Post-Fukushima Safety Enhancements at U.S. Reactors

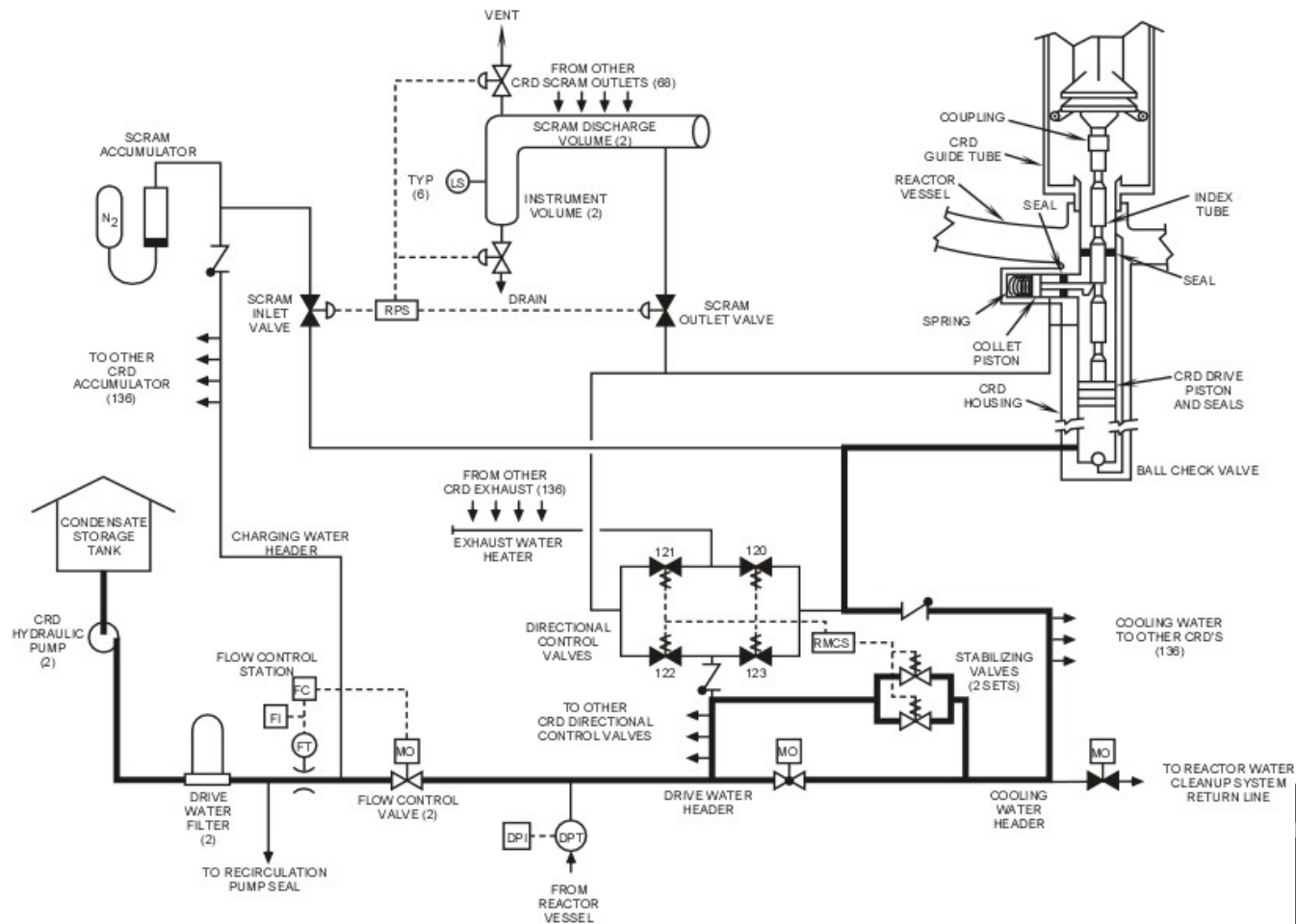


US Industry Response to Fukushima Dai-ichi Accident (Continued)



Maximizing Risk Reductions\Safety Gains from Plant Systems by Using Them for Purposes Beyond Their Original Intent

BWR – Control Rod Drive System (CRD)



Risk Reductions Achieved when Systems are Used Beyond their Original Intent (Past Experience)

BWR – Control Rod Drive System (CRD)

- Design Function: position control rods to change reactor power and rapidly shut down the reactor when required.
- Emergency Function: Inject water into the RCS during emergencies.
- Core Damage Frequency (CDF) with CRD: $\sim 2 \times 10^{-6}/\text{year}^{**}$
- Increase in CDF if CRD is unavailable: $\sim 4 \times 10^{-6}/\text{year}^{**}$

