

COMMISSION BRIEFING SLIDES/EXHIBITS

**BRIEFING ON THE STATUS OF LESSONS
LEARNED FROM THE FUKUSHIMA DAI-ICHI ACCIDENT**

AUGUST 7, 2012

***NRC Commissioner Briefing
on Fukushima
Nuclear Utility Status Report***

August 7, 2012

Jim Scarola, Co-Chairman
Industry Fukushima Response
Steering Committee

Response Plan

The Way Forward

- Coordinate the technical capabilities in support and response to the event
- Remain focused on daily operational excellence to avoid inappropriately displacing all other initiatives
- Validate existing beyond-design basis event response capabilities
- Improve safety by developing and applying lessons

Industry Engagement

- INPO – support / sequence of events / lessons learned / operational initiatives
- EPRI – technical analysis / technical strategies / technical solutions
- OEMs & Owners Groups – operational strategies specific to design
- NEI – design changes / prioritization / stakeholder communication and coordination
- Utilities – all of the above and timely execution

Major Accomplishments

- B.5.b equipment readiness affirmed by inspection and test
- Initial inspections completed for flooding and seismic vulnerabilities
- Station blackout procedures and equipment readiness validated
- Periodic maintenance and drills verified to exist or established

Major Accomplishments

- Fuel pool monitoring enhanced
- Design features and procedural guidance for station response to loss of AC power validated
- FLEX equipment specified and purchased
- Industry response protocol issued

Major Work in Progress

- Regional response capability proposals in review
- Flooding guidance established / training conducted / walk-downs have commenced
- Seismic guidance established / training conducted / walk-downs have commenced

Major Work in Progress

- Flooding and seismic design update scope and methodology in development
- EP rule actions progressing on schedule
- Integration of EOPs, SAMGs, EDMGs and FLEX in development
- Fuel pool level instrumentation in design
- Continuing to assess organizational lessons

Remaining Issues

- Loss of Ultimate Heat Sink - downstream dam failure analysis in or out of flooding scope
- Defined process for assessing the impact of new seismic and flooding hazards on the plant licensing basis

Remaining Issues

- Severe accident mitigation and subsequent filtering strategies
- 10 year design basis update vs. driven by significance and availability of new information

Delivering On Improved Safety

- Initiatives outside Fukushima should not be uniformly relegated to a lesser priority – operator fundamentals / fire protection / material management / security / etc.
- Execution activities are in the field and must continue to be well-managed to avoid unintended consequences

Delivering On Improved Safety

- Lessons have a collective benefit and burden; most benefit is obtained in actions already underway
- Scope control is required to execute current initiatives and rulemaking on a reasonable schedule
- Completion strategy must be defined to transition to the new normal
- Steering committees have been very effective and should continue

Acronyms

- **FLEX** – A phased strategy inclusive of diverse and flexible equipment to mitigate the impact of extreme events
 - Enhances capability to prevent fuel damage with the complete loss of electrical power
 - Multiple sets of reasonably protected portable equipment to provide
 - Coolant to reactor & spent fuel pool
 - Containment Integrity
 - Power critical instrumentation
 - Off-site support centers

Acronyms

- INPO – Institute of Nuclear Power Operations
- EPRI – Electric Power Research Institute
- OEM – Original Equipment Manufacturer
- NEI – Nuclear Energy Institute
- EOP – Emergency Operating Procedure
- SAMG – Severe Accident Mitigation Guideline
- EDMG – Extreme Damage Mitigation Guidelines
- B.5.b – Section of security order issued following 9/11/01 terrorist events

Fukushima Reactor Operator Impacts

August 7, 2012

Casey Pfeiffer

President, PROS

PROS Introduction

- ***PROS (Professional Reactor Operator Society)***
- ***Our mission is to serve individuals involved with safe nuclear operations. The society will work to communicate and promote the knowledge and professional values of our members, and to offer constructive input to the regulatory process on issues related to Operators.***

Current Operator Impacts

- ***Training***
 - ***Fukushima Recommendations along with INPO CPE have already led to more focus training on Multiple Events.***
 - ***Recommendations 8.1 and 8.4 for EOPs, SAMGs, and EDMGs will have major effects on Operators.***

Current Operator Impacts

- ***Training (cont.d)***
 - ***Operators attend training 5 to 6 weeks a year***
 - ***Too much focus on Fukushima Recommendations could lead to issues with Operator Proficiency on higher probability events.***
 - ***PROS recommends a balance of training time.***

Current Operator Impacts

- ***Training (cont'd)***
 - ***Additional training since Fukushima has helped Operators discuss possibility of Beyond Design Basis Events***

Current Operator Impacts

- ***Training (cont'd)***
 - ***4 Events since Fukushima that have challenged operators***
 - Browns Ferry Tornadoes***
 - Fort Calhoun Flooding***
 - North Anna Earthquake***
 - Byron (Loss of Off-site Power)***

Current Operator Impacts

- ***Operator Staffing Plans***

- ***Recommendation 9 states that facility emergency plans address prolonged Station Black Out.***

- ***Utilities need to have plans for Operator/Maintenance staffing beyond immediate EP responders.***

Future Operator Concerns

- ***Equipment Costs***
 - ***PROS concerned the NRC mandated Fukushima improvements may redirect limited resources away from existing programs, modifications, and upgrades requested by Operators.***

Future Operator Concerns

- ***Surveillance Requirements for New Equipment***
 - ***New equipment will have Surveillance needed to be performed to ensure they are ready to work which will cause extra burden at some plants due to staffing challenges.***

Future Operator Concerns

- ***New Equipment and Modifications Effects on Current Plant Design***
 - ***PROS is concerned that plant modifications and new equipment installation to meet Fukushima requirements could create unanticipated problems for Operators.***

Future Operator Concerns

- ***New Equipment and Modifications (cont'd)***
 - ***Examples of Modification that have already effected Operators***
 - ***Flood Barrier for Pump***
 - ***Delay Barriers for Reactor Trip Breakers***

Conclusion

- ***Operators only seeing the beginning of Fukushima recommendations***
- ***PROS agrees the recommendations will be an improvement to safety margin at US facilities***

Conclusion

- ***Current Operator Impacts***
 - ***Training***
 - ***Operator Staffing***
- ***Future Operator Concerns***
 - ***Equipment Cost***
 - ***Surveillance Requirement***
 - ***Modification effect on Current Plant Design***

Conclusion

- ***Operator Unique Perspective***

Impacts on Reactor Operators from Fukushima Lesson Learned Activities

Introduction

PROS – The Professional Reactor Operator Society currently has approximately 600 members.

Our mission is to serve individuals involved with safe nuclear operations. The society will work to communicate and promote the knowledge and professional values of our members, and to offer constructive input to the regulatory process on issues related to Operators.

To carry out this mission, the Professional Reactor Operator Society will engage in the following activities:

- Give voice to our members' professional ideas.
- Exchange technical information concerning operation practices, Operator training, and individual license regulation.
- Communicate professional values held by our members.
- Meet with the U.S. Nuclear Regulatory Commission to provide Operator viewpoints and input on related topics.

