SCHEDULING NOTE

Title: **BRIEFING ON THE STATUS OF LESSONS LEARNED FROM THE FUKUSHIMA DAI-ICHI ACCIDENT (Public Meeting)**

Purpose: To provide the Commission with a status of actions taken by the NRC and industry in response to lessons-learned from the Fukushima Dai-ichi accident, including a discussion of progress on Tier 1 activities, the status of resolving open Tier 2&3 recommendations.

Scheduled: **May 17, 2016**
9:00 a.m.

Duration: Approx. 3 hours

Location: Commissioners' Conference Room, 1st fl OWFN

Participants:	**Presentation**
External Panel	**40 mins.***
Anthony Pietrangelo, Chief Nuclear Officer, Nuclear Energy Institute Topic: • Industry progress on Fukushima lessons learned	10 mins.*
Ken Canavan, Director of Plant Technology, Electric Power Research Institute (EPRI) Topic: • EPRI technical research to address long-term Fukushima lessons learned	10 mins.*
Randy Bunt, Chairman of the BWROG Fukushima Response Committee, Southern Nuclear Company Topic: • BWR activities to complete Fukushima lessons learned	10 mins.*
Paul Gunter, Director, Reactor Oversight Project, Beyond Nuclear Topic: • NGO perspectives on NRC's Fukushima lessons-learned activities	10 mins.*
Commission Q & A	**40 mins.**

Break **5 mins.**

NRC Staff Panel **50 mins.***

Michael Johnson, Deputy Executive Director for Reactor and Preparedness Programs and Fukushima Steering Committee Chairman

Gregory Bowman, Deputy Director (Acting), Japan Lessons-Learned Division

Mohamed Shams, Chief, Hazards Management Branch, Japan Lessons-Learned Division

Jack Davis, Director, Japan Lessons-Learned Division, Office of Nuclear Reactor Regulation

Troy Pruett, Director, Division of Reactor Projects, Region IV

Topics:

- Progress on implementing Tier 1 recommendations
- Overview of staff's final assessment of Group 2 Recommendations
- Status update on Group 3 recommendations
- Plans for NRC oversight of post-Fukushima safety enhancements

Commission Q & A **40 mins.**

Discussion – Wrap-Up **5 mins.**

*For presentation only and does not include time for Commission Q & A's

Briefing on the Status of Lessons Learned from the Fukushima Dai-ichi Accident

Industry Progress

Tony Pietrangelo
Senior Vice President and Chief Nuclear Officer
Nuclear Energy Institute

Key Messages

- FLEX implementation largely complete in 2016
  - Pool instrumentation complete in 2016
  - BWR Mark I & II vents complete in 2018/19
- Continued focus on FLEX through inspections
- Support staff on disposition of Tier 2/3 actions
- Committed to complete majority of mitigation strategy assessments before NRC rulemaking
- NRC rulemaking aligned with significant efforts undertaken by industry/NRC

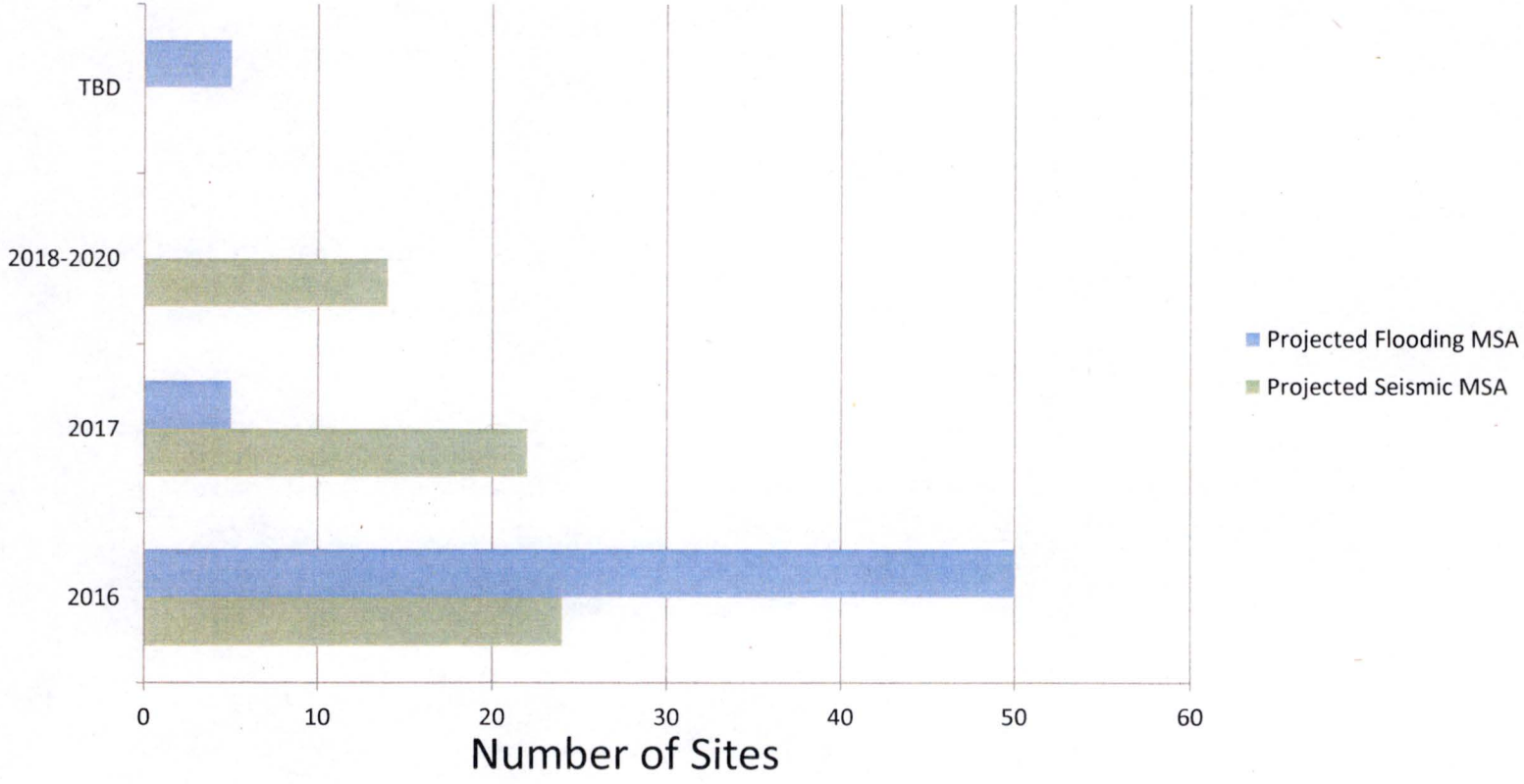
FLEX Implementation

Status	Units
Implementation complete	58
Implementation complete by Fall 2016	29
Implementation complete with the exception of severe accident capable vent	13

FLEX Inspections

- Focus of FLEX implementation shifting to inspections
- Critical importance of knowledge transfer between NRR and Regions
- Additional NRC staff becoming involved with beyond-design-basis events
- Industry task force established to promote consistency
- Lessons learned will be shared with industry and NRC
- Concern with potential for growth in inspection scope without careful NRC management oversight

Flooding and Seismic Mitigation Strategy Assessments (MSA)



*TBD – Majority awaiting FHRR acceptance letter

Seismic MSA for SPRA Sites

- Current focus area for industry and NRC
- Proposed MBDBE rule language sufficiently flexible to allow a risk-informed approach
- Utilize SPRA insights to assess potential for reduction of ELAP/LUHS risk
- Limited benefit of SPRAs for plants with mitigating strategies demonstrated effective using deterministic methods

Flooding Integrated Assessments

- NEI 16-05: External Flooding Assessment Guidelines - provided to the NRC for endorsement in April 2016
- Utilizes Mitigating Strategies for Local Intense Precipitation hazard
- No significant flooding risk reduction expected as a result of performing Integrated Assessments

Proposed NRC Rule for Mitigation Strategies

- Incorporates most important actions undertaken by industry and NRC since 2011
- Focus on codification of existing requirements, not imposition of new requirements
- Industry supports the issuance of this rule in 2017
- Key comments provided in February address implementation schedule, change control process, and the methodology to address reevaluated hazards

Summary

- Safety enhancements have been significant - based on well defined lessons learned from Fukushima
- Safety always has been and will continue to be our foremost priority
- 2016 is critical for completion of Fukushima actions
- Committed to maintain focus beyond 2016 to preserve the significant safety enhancements

Acronyms

- NRC- Nuclear Regulatory Commission
- NRR – Office of Nuclear Reactor Regulation
- MSA - Mitigation Strategy Assessment
- FHRR – Flooding Hazard Reevaluation Report
- SPRA – Seismic Probabilistic Risk Assessment
- MBDBE – Mitigation of Beyond-Design-Basis Events
- ELAP – Extended loss of AC Power
- LUHS – Loss of Ultimate Heat Sink

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Fukushima Daiichi
What have we learned?