** The above numbers are approximate values for a BWR 3 with Mark I Containment. Numbers are highly plant-specific**

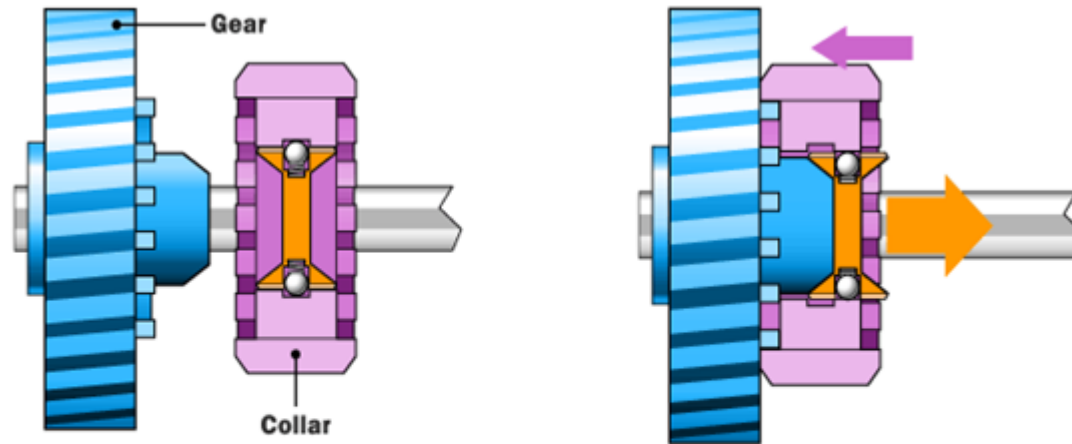
Potential CDF Reductions from FLEX (Some Future Indicators)

Sources: (1) Presentation from G. Krueger (NEI) at NEI Licensing Forum (2017)
(2) PSA 2017 paper, Arom Hakobyan & Craig Nerde (Dominion)

<u>Plant Type</u>	<u>CDF Reduction</u>
BWR Mark I	~ 2-32% (1)
BWR Mark II & III	~ 32-37% (1)
PWR (Surry)	~ 75% (2)

Importance of Synchronizing FLEX Strategies with Existing Systems\Procedures to Glean Additional Safety Benefits

Importance of Synchronizing



Synchronizing

- Systems Interfaces
 - Aligning FLEX ESW with normal ESW to support an emergency function
 - Aligning FLEX diesel to support safety-related bus
- Procedural Interfaces
 - Load Shedding

Some Areas of Potential Credit for FLEX in RIDM

- Incident Response (Management Directive 8.3)
- Significance Determination Process (SDP)
- Accident Sequence Precursor (ASP) Program
- Maintenance Rule 10 CFR 50.65
- Notices of Enforcement Discretion (NOEDs)
- License Amendment Requests

Some Completed Tasks

- Review of Tier 1 and Tier 2 of NEI 16-06
 - Tier 1 and Tier 2 - NRR Office Director (ML16167A034) (August, 2016)
- Review of Tier 3 of NEI 16-06
 - Tier 3 - publicly available memo (ML17031A269) (June 2017)
- Update to section 6 of Volume 1 of the RASP Handbook
 - Guidance on modeling FLEX in risk assessments (ML17192A441)
- Piloting SPAR Model Update

Ongoing Tasks

- Crediting FLEX in “Deterministic” LARs
- Support from Office of Nuclear Regulatory Research
 - Human Reliability Analysis (HRA) guidance and data
 - Updating the SPAR models
- Revision to NUMARC 93-01 (Maintenance Rule scoping criteria)
- Continuous Engagement of Regional Staff
 - SDPs, NOEDs, and MD8.3
- FLEX Data Collection
 - Data is collected through EPRI
 - Different from standard INPO process that we use
- Continue to Monitor Ongoing RIDM areas

Challenges

- Collecting FLEX related operating experience to develop equipment failure probabilities.
- Enhancing Human Reliability Analysis (HRA)
- Developing basis for Human Error Probabilities (HEPs).

CONCLUSIONS

- Use of FLEX strategies exclusively to mitigate BDBEE limits their potential contributions to public safety.
- Synchronizing FLEX strategies with existing systems is critical to glean additional safety benefits.
- NRC is using principles of RIDM to enable nuclear plants to maximize safety gains that can be gleaned from FLEX strategies.