Current Operator Impacts

Training- The Fukushima Recommendations along with INPO Crew Performance Evaluation changes have already led to more focus on Multiple Events in Training. Recommendation 8.1 and Recommendation 8.4 will affect Operators in a major way. The incorporation of the EDMGs, SAMGs, and other mitigating procedures into the EOPs (Emergency Operation Procedures) will require significant training time to achieve Operator proficiency. Also, the NRC has ordered licensees to modify EOP technical guidelines per Recommendation 8.1, the changes in technical content of EOPs will also lead to more Operator Training to become proficient.

Operators already attend training 5 or 6 weeks a year (approximate 12% of our work time). With all of the other training requirements and commitments these training weeks are already quite full. One option could be additional training time, but due to the Nuclear Fatigue Rule, any lengthened training could result in some plants not able to adequately fill their normal shift rotations. Also, too much focus on the Fukushima recommendations would result in less training in other areas (Systems, AOP, EOP, etc). PROS is concerned that excessive training on extremely low probability events could degrade Operator proficiency on higher probability events, which could create bigger problems should one of these higher probability events occur. PROS would recommend that a balance of training time be maintained between the Fukushima type events and other required training.

The additional training that Operators have seen since Fukushima has helped Operators understand and discuss the reality of Beyond Design-Bases events occurring. Since Fukushima, nuclear power plants in the US have seen four events that have challenged Operators. In each of these four events, the operators have responded appropriately and have successfully handled the event. The four events were:.

- Browns Ferry Tornadoes
- Fort Calhoun Flooding
- North Anna Earthquake
- Byron LOOP

Operator Staffing Plans – Recommendation 9 says the facility emergency plans address prolonged SBO (Station Black Out) and multiunit events. This will have an effect on Operators since utilities need to have plans for post-event staffing that go beyond the immediate EP responders. These plans need to include Operators and others who will be implementing the mitigating strategies, and to provide for relief and resting periods.

Future Operator Impacts/Concerns

Equipment Costs

PROS has a concern that the NRC mandated Fukushima improvements may redirect limited resources away from existing programs, modifications, and upgrades requested by Operators. Operators know that plant resources are not infinite, and resources applied to Fukushima recommendations will likely come from programs Operators would consider a higher priority. This in turn could lead to equipment reliability issues that could cause more plant transients and plant shutdowns.

Surveillance Requirements for New Equipment

Some U.S. nuclear facilities are currently facing Operator staffing challenges. The new equipment acquired to meet the Fukushima recommendations (Extra Generators, Pumps, etc.) will have to be tested and maintained, even if it is never used, which will just add to the workload of the existing plant staff. This could limit the amount of time field operators or control room operators have to perform normal daily operational tasks.

New Equipment and Modifications Effects on Current Plant Design

PROS is concerned that plant modifications and new equipment installation to meet Fukushima requirements could create unanticipated problems for Operators. Although designed to function in specific conditions, new equipment can, and has, interfered with Operators performing unrelated tasks during routine operations and post-accident situations. Examples include:

- At one station, flooding barriers were built that inhibit access to thermal barrier booster pumps. These pumps would supply cooling water to reactor coolant pumps in the event normal seal cooling is lost, and are used in EOPs.
- At another station, delay barriers installed on plant stairwells to meet NRC-required anti-terrorist security measures also delay Operators moving about the plant. An Operator on the wrong side of one or more of these barriers will take longer to perform post-event mitigating functions such as locally opening Reactor Trip Breakers during an ATWS, or other time-critical Operator Actions required to meet accident analysis assumptions.

Conclusion

As Operators we have only seen the beginning of the changes from the Fukushima recommendations. PROS agrees that the recommendations will be an overall improvement for the safety margin at facilities in the United States. PROS is expressing these concerns to ensure that the industry and the NRC are aware that implementation of these recommendations could create some negative consequences for Operators. The issues that Operators have already started to see from implementation of these recommendations are training and plant staffing issues. With future issues of equipment costs, additional Surveillance Requirements,

and changes to current plant equipment that could affect how Operators control the plant. PROS feels that the industry and the NRC need to work with Operators to ensure that the recommendations are not just well written ideas and theories, but that implementation of these recommendations will achieve the desired enhancements in safety.



Union of Concerned Scientists

Citizens and Scientists for Environmental Solutions

July 20, 2012

Annette Vietti-Cook
Secretary
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Ms. Vietti-Cook:

By letter dated June 29, 2012, you invited me to make a presentation during a Commission briefing scheduled August 7, 2012, on the implementation of Fukushima lessons learned. The PowerPoint slides and related handouts for my presentation are attached. Per guidance in the invitation letter, I will be emailing copies of these materials to Ms. Rochelle Bavol and Ms. Sandy Joosten on your staff.

We appreciate the opportunity to participate in this briefing and look forward to its discussion.

Sincerely,

David Lochbaum
Director, Nuclear Safety Project
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Chattanooga, TN 37415
(423) 468-9272, office
(423) 488-8318, cell

Attachments:

- 1) PowerPoint slides
- 2) Fukushima Daiichi Unit 1 Spent Fuel Pool Timeline
- 3) Fukushima Daiichi Unit 3 Spent Fuel Pool Timeline
- 4) Fukushima Daiichi Unit 4 Spent Fuel Pool Timeline

Lessons from Fukushima

August 7, 2012

David Lochbaum

Director, Nuclear Safety Project

Union of Concerned Scientists

www.ucsusa.org

What Fukushima Was Not Unexpected.

Reactors were designed with:

- **Earthquakes in mind**
- **Tsunamis in mind**
- **Station blackout (SBO) in mind**
- **Severe accident management guidelines (SAMGs) in mind**
- **Emergency planning in mind**

What Fukushima Was

Reality exceeding unrealistic assumptions:

- **Earthquake greater than design**
- **Tsunami higher than design**
- **SBO longer than design**
- **SAMGs unable to cope with breadth/nature of challenges**
- **Emergency planning overwhelmed by scale of needs**

Lesson from Fukushima

Fukushima's fixes should not rely on unrealistic assumptions.

But Fukushima's assumptions were considered realistic until reality showed otherwise.

Therefore, Fukushima's fixes should include margin analyses as reality checks.