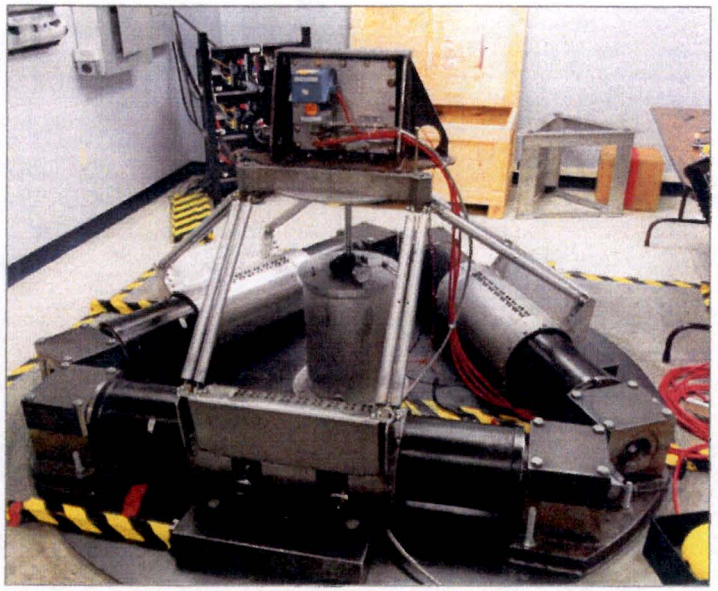
Ken Canavan
Director, Plant Technology

NRC Commission Briefing
May 17, 2016

EPRI Fukushima Research and Development

- **Immediate Response**
  - Water Treatment and Radiological Control
  - Spent Fuel Pool Analyses
- **Short Term Actions**
  - Severe Accident Management
  - Radiological Release Mitigation Strategies
  - Flooding and Portable Mitigation Equipment
  - Accelerated Seismic Research
- **Long Term Understanding**
  - Fukushima Technical Evaluation
  - Modular Accident Analysis Program (MAAP)
  - External Hazard Research
  - Other Accident Issues
  - Accident Tolerant Fuel

Accelerated and Long Term Seismic Research

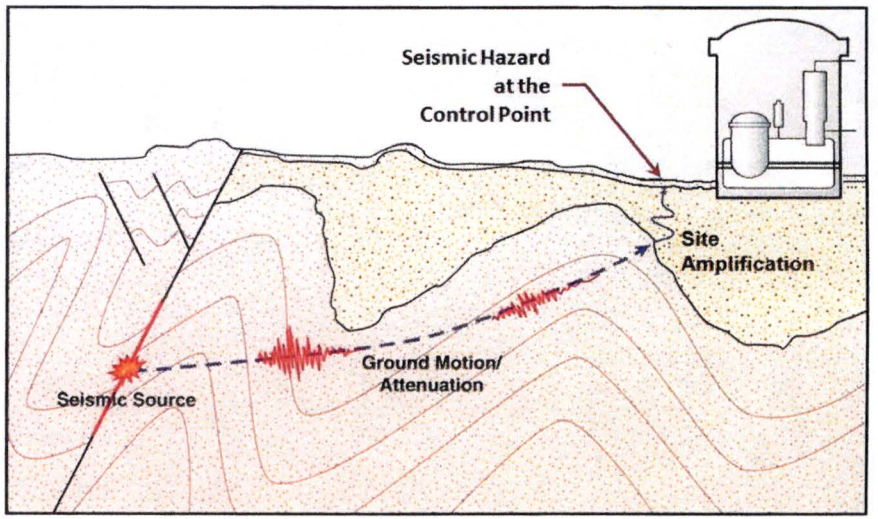


Seismic Risk Research

- Better understanding of seismic hazard
- Improved assessment of structural response
- Improved analysis of failure potential for structures and components ("fragility")
- Better modeling of impacts in risk assessments

Post-Fukushima Research

- Improved ground-motion models
- Extensive testing of components for sensitivity to high-frequency motion
- Evaluation of operating experience to inform seismic fragilities
- Probabilistic Risk Assessment (PRA) modeling of seismic effects and human reliability



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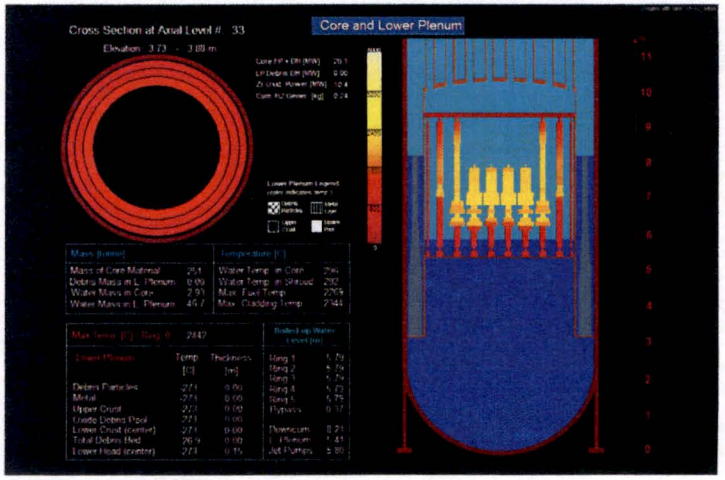
Fukushima Technical Evaluation

Objectives

- In-depth technical understanding of accident
- Sound basis for longer-term industry decisions
  - Enhanced analytical models for subsequent analyses
  - International benchmarking and gap analyses

Tasks underway

- Confirm and document event progression
- Compile and assess radiological transport and contamination data
- International benchmarking



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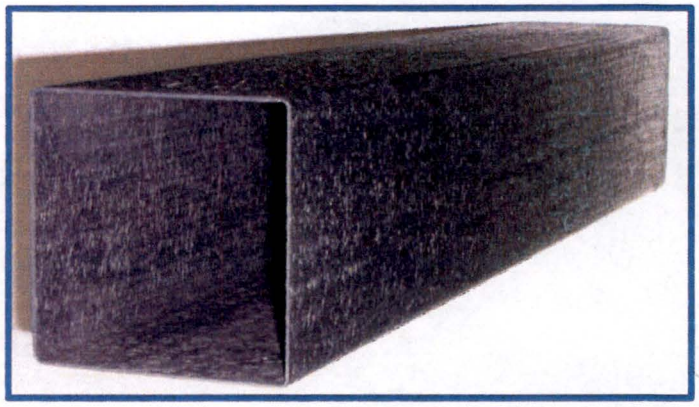
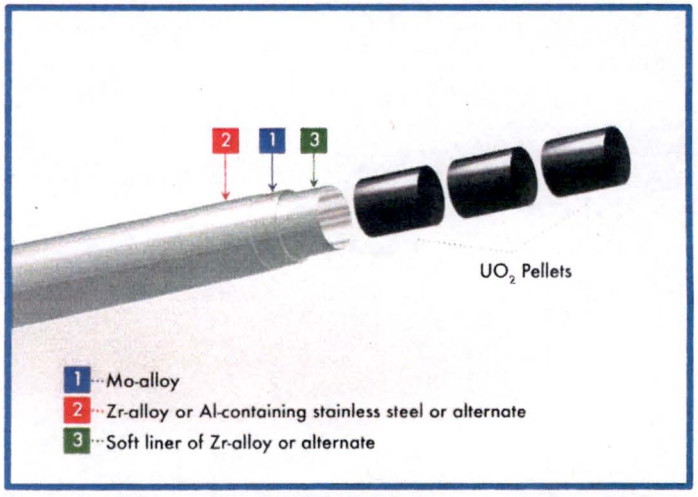
Accident Tolerant Fuel

- **Question:** what if there was no zirconium in the core?
  - Lower hydrogen production
  - Longer mitigation time
- **Research task:** evaluate the feasibility of concepts for fuel and core structures
  - Silicon Carbide BWR fuel channels
  - Molybdenum fuel cladding concepts
- **EPRI's role:** assist global collaboration to accelerate development



BWR Silicon Carbide Composite Channel



Molybdenum Alloy Fuel Cladding

Summary

- **A significant body of research and development has been completed in response to Fukushima**
- Key long term research and development activities
  - Severe accidents – continue to learn from Fukushima to
    - Inform the global understanding of severe-accident management
    - Improve the ability to predict outcomes to aid in event response
  - External events – continue developing methods for assessing external hazards to better understand and manage risks
  - Other areas – continue to developed a better understanding of
    - Interactions for events affecting multiple units at a site
    - Accidents that persist and evolve over longer periods
    - Human response and reliability

Much has been learned and implemented: the global nuclear industry is safer as a result

Together…Shaping the Future of Electricity

BWR Activities to complete Fukushima Lessons Learned

Randy Bunt (Southern Nuclear) – BWROG
Fukushima Response Committee Chairman

NRC Commission Briefing
May 17, 2016
Washington, DC

BWR OWNERS' GROUP

BWR Expertise – Proven Solutions

Topics

- Status of FLEX Strategies
- Status of Severe Accident Hardened Containment Vent System (HCVS) Hardware and Strategy
- Status of Emergency Operating Procedures, Severe Accident Mitigation Guidelines and Technical Support Guidelines (EOP/SAMG/TSG)
- Planned Actions for Mitigating Strategies Proposed Rule
- Summary

Note: No statement or information contained in this presentation shall be deemed to constitute a commitment, or change in a commitment made, on behalf of any utility.

BWR Status of FLEX Strategies

- Industry-wide, the US BWR fleet is expected to be materially complete on implementing FLEX Strategies by the end of 2016.
- The Mark I and II plants will enhance their FLEX capability with upgraded hardened wet well vents between 2016 and summer of 2018 per order EA-13-109 requirements.
- Approximately 1/3 of the BWR fleet will issue FLEX Final Integrated Plans (FIP) by the end of 2016. The remainder of the BWR fleet will submit following the completion of the NRC order EA-13-109 wet well vent enhancements at their site.
- 2 BWR plants are expecting FLEX inspections in Spring - Summer 2016. The remainder of plant inspections are expected to extend into 2018.
- BWR plants are working to the established timelines for Mitigating Strategy Assessments (MSA) of Flooding and Seismic using NEI 12-06, revision 2 guidance.
  - Flood MSA: most to complete in 2016 and remainder in 2017.
  - Seismic MSA: most to complete in 2017.

Severe Accident Hardened Vent

- US BWR Mark I and II applicable sites are implementing both hardware (phase 1) and strategy (phase 2) elements of the NRC order EA-13-109.
- The impacted BWRs will install wet well (hardware) enhancements by mid-2018.
- The impacted BWRs will implement the strategy for Severe Accident Water Addition and Management by the June of 2019 to comply with NRC order EA-13-109 phase 2.
  - The impacted BWR Units expect Staff Evaluations on the phase 2 Overall Integrated Plan (OIP) by summer 2016.
- The fleet expects order closure inspections to occur in 2018-2020.
  - OIPs, audits, staff evaluations and inspections are expected to be the durable record for closure of the order.