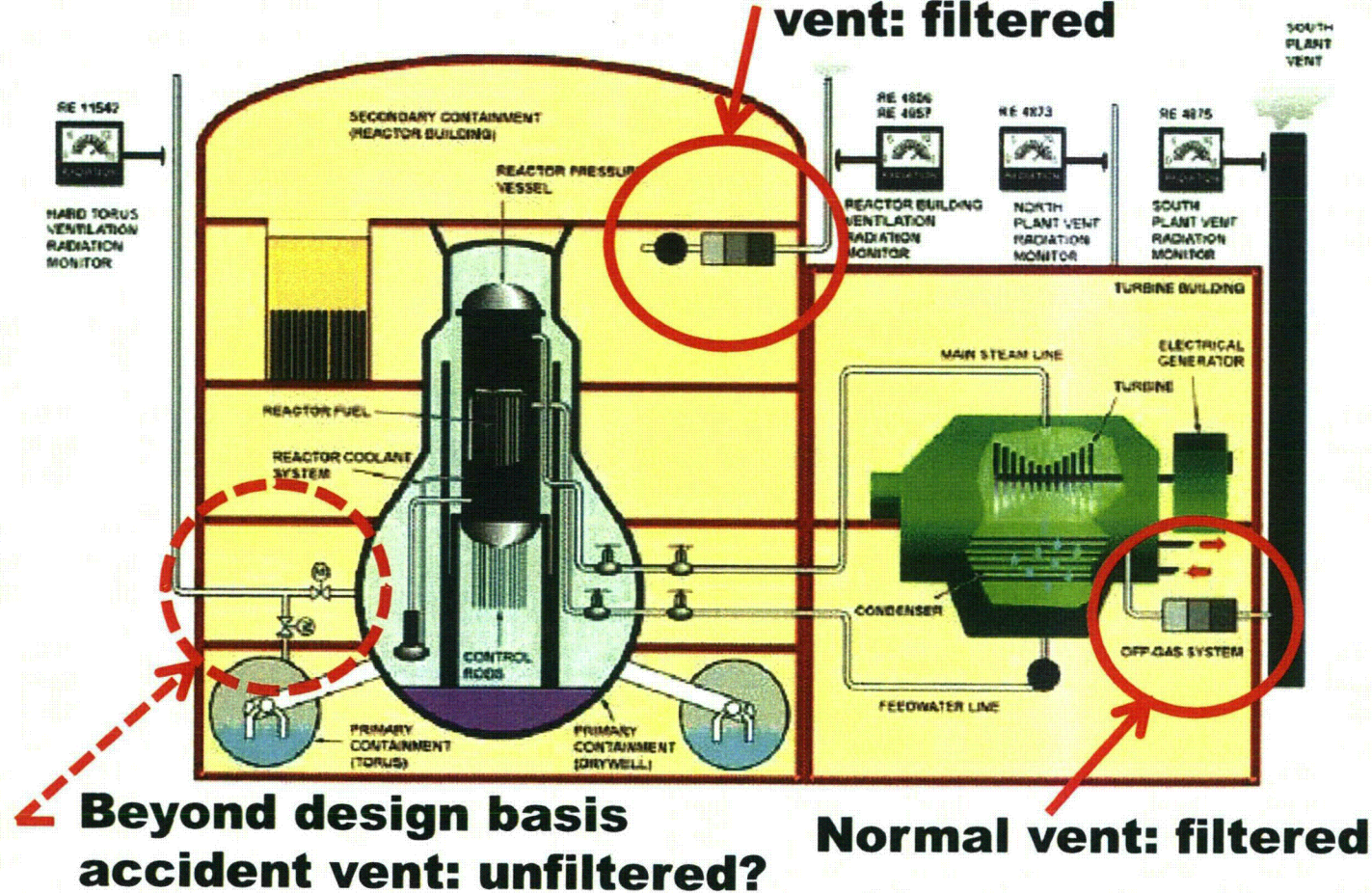
Lesson: Hydrogen Control

NRC should require:

Instrumentation to monitor hydrogen in secondary containments of BWRs with Mark I and II containments and buildings housing spent fuel pools of PWRs and BWRs with Mark I and II containments.

Lesson: Filtered Vents

**Design basis accident
vent: filtered**



Lesson: Filtered Vents

Normal, everyday gaseous effluents from U.S. BWRs are filtered.

Design basis accident gaseous releases are filtered.

It's imprudent not to filter gaseous releases during severe accidents.

Lesson: Spent Fuel Pools

Fukushima Daiichi Summary Display		
Priority	Unit	STATUS AS OF 06:00 EDT (19:00 Local) - 03/16/2011
4	1	Core Status - Severe core damage (based on the amount of hydrogen generated). Radiation has been released. Possible RCS breach. (GE) Sea water injection to RPV.
		Containment - Primary apparently intact. Secondary Containment destroyed.
		Spent Fuel Pool - No information on SFP status.
3	2	Core Status - Severe core damage likely. Radiation release has occurred. Possible RCS breach (GE). Sea water injection to RPV.
		Containment - Primary apparently intact. Secondary Containment lost.
		Spent Fuel Pool - No information on SFP status. Some reports attribute smoke/steam coming from the SFP.
2	3	Core Status - Severe core damaged (based on the amount of hydrogen generated). Radiation has been released. Possible RCS breach. (GE). Sea water injection to RPV.
		Containment - Primary apparently intact. Secondary Containment destroyed.
		Spent Fuel Pool - May be in the same condition as Unit 4 SFP below. (Monninger)
1	4	Core off-loaded to Spent Fuel Pool. Secondary Containment destroyed. Walls of SFP have collapsed. No SFP cooling is possible at this time. TEPCO requests recommendations. (Monninger)
5	5	Shutdown since January 3, 2011. Core loaded in RPV. RPV/SFP levels lower than normal and decreasing. Unit 6 D/G providing make-up water to Unit 5. (IAEA).
6	6	Shutdown since August 14, 2010. Core loaded in RPV. RPV/SFP levels lower than normal. Unit 6 D/G providing make-up water to Unit 5. (IAEA).

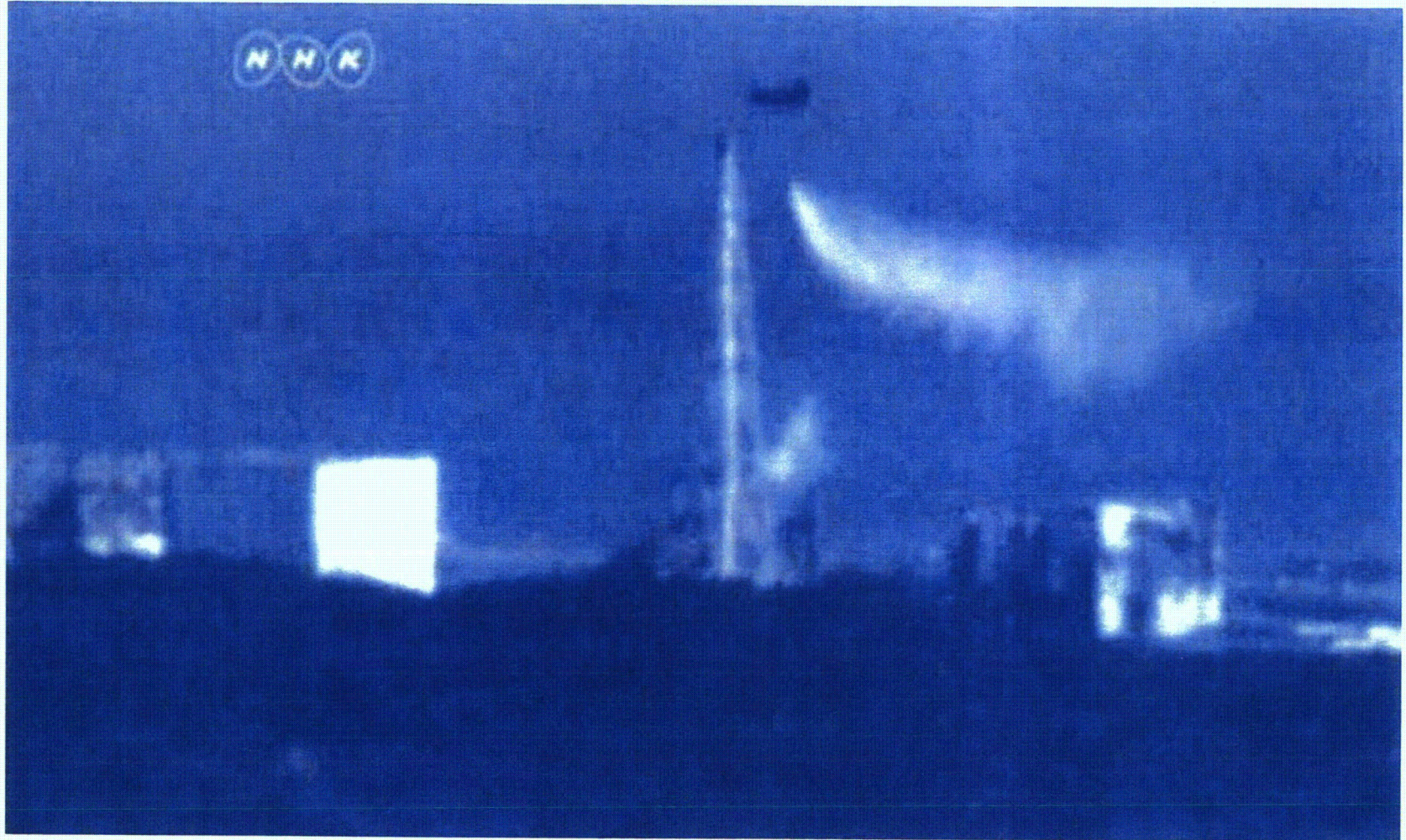
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Lesson: Spent Fuel Pools