Status of EOP/SAMG/TSG

EOPs:

- BWR fleet has incorporated FLEX required actions concurrent with FLEX material completion by end of 2016.
- Full EOP upgrade to revision 3 is expected concurrent with SAMG commitment of June 2017, but majority of units are at revision 3 levels.

SAMGs:

- BWR owners committed to the NRC via letters in late 2015 to have SAMG revision 3 incorporated by June 2017.
- BWR units impacted by NRC order EA-13-109 require incorporation of the required items from revision 3 for phase 1 and severe accident water addition/management for phase 2.

TSGs:

- BWROG is hosting US workshops in 2016 and 2017 on use of TSG calculation aids. International workshops held in 2015 and more are planned for 2016.
- Latest TSG, with Fukushima lessons learned insights, was issued with revision 3 and is considered part of implementation of SAMG.

Planned Actions for MS Proposed Rule

- Expect BWR fleet will be implementing the MS Rule within the approved timeline consistent with the rest of the US nuclear fleet.
- Anticipated actions are as follows:
  - Anticipate documentation enhancements needed for the change of Extreme Mitigation Actions from 50.54(hh) to 50.155.
  - Develop and perform demonstrations on FLEX and procedure interactions in Emergency Preparedness arena.
  - Complete documentation on MS Rule elements based on previously completed Fukushima Task Force Items.

Summary

The BWR fleet will be materially complete with FLEX such that sites can mitigate Beyond Design Basis External Events by the end of 2016.

The BWR Mk I and II units are enhancing the capability to vent the wet well and manage water addition to protect containment in a beyond design basis or a severe accident event beginning in 2016.

The BWR fleet is expecting to respond to the ongoing efforts on the proposed MS Rule requirements and changes to the ROP for oversight of SAMGs consistent with the NEI and industry response.

Fukushima Lessons Unlearned for Defense-In-Depth:

Example of Regulatory Treatment of ^{131}Iodine Containment and Emergency Planning

Commission Briefing
U.S. Nuclear Regulatory Commission
May 17, 2016

Paul Gunter
BeyondNuclear.org

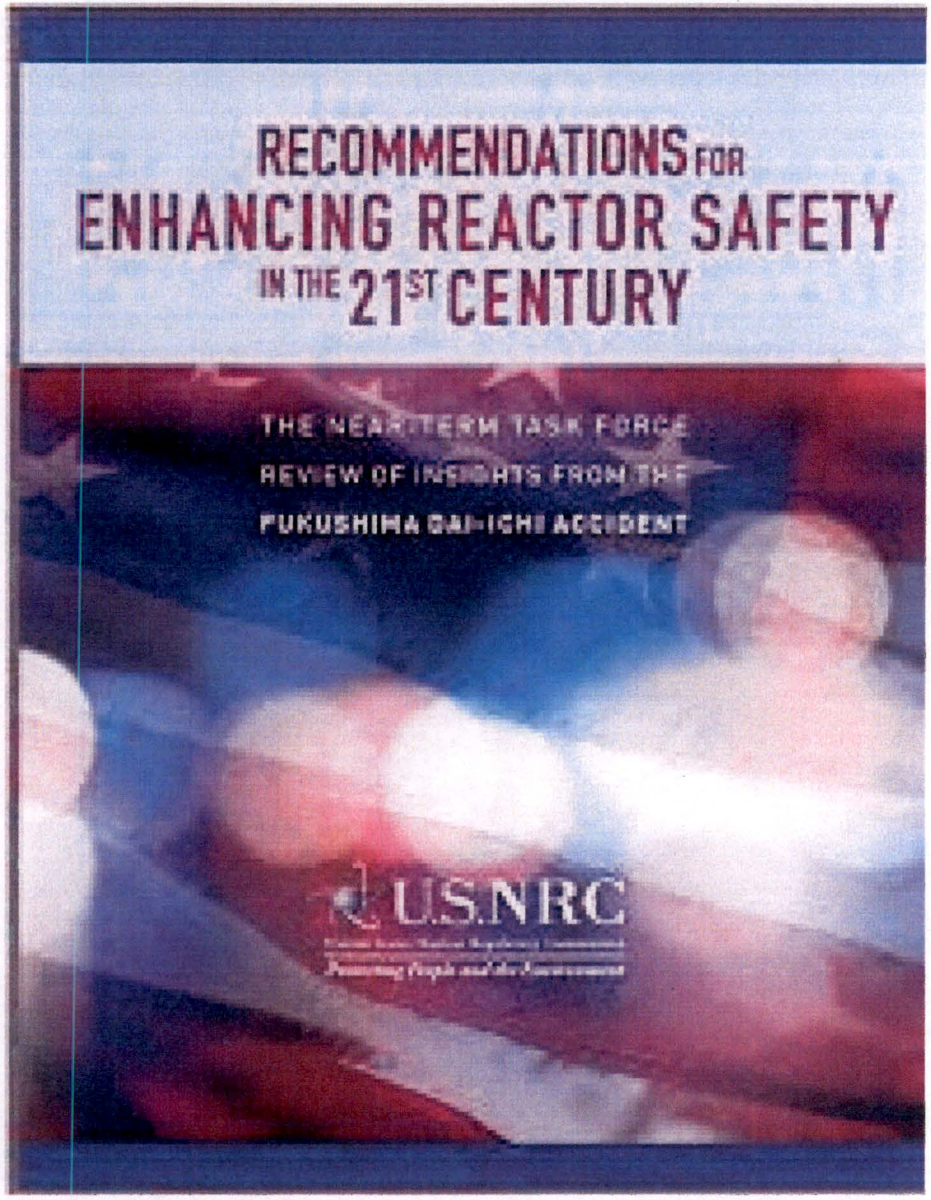
BEYOND NUCLEAR

Historically Unreliable Fukushima-Style Containment Systems [GE Mark I and II Boiling Water Reactors]

Focus on radioactive iodine released by severe accidents and sabotage

- ^{131} iodine radioactive half-life of 8 days and recognized as adverse risk to public health
- Filtration during reactor containment venting can reduce uncontrolled radioactive releases to the environment and population exposure
- Safe, effective prophylactic potassium iodide (KI) can be predistributed to protect the thyroid gland particularly young children

Post-Core Damage Containment Protection



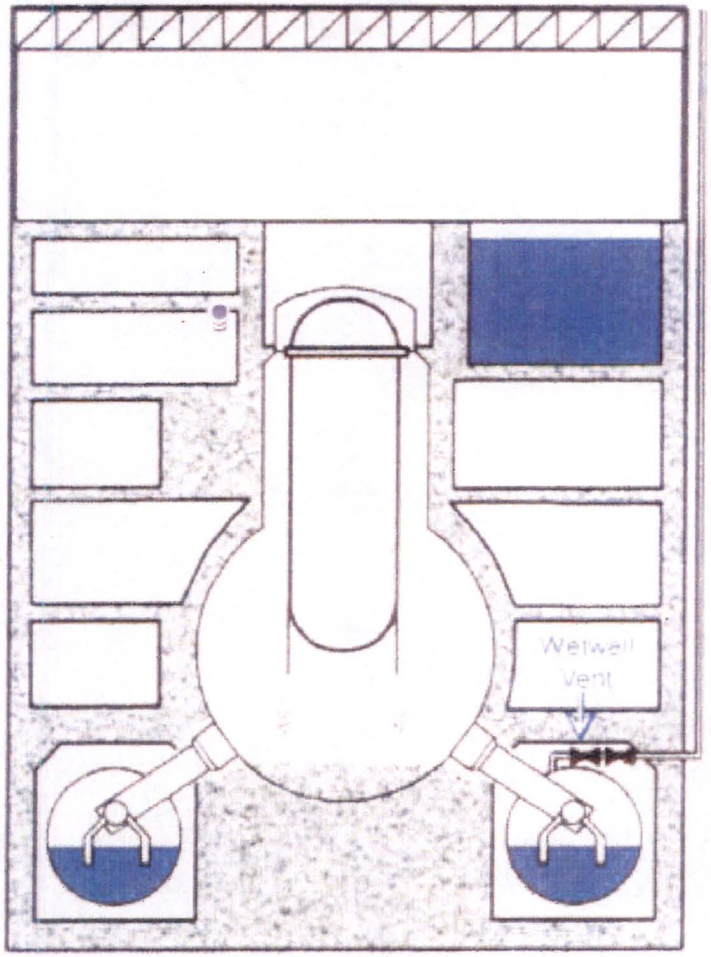
- ❑ **Commission rejects its staff recommendation to order external engineered filters on Hardened Containment Vents per SECY12-0157**
- ❑ **Commission abandons proposed rulemaking for Containment Protection and Release Reduction (CPRR) and staff effort to set performance criteria for Severe Accident Water Addition (SAWA)**

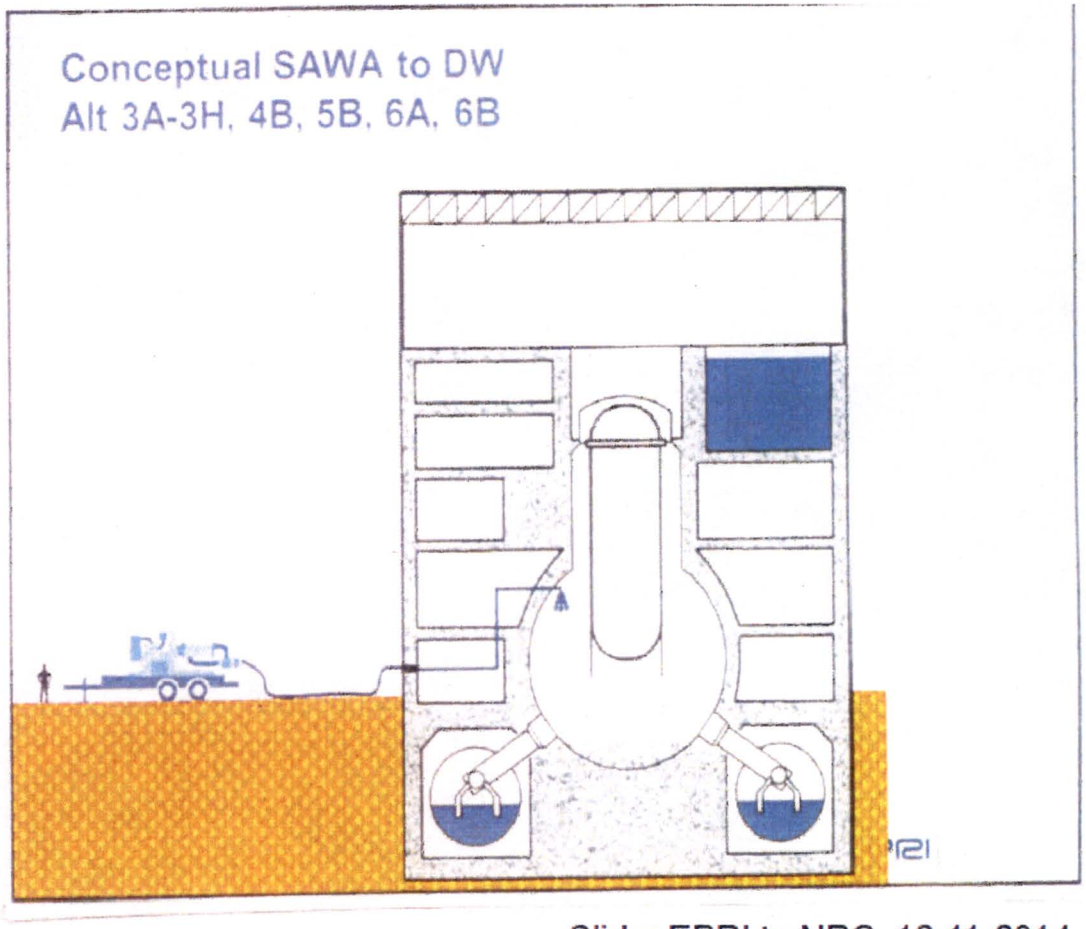
Base Case for NRC Enforcement Action (EA 13-109)

Phase 1 Hardened Containment Vent on the Wet Well

Phase 2 Severe Accident Water Addition into the Dry Well

Base Case – SAC WW Vent Only



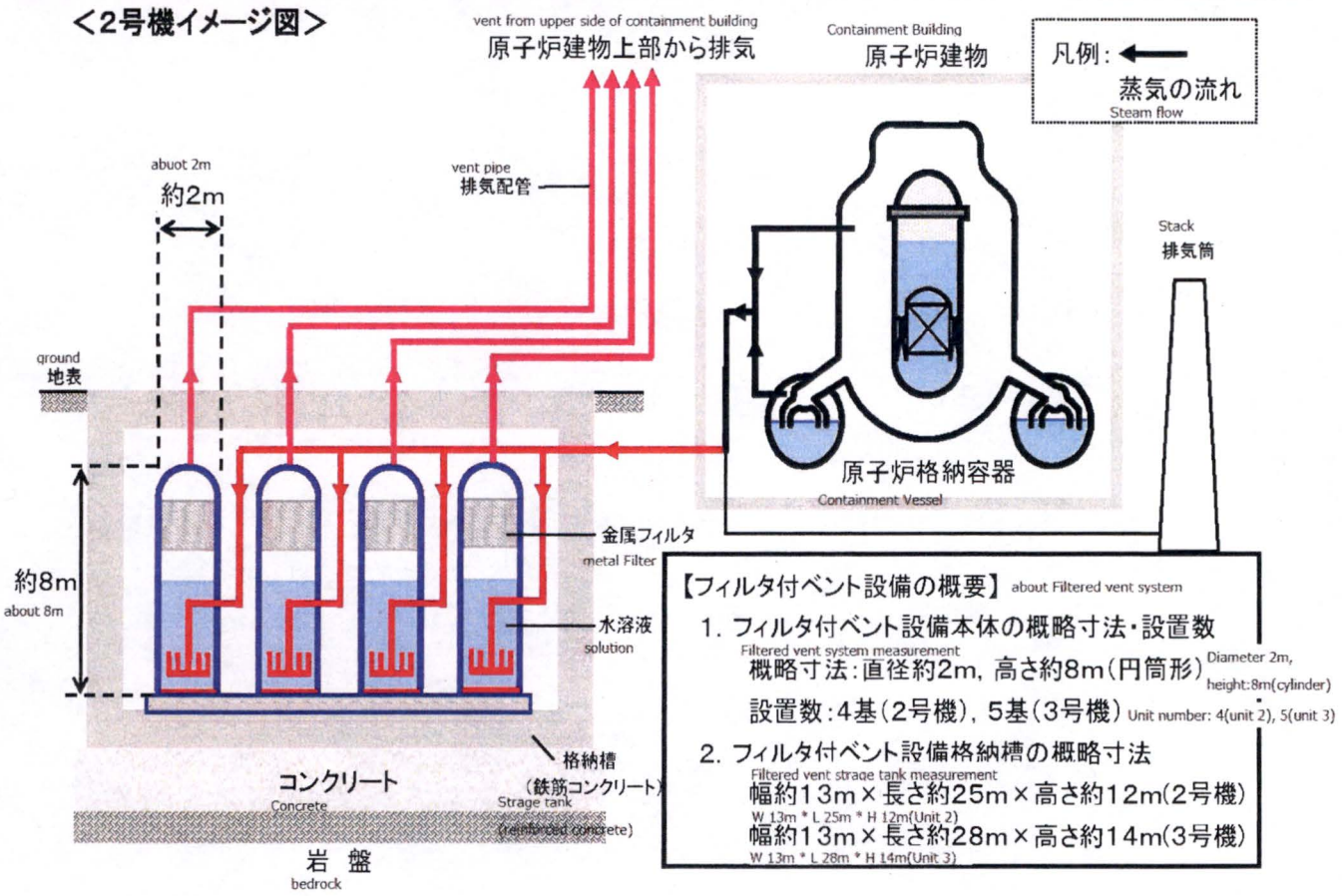


Slide: EPRI to NRC, 12-11-2014

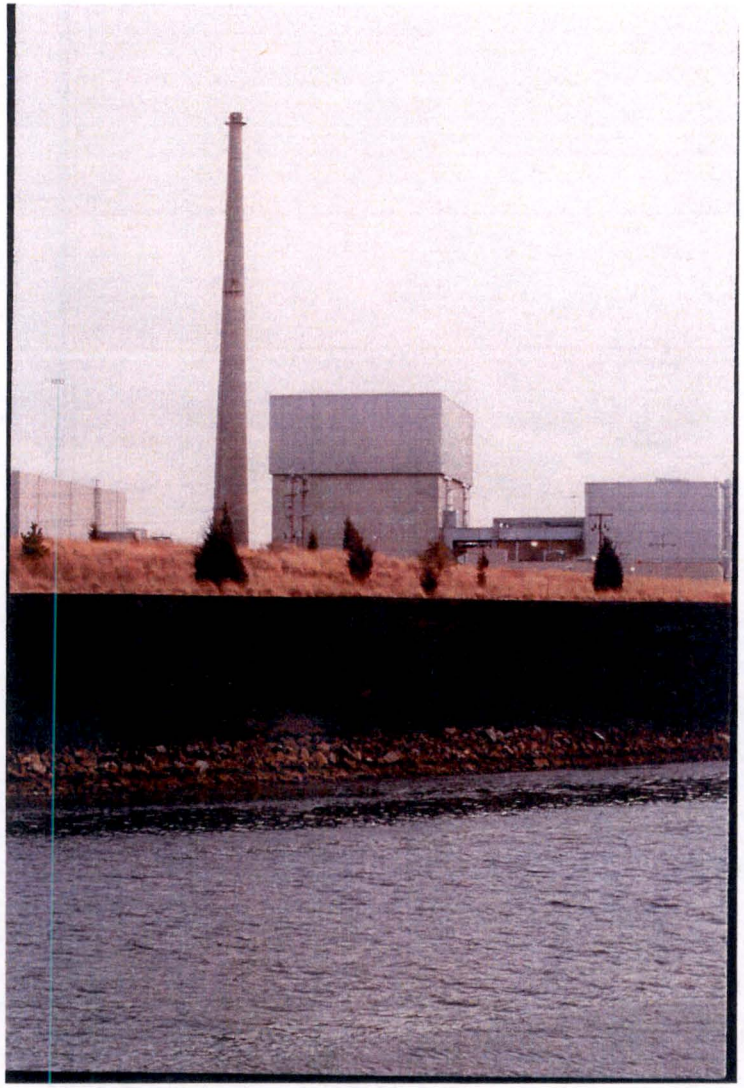
External Filtered Hardened Containment Vents are a prerequisite for reactor restarts in Japan