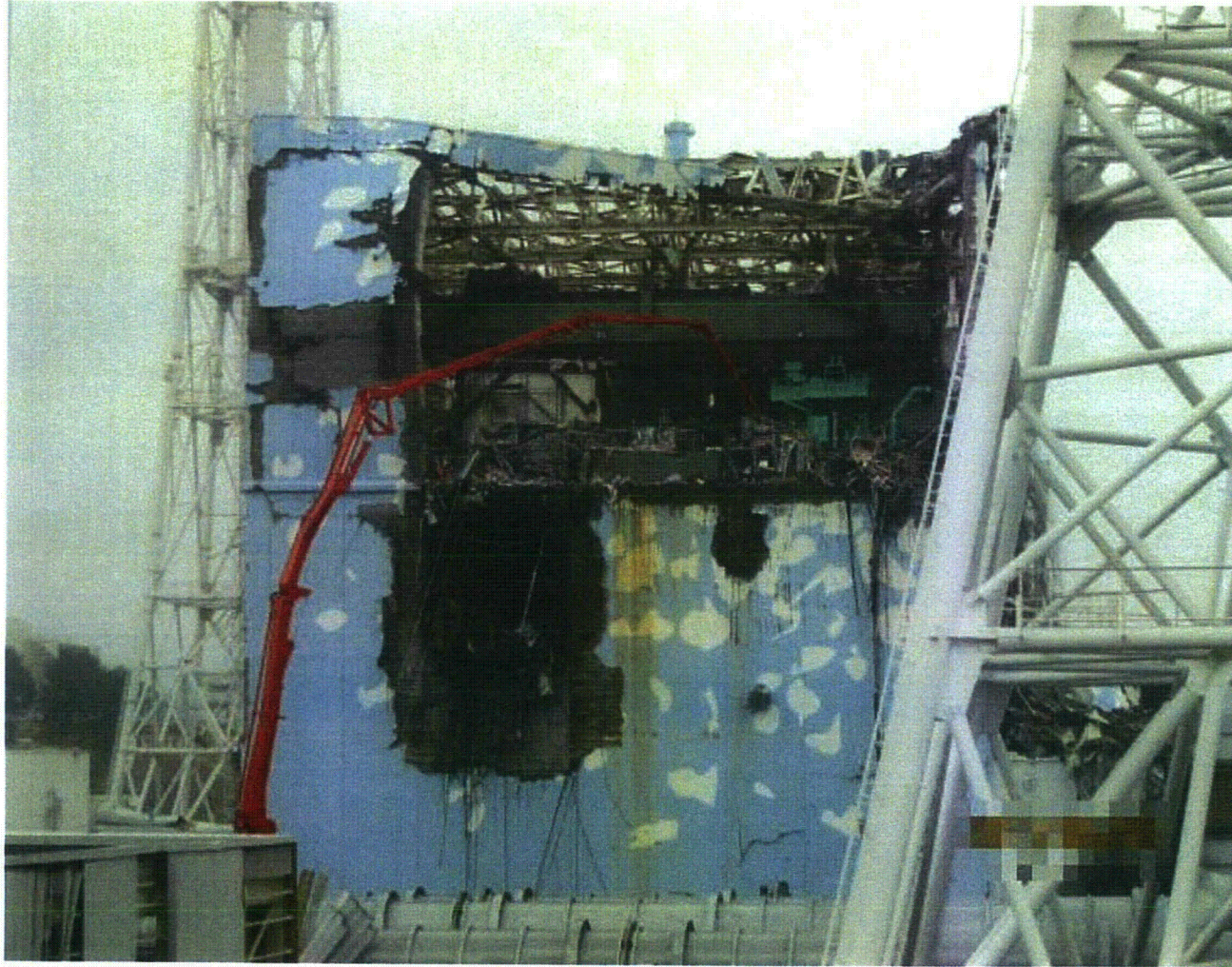
Three reactor units—in worse condition than Three Mile Island Unit 2 ever got at any time during its accident—were a lower priority in NRC's eyes than a single spent fuel pool.

It's unrealistic to now pretend spent fuel pools are benign.