添付資料

フィルタ付ベント設備の概要

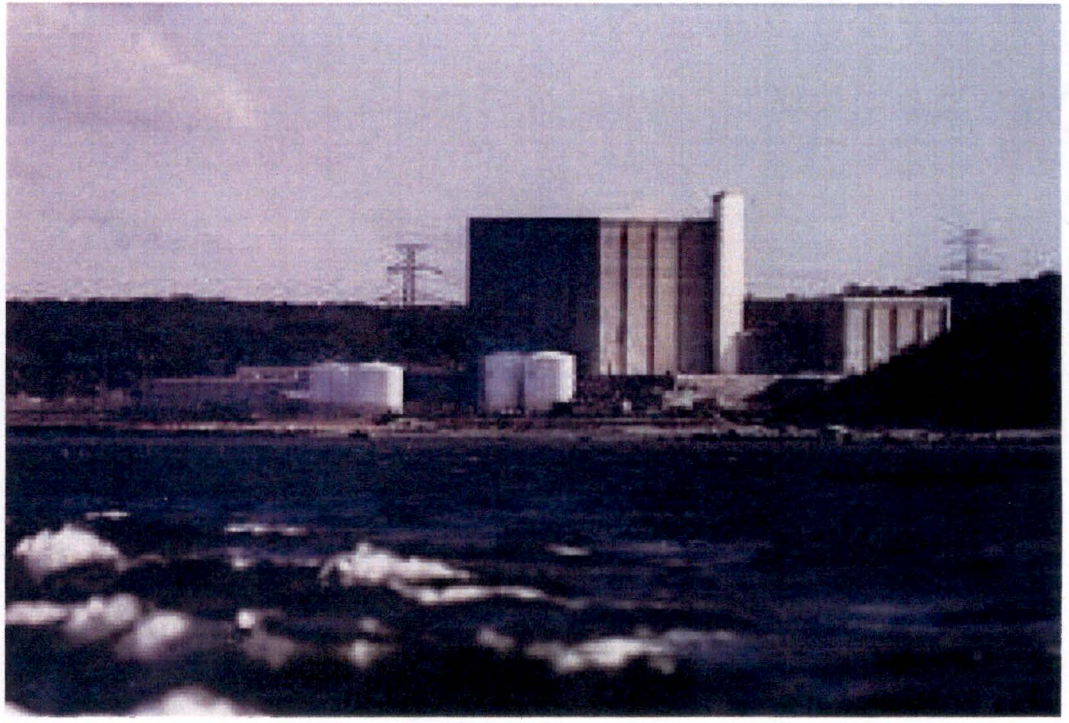


NRC grants "Extension to Comply" with EA 13-109



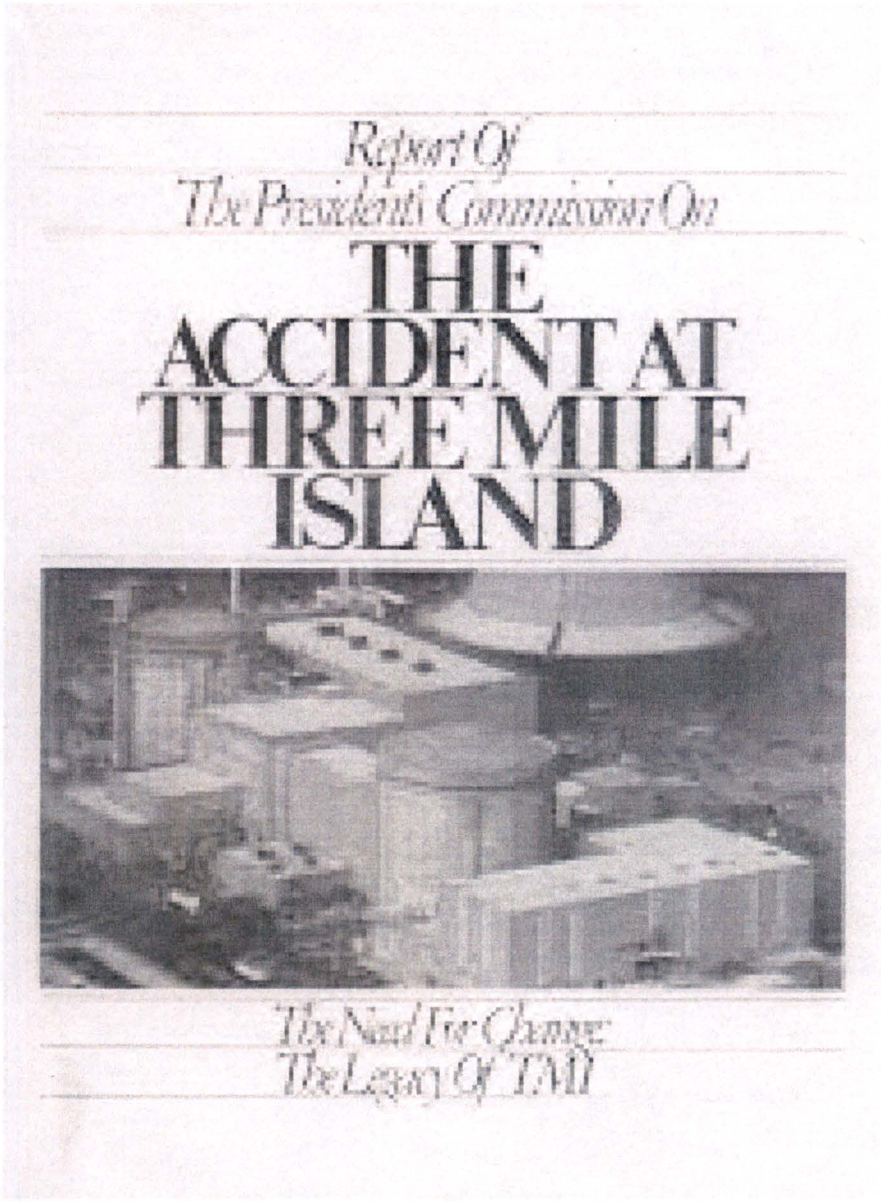
Oyster Creek, NJ

NRC waives enforcement of Order for world's first Fukushima-style reactor without a single public meeting (2015)



More waivers of Order anticipated

Emergency Planning and Radioactive Iodine



The potassium iodide lesson learned from Three Mile Island (1979)

Feb. 2016, Commission voted to not expand voluntary KI distribution despite inadequacies

AMA
AMERICAN MEDICAL ASSOCIATION

AMA Publication of Disaster Medicine and Public Health Preparedness (October 2012) "Nuclear Power Plant Emergency Preparedness Results from an Evaluation of Michigan Potassium Iodide Distribution Program"

- **25 of 34 eligible states participate in KI distribution within the 10-mile Emergency Planning Zone of nuclear power stations**
- **Michigan Department of Community Health surveyed residents in the state's three radiological Emergency Planning Zones finding that the current voluntary distribution plan to redeem vouchers for KI only "5.3% of eligible residences took advantage of the opportunity to secure a free supply of KI for their households."**

A Lesson Unlearned for the United States: NRC Failure to Act on Effective Prophylactic Protection with Potassium Iodide (KI)

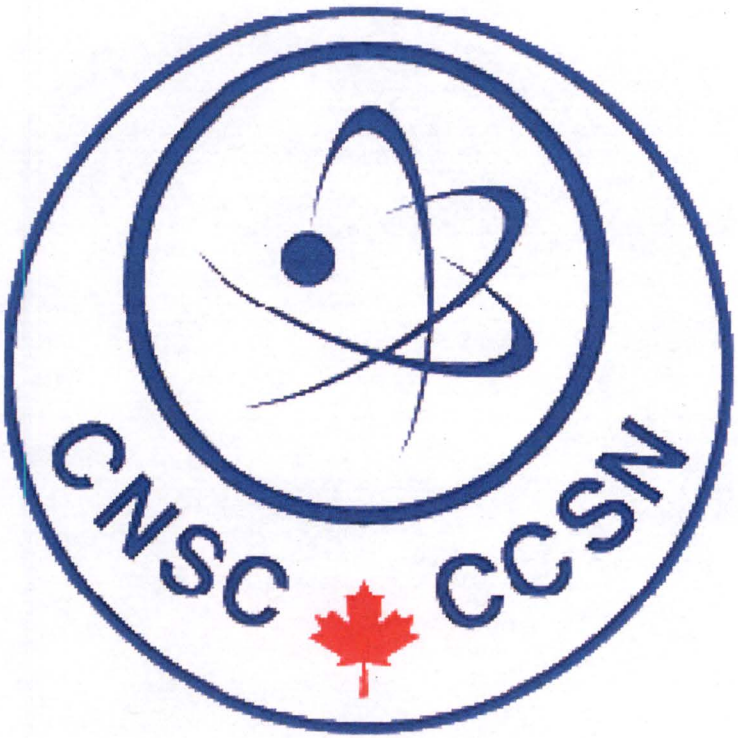
AMERICAN THYROID ASSOCIATION®

FOUNDED 1923

The ATA has recommended

- ❑ **Pre-distribution of KI by direct delivery to every resident within the radius of 50-miles of nuclear reactors**
- ❑ **Stockpiling KI in hospitals, police stations and fire departments within a radius of 200-miles of nuclear reactors**