Lesson: Spent Fuel Pools



Lesson: Spent Fuel Pools



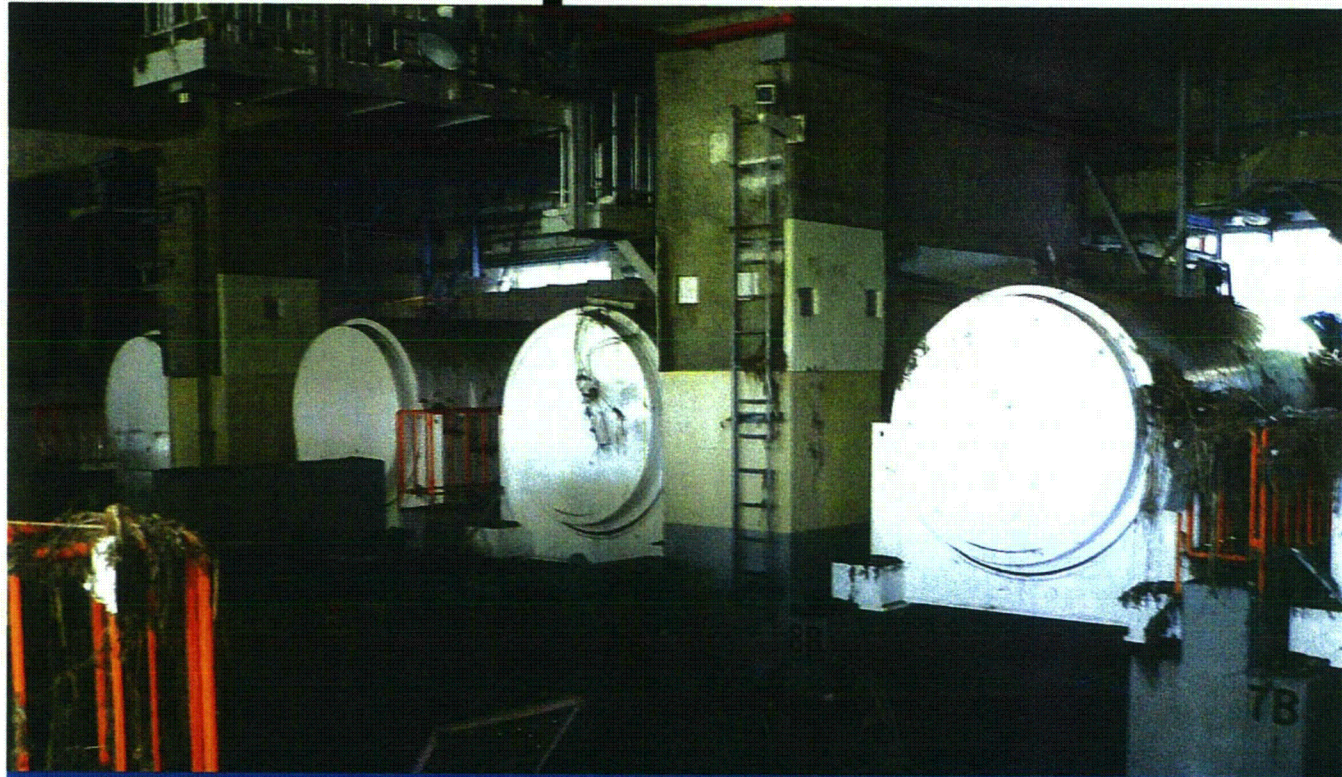
Lesson: Spent Fuel Pools

NRC should require:

All irradiated fuel discharged from the reactor more than 5-6 years ago to be transferred into dry storage.

It's unwise to ignore reality.

Lesson: Spent Fuel Pools



Dry storage at Fukushima did not make the NRC's priority list – even in last place. BIG LESSON IF WE JUST PAY ATTENTION

Lesson: Spent Fuel Pools

NRC should require:

**All reactors to comply with
General Design Criterion 44 and
10 CFR 50.49.**

**It's unrealistic to assume that
spent fuel pool decay heat
loads vanish during accidents.**

Lesson: Spent Fuel Pools

NRC should require:

All BWRs with Mark I and II designs to evaluate effects of water sprays, if installed.

It's unwise to "fix" a natural tsunami disaster with a man-made tsunami disaster.

Lesson: KI

NRC team in Japan had KI even though stationed more than 10 miles from Fukushima.

US public living and working more than 10 miles from nuclear plants need and deserve KI for protection.

Lesson: Severe Accident Procedures and Training

In 2011, Millstone and Pilgrim experienced self-inflicted problems due to operator performance problems.

It is unrealistic to assume that operators will perform better under high-stress and in implementing procedures seldom seen.

Lesson: Severe Accident Procedures and Training

Recommendations:

Operators' initial and continued licenses must evaluate their proficiency using severe accident procedures.

If this training might distract from design basis training, hire more operators.

Lesson: One Voice

U.S. government recommended different protective measure than did Japanese government, causing several states to question whether NRC would publicly challenge protective measures called for by governors.

Lesson: One Voice

Recommendation:

Biennial emergency exercises should periodically include NRC “disagreeing” with state’s emergency orders in order to role-play how disagreements will be reconciled.

Fukushima Daiichi Unit 1 Spent Fuel Pool Timeline

Date	Time	Event
3/13/2011	1400	TEPCO reported "coordinating with the relevant authorities and departments as to how to cool down the water in the spent nuclear fuel pool."
3/14/2011	300	TEPCO workers are coordinating with Japanese authorities on how to cool the water in the spent fuel pool
3/14/2011	1730	NRC status report indicated no problems with spent fuel pool but it was not known if spent fuel pool cooling was available
3/14/2011	2240	NRC's Jim Trapp informed NRC Ops Center that "there is no current issue with spent fuel pools"
3/14/2011	2252	Argonne National Laboratory staffer emails NRC colleagues with concern over the spent fuel pool after the hydrogen explosion
3/15/2011	202	NRC email reported boiling in the spent fuel pool with makeup with seawater when able
3/15/2011	438	NRC's Marty Virgilio provided status briefing: "No concerns with SFP. Without AC and limited DC, need to keep eye on SFPs."
3/15/2011	552	NRC ET log noted "SFPs not on status update: going to add, including projection of how long before need makeup to SFP."
3/15/2011	1900	Spent fuel pool water level is unknown
3/15/2011	2030	Spent fuel pool water level is unknown
3/15/2011	2258	Argonne National Laboratory staffer emails NRC colleagues with concern over the spent fuel pool cooling
3/16/2011	1255	IAEA reported that the status of the spent fuel pool is unknown
3/16/2011	1828	NRC team in Japan reported to NRC Ops Center following contact with TEPCO: spent fuel pool water level is boiling away
3/16/2011	1930	NRC status report indicated that the spent fuel pool water level is decreasing
3/17/2011	120	Japanese government requested mobile, diesel-powered pumps capable of injecting 500 gallons per minute of water into the spent fuel pool; US Forces in Japan conveyed the request to the NRC
3/17/2011	800	NRC Office of Public Affairs updated its talking points to indicate the status of the spent fuel pool is unknown
3/17/2011	800	NRC status report indicated the spent fuel pool water level is unknown
3/17/2011	1720	NRC's Chuck Casto reported that water dumping from helicopter had been suspended
3/18/2011	1630	Jim Lyons of IAEA stated their top concern was the spent fuel pools "due to their being a direct path for radiological release"
3/22/2011	1605	NRC team in Japan reported to the NRC Operations Center following its meeting with NISA that NISA believed the spent fuel pool had at least 20 days margin due to low decay heat levels
3/24/2011	424	NRC Reactor Safety Team reported their belief that the spent fuel pool decay heat conservatively required about 25 gallons per minute of cooling water flow

3/29/2011	32	ORNL emailed NRC that it had information from NEI and EPRI that Units 1, 2, and 3 had both aluminum storage racks and borated aluminum storage racks while Unit 4 has only non-borated stainless steel storage racks
3/31/2011	1303	Workers began spraying fresh water into the spent fuel pool using a concrete pump truck
3/31/2011	1604	Workers stopped spraying fresh water into the spent fuel pool using a concrete pump truck after delivering about 90 tons of water
4/2/2011	1716	Workers started a short test using the concrete pump truck to spray water into the spent fuel pool to confirm proper placement of the nozzle.
4/2/2011	1719	Workers stopped a short test using the concrete pump truck to spray water into the spent fuel pool to confirm proper placement of the nozzle.

Fukushima Daiichi Unit 3 Spent Fuel Pool Timeline

Date	Time	Event
3/13/2011	1400	TEPCO reported "coordinating with the relevant authorities and departments as to how to cool down the water in the spent nuclear fuel pool."
3/14/2011	1730	NRC status report indicated no problems with spent fuel pool but it was not known if spent fuel pool cooling was available
3/14/2011	2240	NRC's Jim Trapp informed NRC Ops Center that "there is no current issue with spent fuel pools"
3/14/2011	2252	Argonne National Laboratory staffer emails NRC colleagues with concern over the spent fuel pool after the hydrogen explosion
3/15/2011	438	NRC's Marty Virgilio provided status briefing: "No concerns with SFP. Without AC and limited DC, need to keep eye on SFPs."
3/15/2011	552	NRC ET log noted "SFPs not on status update: going to add, including projection of how long before need makeup to SFP."
3/15/2011	1312	NRC status report indicated that Unit 1 had stable reactor core cooling with substantial debris in its spent fuel pool from the hydrogen explosion
3/15/2011	1900	Spent fuel pool water level is unknown
3/15/2011	2258	Argonne National Laboratory staffer emails NRC colleagues with concern over the spent fuel pool cooling
3/16/2011	300	NRC status report indicated possibility of steam/smoke emanating from unit due to water boil-off or zirconium-water reaction
3/16/2011	1255	IAEA reported that the status of the spent fuel pool is unknown
3/16/2011	1828	NRC team in Japan reported to NRC Ops Center following contact with TEPCO: spent fuel pool had zirconium water reaction
3/16/2011	1930	NRC status report indicated that the spent fuel pool water level is decreasing with zirconium-water interaction
3/17/2011	120	Japanese government requested mobile, diesel-powered pumps capable of injecting 500 gallons per minute of water into the spent fuel pool; US Forces in Japan conveyed the request to the NRC
3/17/2011	800	NRC Office of Public Affairs updated its talking points to indicate the spent fuel pool is likely boiling due to the presence of steam
3/17/2011	842	NRC ET logged conference call: Chairman Jaczko asked if the spent fuel pool has a crack with a possible loss of water inventory. The NRC staff answered yes
3/17/2011	948	Self Defense Force started using huge buckets to drop seawater into the Unit 3 and 4 spent fuel pools
3/17/2011	952	Self Defense Force dropped seawater onto the unit from helicopters
3/17/2011	958	Self Defense Force dropped seawater onto the unit from helicopters
3/17/2011	1001	Self Defense Force dropped seawater onto the unit from helicopters
3/17/2011	1610	Riot police arrived at the site for "grand discharge"
3/17/2011	1905	Police water cannon began shooting water aimed at the spent fuel pool

3/17/2011	1905	Riot police began water spray
3/17/2011	1913	Riot police stopped water spray
3/17/2011	1922	Police water cannon stopped shooting water at the spent fuel pool
3/17/2011	1935	Five Self Defense Forces emergency fire vehicles began shooting water aimed at the spent fuel pool
3/17/2011	1935	Self Defense Force began water spray from the ground using a water-laden tank on a fire engine
3/17/2011	1945	Self Defense Force began water spray from the ground using a water-laden tank on a fire engine
3/17/2011	1945	Self Defense Force supplied 30 tons of water from the ground using 5 special pumper trucks.
3/17/2011	2000	Self Defense Force began water spray from the ground using a water-laden tank on a fire engine
3/17/2011	2007	Self Defense Force began water spray from the ground using a water-laden tank on a fire engine
3/17/2011	2009	Five Self Defense Forces emergency fire vehicles stopped shooting water at the spent fuel pool
3/17/2011	2009	Self Defense Force ended the supply of 30 tons of water from the ground using 5 special pumper trucks.
3/17/2011	2130	National Police Academy attempted to supply water into the spent fuel pool using a pumper truck. High radiation levels prevented the truck from getting close to the building and water did not reach the spent fuel pool
3/17/2011	2130	Self Defense Force dropped four large buckets of seawater into the spent fuel pool
3/17/2011	2359	An estimated 140 tons of water was delivered to the spent fuel pool this day from all sources
3/18/2011	1630	Jim Lyons of IAEA stated their top concern was the spent fuel pools "due to their being a direct path for radiological release"
3/18/2011	1927	NRC ET logged that NRC Reactor Safety Team concluded that the spent fuel pool was initially dry when sprayed with water by fire trucks because of the large steam plume shown in photographs
3/18/2011	2359	An estimated 42 tons of water was delivered to the spent fuel pool this day from all sources
3/19/2011	30	Tokyo Fire Department Hyper Rescue Squad began spraying 300 liters/minute of water at the spent fuel pool.
3/19/2011	110	Tokyo Fire Department Hyper Rescue Squad stopped spraying 300 liters/minute of water at the spent fuel pool. An estimated 120 tons of seawater had been discharged.
3/19/2011	946	NRC status report indicated that photos showed massive structural and system damage to multiple levels of the reactor building and that the NRC and GE are analyzing the photos to determine potential for extreme spent fuel pool damage and whether or not the drywell head is intact.
3/19/2011	946	NRC status report stated "Water sprays to Unit 3 having little or no impact"

3/19/2011	1410	The Hyper Rescue Unit of the Tokyo Fire Department began spraying water into the spent fuel pool and was expected to continue doing so until 12:30am
3/19/2011	2000	NRC team in Japan "are fairly certain that pools at Units 3 and 4 are dry."
3/19/2011	2359	An estimated 2,520 tons of water was delivered to the spent fuel pool this day from all sources
3/20/2011	340	The Hyper Rescue Unit of the Tokyo Fire Department stopped spraying water into the spent fuel pool
3/20/2011	1900	About 3,742 tons of water in total had been sprayed at the spent fuel pool
3/20/2011	1900	NRC team in Japan now believes there is water in the spent fuel pool
3/20/2011	2130	Tokyo Fire Department began spraying water at the spent fuel pool
3/21/2011	358	Tokyo Fire Department stopped spraying water at the spent fuel pool; roughly 1,137 tons had been delivered
3/22/2011	1510	Tokyo Fire Department began spraying water into spent fuel pool
3/22/2011	1559	Tokyo Fire Department stopped spraying water into spent fuel pool. About 180 tons was delivered
3/23/2011	1103	Workers began injecting water into the spent fuel pool via the Cooling and Purification Line
3/23/2011	1320	Workers stopped injecting water into the spent fuel pool via the Cooling and Purification Line after delivering about 35 tons of water
3/24/2011	328	NRC fire protection staffer reviewing photos of what the media called a fire stated: "The plume sort of ends, not dissipate like thick smoke usually does. ... This may really be the U3 SPF boiloff. This amount of steam seems a lot for decay heat. This may really be nuclear heat from an undesired criticality."
3/24/2011	424	NRC Reactor Safety Team reported their belief that the spent fuel pool decay heat conservatively required about 25 gallons per minute of cooling water flow
3/24/2011	535	Workers began injecting seawater into the spent fuel pool via the Cooling and Purification Line
3/24/2011	1605	Workers stopped injecting seawater into the spent fuel pool via the Cooling and Purification Line after delivering 120 tons of water
3/25/2011	1328	Kawasaki City Fire Bureau supported by the Tokyo Fire Department began spraying water into the spent fuel pool
3/25/2011	1600	Kawasaki City Fire Bureau supported by the Tokyo Fire Department stopped spraying water into the spent fuel pool after delivering about 460 tons of water
3/27/2011	1000	NRC Reactor Safety Team assessment: "Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4."
3/27/2011	1234	Workers began spraying water into the spent fuel pool using a concrete pump truck with a flow rate of 50 tons per hour