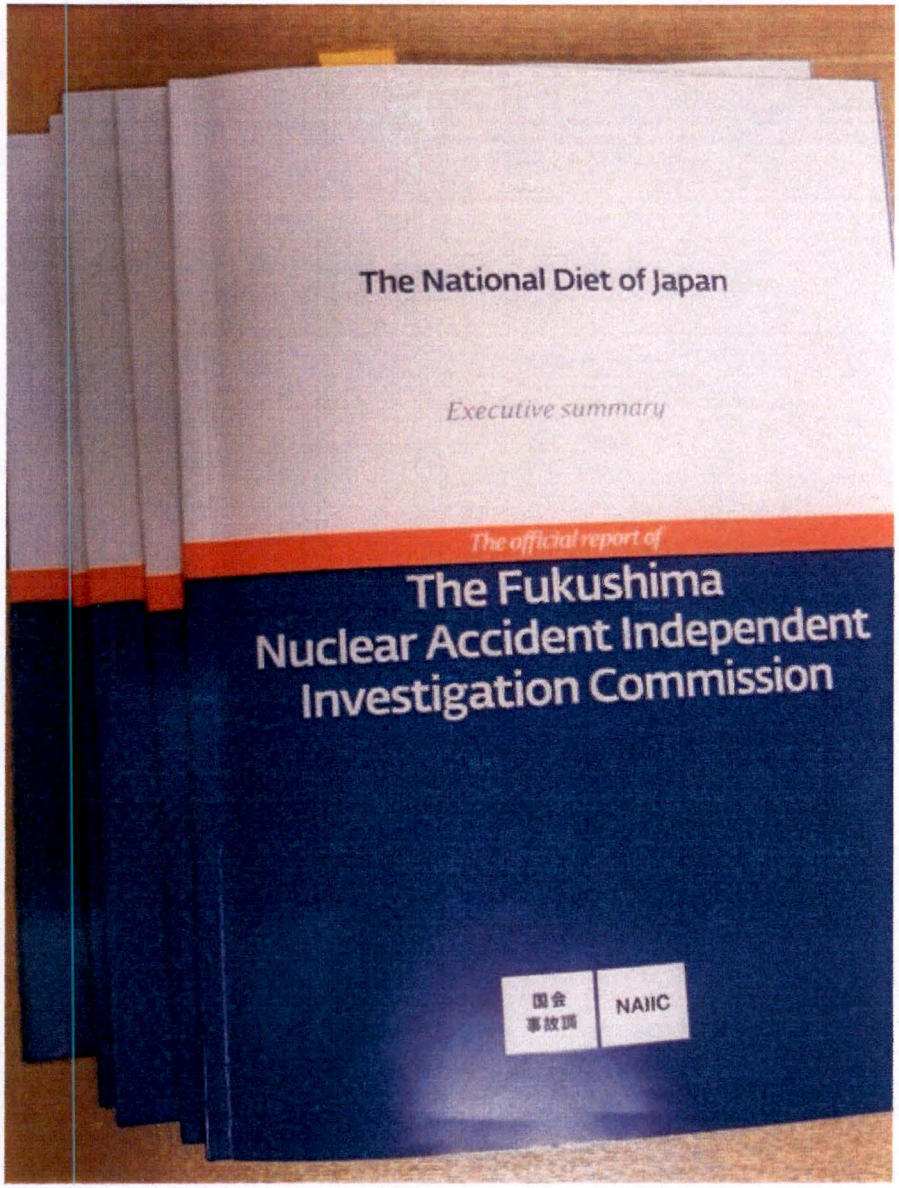
Canadian Nuclear Safety Commission



- December 31, 2015, CNSC required the completion of predistribution by direct delivery of KI to every resident within 6 miles of all Canadian nuclear power stations

- May 10, 2016, Canada expands public health awareness campaign for KI predistribution out to 31 mile radius of all nuclear power stations

Nuclear "regulatory capture"



Findings of Japan National Diet's independent investigation determined that Fukushima was "a profoundly manmade disaster" involving

- ❑ **"willful negligence"**
- ❑ **"regulatory capture"**
- ❑ **"collusion of government, regulator and TEPCO"**
- ❑ **"letting operators apply regulations on a voluntary basis"**

U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

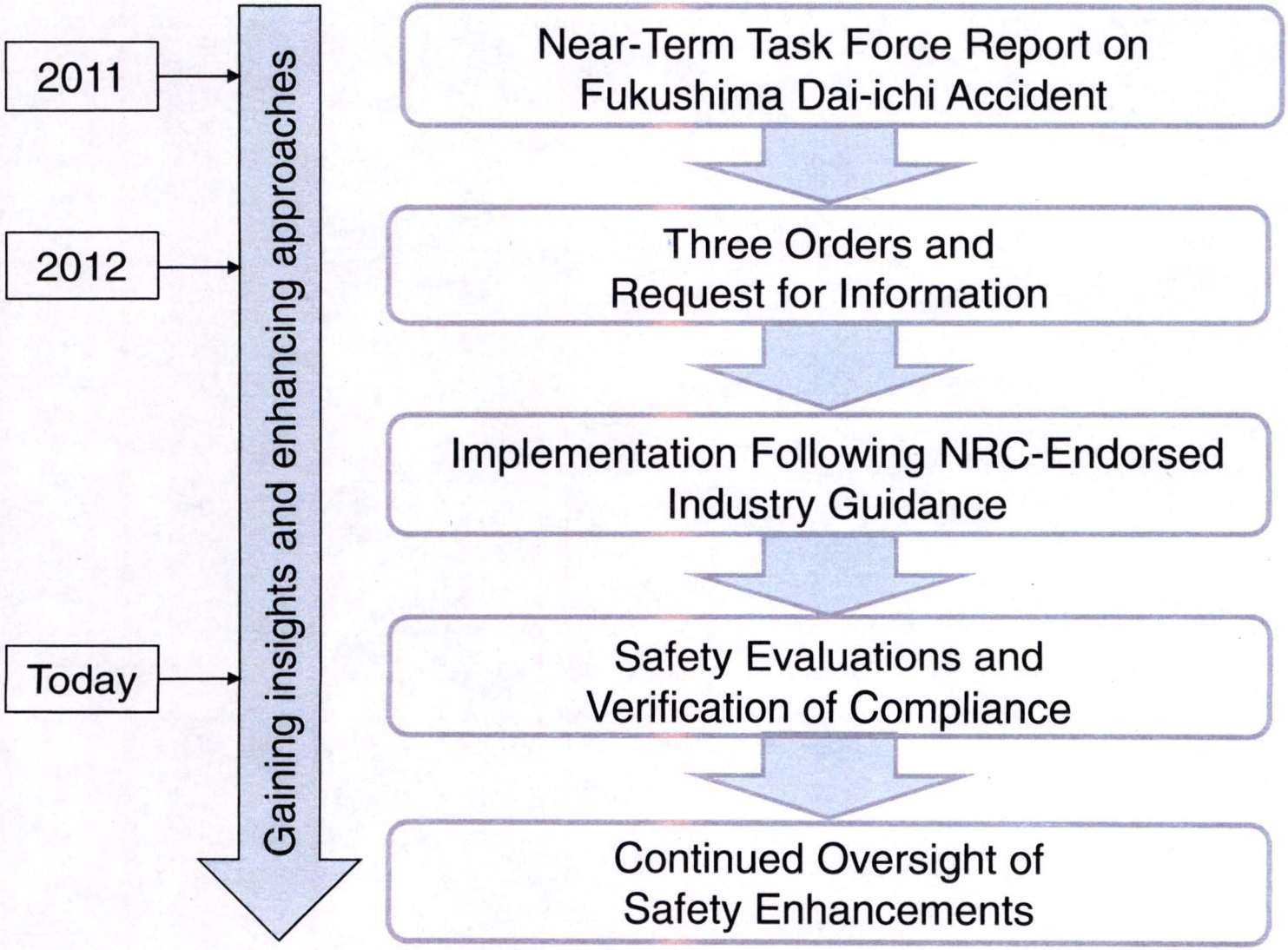
Briefing on the Status of Lessons Learned from the Fukushima Dai-ichi Accident

Michael Johnson

Deputy Executive Director for Reactor and Preparedness Programs

May 17, 2016

Evolution of Fukushima Activities



A Comprehensive Approach

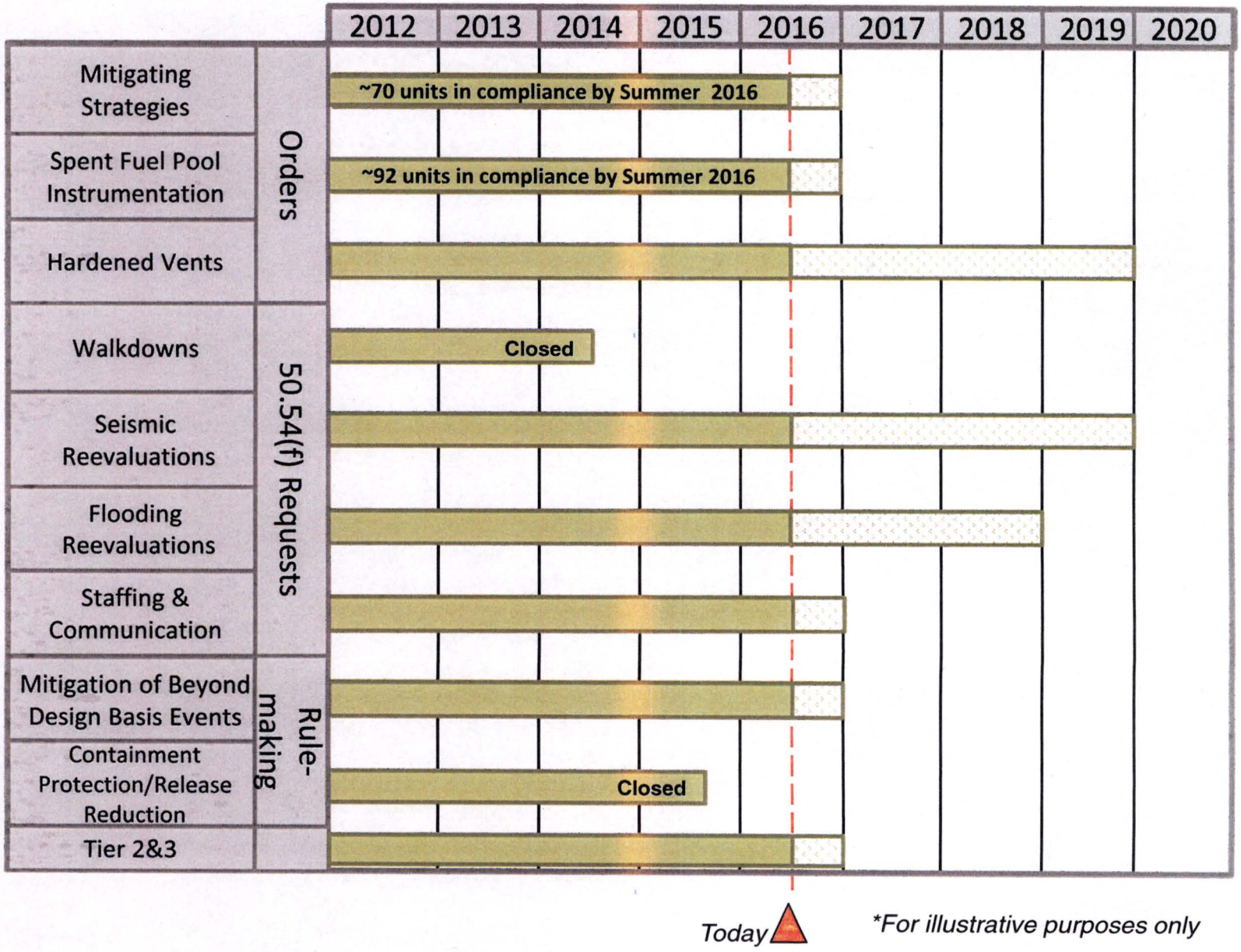
	Recommendation	Status
Ensuring Protection from External Events	2.1 – Reevaluation of seismic & flooding hazards	Ongoing
	2.2 – Periodic reconfirmation of hazards	Ongoing
	2.3 – Seismic & flooding hazard walkdowns	Closed
	Other – Reevaluate other external hazards	Ongoing
Enhancing Mitigation of Beyond-Design-Basis Events	4.1 – Mitigation of beyond design basis events rulemaking*	Ongoing
	4.2 – Mitigation of beyond design basis events order	Ongoing
	5.1 – Severe accident capable hardened vents order	Ongoing
	5.2 – Vents for other containment designs	Closed
	6 – Hydrogen control and mitigation	Closed
	7.1 – Reliable spent fuel pool instrumentation	Ongoing
	7.2- 7.5 – Spent fuel pool water makeup capability*	Ongoing
Strengthening Emergency Preparedness for Multi-Unit Events	8.1-8.4 – Onsite emergency response capabilities*	Ongoing
	9.1-9.4 – Rulemaking to enhance emergency plans*	Ongoing
	10.1-10.2 – Analyze and evaluate other EP considerations*	Ongoing
	10.3 – Evaluate ERDS capabilities	Closed
	11.2&11.4 – Decision-making and public education	Closed
Regulatory Philosophy	1 – Reassess regulatory framework	Closed
	12.1 – Include defense in depth requirements within ROP	Closed
	12.2 – Enhance staff training on severe accidents & SAMGs	Closed
Radiological Consequences	11.3 – Real time radiation monitoring within EPZ	Ongoing
	Other – Containment vent filters/filtering strategies	Closed
	Other – Expand EPZ size beyond 10 miles	Closed
	Other – Pre-stage KI to residents beyond 10 miles	Closed
	Other – Expedited transfer of spent fuel to dry storage	Closed

*Integrated into MBDBE rulemaking due by end of 2016

Speakers

- **Jack Davis, Director, Japan Lessons-Learned Division (JLD)**
  - **Overall Progress and Update on Tier 1 Activities**
- **Mohamed Shams, Chief, Hazards Management Branch, JLD**
  - **Seismic and Flooding Hazard Reevaluations**
- **Gregory Bowman, Deputy Director, JLD**
  - **Resolution of Tier 2 and 3 Recommendations**
- **Troy Pruett, Director, Division of Reactor Projects, Region IV**
  - **Long-term Oversight**

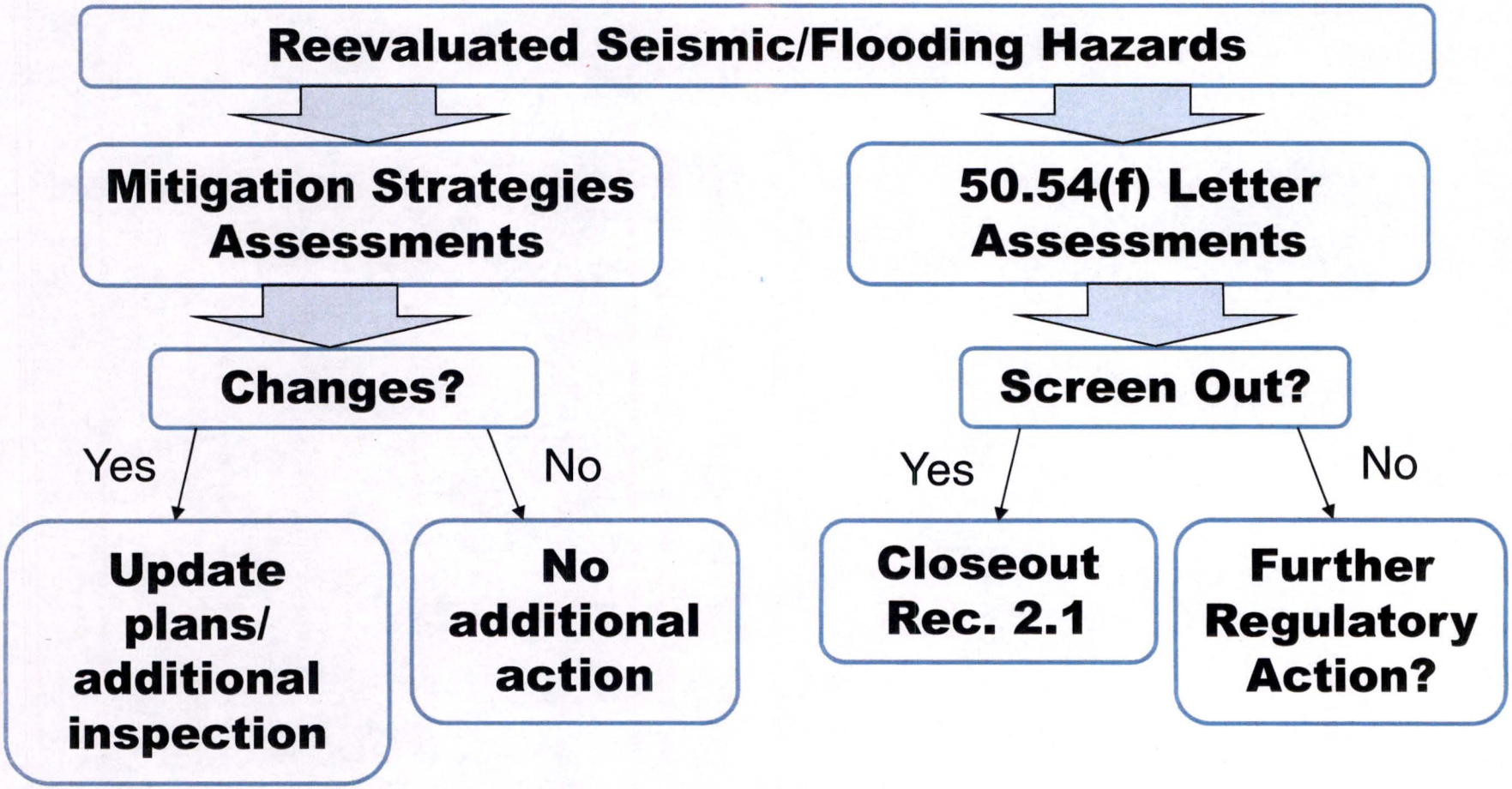
Implementation On/Ahead of Schedule



Comments Received on Mitigation of Beyond-Design-Basis Events Proposed Rule

- Improve clarity in the use of the term "loss of all ac"
- Remove requirement for multiple source term dose assessment
- Clarify use of risk insights for addressing reevaluated hazards
- Establish process to define when changes require prior NRC approval
- Allow flexibility with implementation timeframes

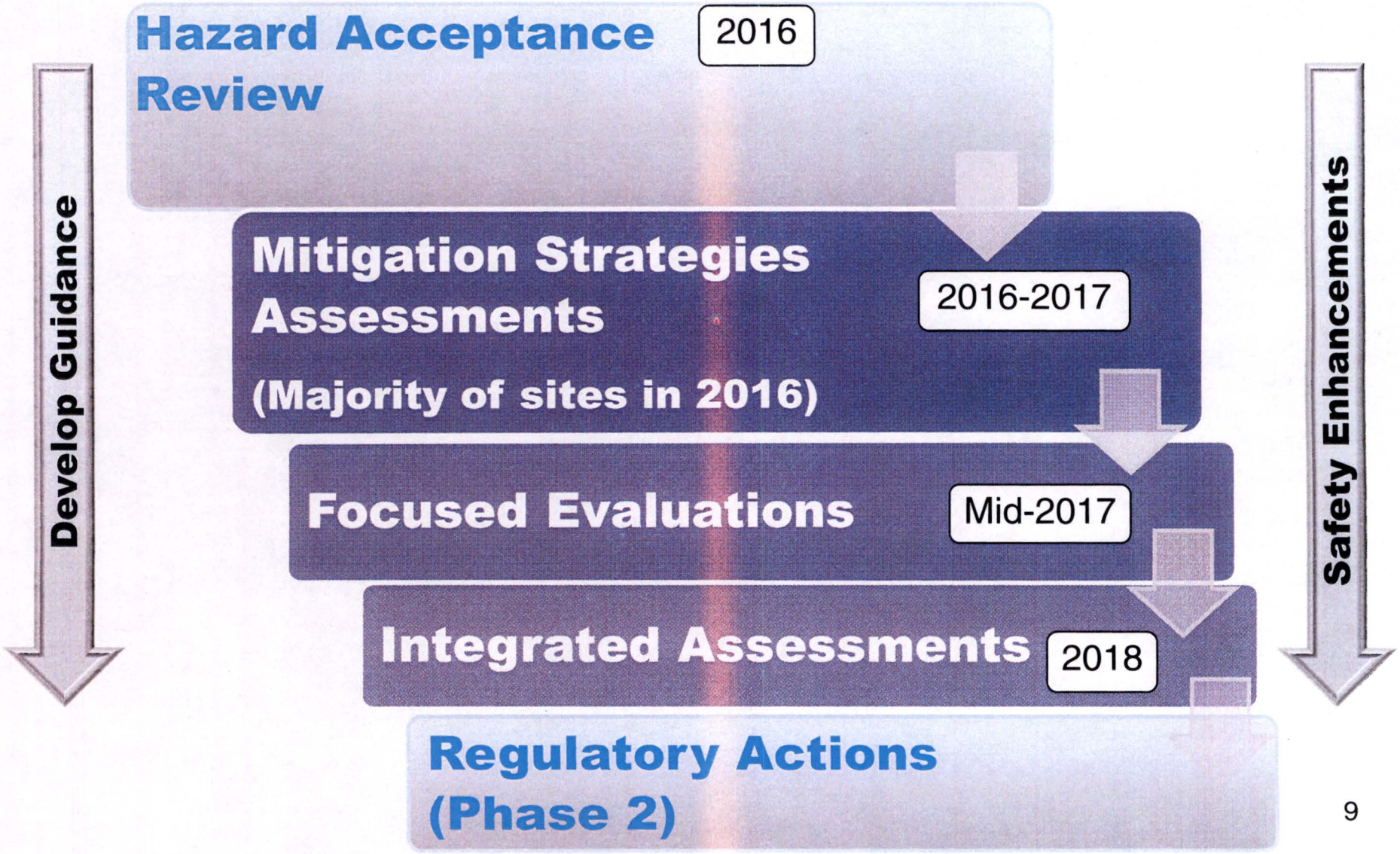
Closure of Seismic and Flooding Hazard Reviews