3/27/2011	1436	Workers stopped spraying water into the spent fuel pool using a concrete pump truck with a flow rate of 50 tons per hour after delivering about 100 tons of water
3/29/2011	32	ORNL emailed NRC that it had information from NEI and EPRI that Units 1, 2, and 3 had both aluminum storage racks and borated aluminum storage racks while Unit 4 has only non-borated stainless steel storage racks
3/29/2011	318	NRC Operating Experience Community report stated that "...it is believed that the Unit 3 and 4 SFPs may have been compromised resulting in at least some degree of fuel uncovering."
3/29/2011	1417	Workers began spraying water into the spent fuel pool using a concrete pump truck with a flow rate of 50 tons per hour
3/29/2011	1717	NRC distributed NISA/NRC assessment prior to NRC / TEPCO meeting tomorrow morning. NISA concludes that spent fuel pool is not damaged. NRC concludes condition is indeterminate.
3/29/2011	1818	Workers stopped spraying water into the spent fuel pool using a concrete pump truck with a flow rate of 50 tons per hour after delivering about 100 tons of water
3/31/2011	1630	Workers began spraying fresh water into the spent fuel pool using a concrete pump truck
3/31/2011	1933	Workers stopped spraying fresh water into the spent fuel pool using a concrete pump truck after delivering about 105 tons of water
4/1/2011	551	NRC email that "the Fukushima Daiichi Unit 3 SPF is or may be day. And has been for some time."
4/2/2011	952	Workers began spraying fresh water into the spent fuel pool using a concrete pump truck
4/2/2011	1254	Workers stopped spraying fresh water into the spent fuel pool using a concrete pump truck
4/4/2011	1703	Workers began spraying fresh water into the spent fuel pool using a concrete pump truck
4/4/2011	1919	Workers stopped spraying fresh water into the spent fuel pool using a concrete pump truck after delivering about 70 tons of water
4/7/2011	653	Workers began spraying water at the spent fuel pool using a concrete pump truck
4/7/2011	853	Workers stopped spraying water at the spent fuel pool using a concrete pump truck after delivering about 70 tons of water
4/8/2011	1706	Workers began spraying water at the spent fuel pool using a concrete pump truck
4/8/2011	2000	Workers stopped spraying water at the spent fuel pool using a concrete pump truck after delivering about 75 tons of water
4/10/2011	1715	Workers began spraying water at the spent fuel pool using a concrete pump truck
4/10/2011	1915	Workers stopped spraying water at the spent fuel pool using a concrete pump truck after delivering about 80 tons of water

Fukushima Daiichi Unit 4 Spent Fuel Pool Timeline

Date	Time	Event
3/11/2011	1445	The spent fuel pool to refueling cavity gates were installed. The spent fuel pool water temperature was 27C (80.6F)
3/13/2011	1400	TEPCO reported "coordinating with the relevant authorities and departments as to how to cool down the water in the spent nuclear fuel pool."
3/14/2011	408	Spent fuel pool water temperature reported at 84C
3/14/2011	2240	NRC's Jim Trapp informed NRC Ops Center that "there is no current issue with spent fuel pools"
3/15/2011	408	Spent fuel pool water temperature was 183F
3/15/2011	438	NRC's Marty Virgilio provided status briefing: "No concerns with SFP. Without AC and limited DC, need to keep eye on SFPs."
3/15/2011	552	NRC ET log noted "SFPs not on status update: going to add, including projection of how long before need makeup to SFP."
3/15/2011	600	During press conference with Cabinet Secretary Edano, it was announced that a fire was burning in the Unit 4 spent fuel pool
3/15/2011	1030	METI issued directive to extinguish the fire and prevent recriticality of the fuel in the spent fuel pool
3/15/2011	1049	TEPCO contacted the Department of State who relayed a request to the NRC: "Unit 4 fuel on fire. Requesting boron."
3/15/2011	1100	Prime Minister issued statement that fire broke out on Unit 4 presumably due to hydrogen generated by its spent fuel
3/15/2011	1147	NRC ET logged "Unit 4 zirc fire"
3/15/2011	1230	Jack Grobe updated Commissioners' assistants via telecon: spent fuel pool dry and appears to be undergoing zirconium fire
3/15/2011	1312	NRC status report indicated that the Unit 4 "SFP is dry" with a "Potential fuel pool zirconium fire"
3/15/2011	1900	There is possible loss of water from the spent fuel pool
3/15/2011	1902	Dan Dorman updated Commissioners' assistant via telecon: fire in spent fuel pool reported out; NRC staff believes it might have been zirconium fire
3/15/2011	2012	NRC ET logged that fire was a lubricating oil fire, not a zirconium fire
3/15/2011	2030	High radiation dose rates measured between Units 3 and 4 suspected to be from the Unit 4 spent fuel pool
3/15/2011	2030	Workers having difficulty maintaining cooling and water level in the spent fuel pool
3/15/2011	2200	METI directed TEPCO to inject water into the spent fuel pool
3/15/2011	2209	NRC email reported that Unit 4 "may be having a spent fuel pool meltdown."
3/16/2011	230	NRC's updated RASCAL run to reflect the actual inventory of 1,331 fuel assemblies in the spent fuel pool showed the radiation dose at 20 miles to be 1.4 rem, above the PAG level of 1.0 rem. At 30 miles, the radiation dose is 0.9 rem.

3/16/2011	300	High radiation dose rates measured between Units 3 and 4 suspected to be from the partially uncovered Unit 4 spent fuel pool
3/16/2011	300	NRC status report indicated that spent fuel pool's ability to retain water is in doubt
3/16/2011	1154	Grobe suggested running case assuming 50 to 75 percent of the fuel in the spent fuel pool was damaged with no containment and no water in pool to see what radiation doses might be expected
3/16/2011	1230	NISA reported "Damage to Fuel Rods Suspected" in spent fuel pool
3/16/2011	1255	IAEA reported that fuel in the spent fuel pool is uncovered
3/16/2011	1300	NRC ET logged that GE confirmed that spent fuel pool did not experience a zirconium fire
3/16/2011	1416	NRC's understanding was that cooling of the spent fuel pool water has been lost and spent fuel is uncovered
3/16/2011	1416	Based on NRC's understanding of plant conditions, NRC performed a dose projection assuming that the full core offload in the spent fuel pool was fully uncovered and had experienced 50% fuel damage. The dose projection results led the NRC staff to recommend "Prompt restriction of shipping down wind to 50 miles" and "Evacuation of populations out to 50 miles downwind to be completed before Sunday in anticipation of wind shifts."
3/16/2011	1559	NRC headquarters informed its team in Japan that IAEA believes spent fuel is uncovered
3/16/2011	1828	NRC team in Japan reported to NRC Ops Center following contact with TEPCO: spent fuel pool had zirconium water reaction; pool has no walls and cannot hold water; TEPCO discussing dropping sand on the spent fuel pool
3/16/2011	1900	NRC assigned Priority 1 to the spent fuel pool; walls of spent fuel pool collapsed; no spent fuel pool cooling possible at this time
3/16/2011	1930	NRC status report indicated a total loss of water from the spent fuel pool with no ability to retain water in the pool; zirconium-water reaction taking place
3/17/2011	45	NRC team in Japan met with TEPCO: don't think the spent fuel pool walls have been blown out because there would be streaming radiation if that were the case
3/17/2011	120	Japanese government requested mobile, diesel-powered pumps capable of injecting 500 gallons per minute of water into the spent fuel pool; US Forces in Japan conveyed the request to the NRC
3/17/2011	146	NRC email reported "The white steam is the fuel pool boiling. Site boundary dose is around 200 mrem/hr."
3/17/2011	300	NRC status report stated "There is no water in the spent fuel pool and the pool's ability to retain water is in doubt."
3/17/2011	616	Conference call between Chairman Jaczko and Chuck Castro: Chairman: we believe the spent fuel pool is dry? Casto: Yes, and pool walls have collapsed, can't maintain inventory at all
3/17/2011	659	NRC ET logged update from NRC team in Japan: access road to Unit 4 is blocked; workers have already or will soon remove debris around access
3/17/2011	704	NRC email to NRC senior management reported "Unit 4 spent fuel pool - likely dry, structural integrity uncertain, uncertain can hold water."