Significant Progress in Hazard Reevaluation

Seismic		Flooding	
Hazard Reevaluation Reports Received	(100%)	Hazard Reevaluation Reports Received	(93%)
Acknowledgement Letters Issued	(100%)	Hazard Acceptability Letters Issued	(84%)
Expedited Approach Received	(100%)	Interim Actions Received	(93%)
Expedited Approach Response	(97%)	Interim Actions Inspected	(85%)
Staff Assessments Issued	(95%)	Staff Assessments Issued	(25%)

Flooding Action Plan Implementation is on Track



Seismic Hazard Reevaluation is on Schedule

Status Summary of Tier 2 and 3 Recommendations

Resolved

3	Enhanced capability to prevent/mitigate seismically-induced fires & floods
5.2	Reliable hardened vents for other containment designs
6	Hydrogen control and mitigation inside containment or in other buildings
9.3	ERDS capability throughout accident (partial)
10	Additional EP topics for prolonged SBO and multiunit events (partial)
11	EP topics for decision-making, radiation monitoring, and public education (partial)
12.1	Reactor Oversight Process modifications to reflect Defense in Depth framework
12.2	Staff training on severe accidents and resident inspector training on SAMGs
-	Expedited transfer of spent fuel to dry cask storage
-	Revisit emergency planning zone size & pre-stage potassium iodide beyond 10 miles
-	Reactor and containment instrumentation
7.2 – 7.5	Spent fuel pool makeup capability
9.1/9.2	EP enhancements for prolonged SBO and multiunit events
9.3	Emergency preparedness (partial)
9.4	Improve ERDS capability
10	Additional EP topics for prolonged SBO and multiunit events (partial)
11	EP topics for decision-making, radiation monitoring, and public education (partial)
-	Reevaluation of external hazards other than seismic and flooding
2.2	Periodic confirmation of external hazards
11	EP topics for decision-making, radiation monitoring, and public education (partial)

Closed | Subsumed in Tier 1 | Further Assessment

Closed – Evaluation of Instrumentation Enhancements

ACRS: Assess need to enhance instrumentation to survive beyond-design-basis events

Tier 3 → Further staff study; dependent on higher-priority recommendations

Summary of Final Evaluation

- Tier 1 enhancements and existing requirements.
- Insights from MBDBE rulemaking analyses.
- Ongoing work to develop consensus standard.
- *Addressed comments from ACRS and stakeholders.*
- *Added information on SAMG principles/approaches.*
- ***Conclusion – No additional regulatory action necessary.***

Closed – Evaluation of Vents for Other Containment Designs

5.2: Reevaluate the need for hardened vents for other containment designs

Tier 3 → Dependent on insights from Tier 1 activities (Order EA-13-109 and related rulemaking)

Summary of Final Evaluation

- Significant information from previous/ongoing studies.
- EA-13-109 in progress for Mark I and II containments.
- Mitigating strategies for all containment designs.
- *Addressed comments from ACRS and stakeholders.*
- *Added insights from ongoing SOARCA study.*
- ***Conclusion – No additional regulatory action necessary.***

Closed – Evaluation of Hydrogen Control and Mitigation

6: Identify insights about hydrogen control and mitigation inside containment or in other buildings

Tier 3 → Dependent on insights from Tier 1 activities and further evaluation

Summary of Final Evaluation

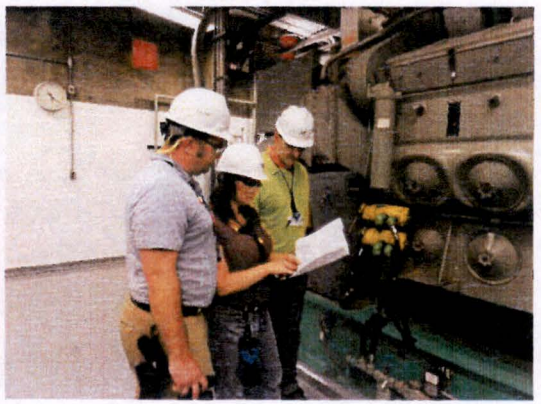
- Existing requirements in 10 CFR 50.44.
- Significant information from previous studies.
- EA-12-049 and EA-13-109 enhance safety.
- *Addressed comments from ACRS and stakeholders.*
- *Added insights from ongoing SOARCA study.*
- ***Conclusion – No additional regulatory action necessary.***

Group 3 Recommendations Are On Schedule

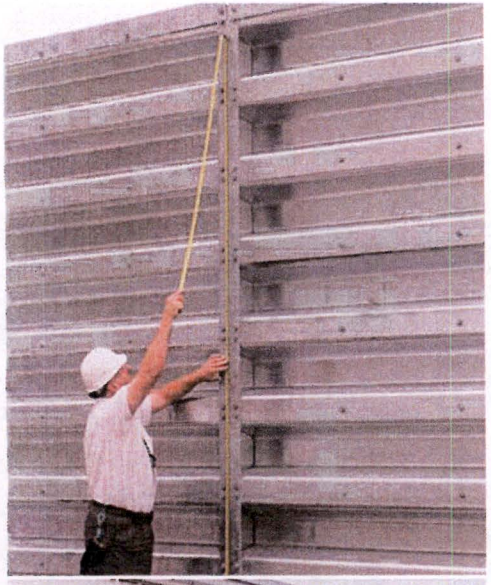
- **Ongoing analysis to address the following recommendations:**
  - **Evaluation of other external hazards**
  - **Periodic confirmation of external hazards**
  - **Real-time radiation monitoring in EPZs and on-site**
- **Results of external hazard screening to Commission by end of May 2016**
- **Goal to resolve all remaining Tier 2&3 recommendations by the end of 2016**

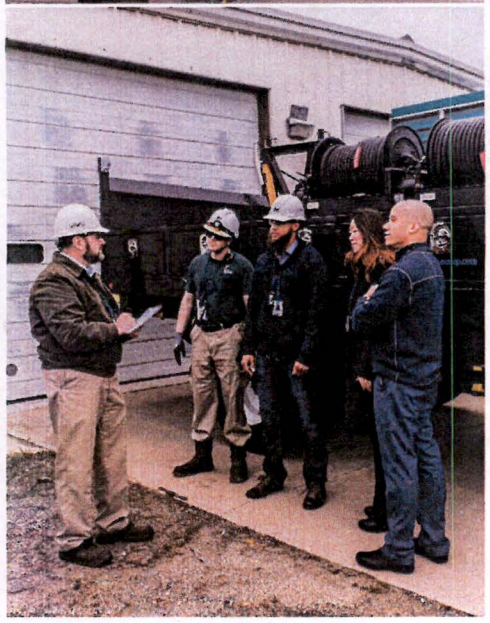
Post-Compliance Inspections

- NRC conducted on-site audits during evaluation of licensees' plans
- NRC safety evaluations capture staff's assessment
- Temporary Instruction 191 is being used to verify compliance



Results of Initial Inspections





- Temporary Instruction 191 results
- No findings of significance identified
- Issues addressed in corrective action programs
- All issues discussed with cross-regional panel
- Inspection activity increases in 2017

Future Oversight Plans

- Transition plan has been crafted
- Continue to develop and use normal agency processes
- Address lessons learned from Temporary Instruction 191 inspections
- Collaboration on training and information sharing
- Finalize oversight program for National SAFER Response Centers and Severe Accident Management Guidelines

Path Forward for Completing Lesson-Learned Initiatives

- **Significant progress has been achieved**
  - **Majority of safety benefit will be in place by end of 2016**
- **Additional work is needed to closeout Fukushima lessons learned**
- **Continued engagement with stakeholders**
- **Consistent with international community**

Acronyms

AC	Alternating Current	KI	Potassium-Iodide
ACRS	Advisory Committee on Reactor Safeguards	MBDBE	Mitigation of Beyond Design Basis Events
CEUS	Central and Eastern United States	NRC	Nuclear Regulatory Commission
CFR	Code of Federal Regulations	ROP	Reactor Oversight Process
EA	Enforcement Action	SAMG	Severe Accident Management Guidelines
EP	Emergency Preparedness	SAFER	Strategic Alliance for FLEX Emergency Response
EPZ	Emergency Planning Zone	SBO	Station Blackout
ERDS	Emergency Response Data System	SOARCA	State-of-the-Art Reactor Consequence Analyses
JLD	Japan Lessons-Learned Division	WUS	Western United States