3/17/2011	800	NRC Office of Public Affairs updated its talking points to indicate the spent fuel pool is likely dry and the integrity of the pool is in question
3/17/2011	800	NRC status report indicated that the spent fuel pool is likely dry due to no evidence of steam
3/17/2011	800	NRC status report indicated the spent fuel pool water level is likely dry because no steam has been observed
3/17/2011	842	NRC ET logged conference call: Chairman Jaczko asked if the spent fuel pool was dry with a possible zirconium fire. The NRC staff answered they believe there is no water and structural integrity of the pool is uncertain
3/17/2011	948	Self Defense Force started using huge buckets to drop seawater into the Unit 3 and 4 spent fuel pools
3/17/2011	1008	NRC ET logged conference call: Chairman asked for source of statement that pool had no water. Casto said Japanese government showed them pictures taken after the explosion looking like that pool lost structural integrity. Virgilio reported that John Monninger and Jim Trapp were each told by TEPCO that the spent fuel pool was dry.
3/17/2011	1055	NRC ET logged that DEDO Ordaz just heard from Casto that "he is very convinced there is no water in #4."
3/17/2011	1413	NRC ET logged update from NRC team in Japan: TEPCO believes water in spent fuel pool. NRC team believes there is no water in spent fuel pool based on images. Spent fuel pool stopped steaming, so it might be dry.
3/17/2011	1720	NRC's Chuck Casto reported that water dumping from helicopter had been suspended
3/17/2011	2200	METI directed TECPO to inject water into the spent fuel pool
3/18/2011	504	NRC email reported that NEI updated the spent fuel pool wall collapse story. NEI reported that "One of the side walls of the suspended spent fuel pool at FK 4 (or was it 3) collapsed, and only the stainless steel liner is holding the pool together."
3/18/2011	925	NRC team in Japan queried headquarters whether it would be better to leave a "dried out fuel pool" alone to let existing heat transfer mechanisms provide cooling or to run the risk of radiological releases caused by fuel rod quenching upon adding water to the pool.
3/18/2011	1630	Jim Lyons of IAEA stated their top concern was the spent fuel pools "due to their being a direct path for radiological release"
3/19/2011	513	NRC ET logged: "4 is presumed dry. No steam coming out."
3/19/2011	1030	NRC assigned Priority 2 to the spent fuel pool; NRC estimated a spent fuel pool margin of 6 days; JAIF suspects damage to fuel rods in the spent fuel pool; water being supplied by water cannons and fire trucks
3/19/2011	2000	NRC team in Japan "are fairly certain that pools at Units 3 and 4 are dry."
3/20/2011	820	Self Defense Force started spraying water into the spent fuel pool
3/20/2011	1822	Self Defense Force began spraying water at the spent fuel pool

3/20/2011	1830	Self Defense Force began spraying water over the spent fuel pool
3/20/2011	1900	NRC team in Japan now believes there is water in the spent fuel pool
3/20/2011	1943	Self Defense Force stopped spraying water at the spent fuel pool; about 81 tons had been delivered
3/20/2011	1946	Self Defense Force stopped spraying water over the spent fuel pool
3/20/2011	2359	An estimated 160 tons of water were delivered to the spent fuel pool this day from all sources
3/21/2011	637	Self Defense Force began spraying water at the spent fuel pool (TEPCO used one high pressure water cannon supplied by the US Army)
3/21/2011	637	Self Defense Force began spraying water at the spent fuel pool using 13 fire engines
3/21/2011	841	Self Defense Force stopped spraying water at the spent fuel pool; about 91 tons had been delivered
3/21/2011	1903	NRC staff provided Chairman with results from an analysis of damage to all the fuel in the spent fuel pool; MELCOR results "decay heat levels in the pool are sufficiently low that concrete ablation will not occur. Therefore, the melt would be retained in the spent fuel pool."
3/21/2011	2359	An estimated 92.2 tons of water were delivered to the spent fuel pool this day from all sources
3/22/2011	1000	NRC status report showed fuel damage suspected in the spent fuel pool (JAIF); seawater sprayed into spent fuel pool; Priority 2
3/22/2011	1717	Workers began spraying water into the spent fuel pool using a concrete pump truck with a flow rate of 50 tons per hour
3/22/2011	1900	NRC status report stated "pool likely dry at one point causing significant fuel damage"
3/22/2011	2032	Workers stopped spraying water into the spent fuel pool using a concrete pump truck. About 150 tons of water was delivered
3/23/2011	1000	Concrete Pump Truck began supplying 50 tons per hour of water makeup to the spent fuel pool
3/23/2011	1302	Concrete Pump Truck stopped supplying 50 tons per hour of water makeup to the spent fuel pool. About 130 tons of water was delivered.
3/24/2011	424	NRC Reactor Safety Team reported their belief that the spent fuel pool decay heat required about 70 gallons per minute of cooling water flow
3/24/2011	1436	Workers began spraying seawater into the spent fuel pool at 50 tons per hour using the Concrete Pump Truck
3/24/2011	1730	Workers stopped spraying seawater into the spent fuel pool at 50 tons per hour using the Concrete Pump Truck after delivering about 150 tons of water
3/25/2011	605	Workers began injecting seawater into the spent fuel pool via the Fuel Pool Cooling Line
3/25/2011	1020	Workers stopped injecting seawater into the spent fuel pool via the Fuel Pool Cooling Line
3/25/2011	1905	Workers began spraying seawater into the spent fuel pool at 50 tons per hour using the Concrete Pump Truck

3/25/2011	2207	Workers stopped spraying seawater into the spent fuel pool at 50 tons per hour using the Concrete Pump Truck after delivering about 150 tons of water
3/26/2011	1330	NRC status summary had Unit 4 as the #4 Priority
3/27/2011	1000	NRC Reactor Safety Team assessment of the spent fuel pool: "Low water level, spraying with sea water, hydrogen from the fuel pool exploded, fuel pool is cool heating up very slowly (JAIF, NISA, TEPCO) Temperature is unknown (NISA)." "Given the amount of decay heat in the fuel in the pool, it is likely that in the days immediately following the accident, the fuel was partially uncovered. The lack of cooling resulted in zirc water reaction and a release of hydrogen. The hydrogen exploded and damaged secondary containment. The zirc water reaction could have continued, resulting in a major source term release. Fuel particulates may have been ejected from the pool (based on information of neutron emitters found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 3)."
3/27/2011	1655	Workers began spraying water into the spent fuel pool using a concrete pump truck with a flow rate of 50 tons per hour
3/27/2011	1925	Workers stopped spraying water into the spent fuel pool using a concrete pump truck with a flow rate of 50 tons per hour after delivering about 125 tons of water
3/28/2011	1600	NRC call with team in Japan indicated that upcoming meeting with TEPCO would seek to ascertain how they measured spent fuel pool water level. If via level in skimmer surge tank, it is indirect and may not represent true spent fuel pool water levels.
3/29/2011	32	ORNL emailed NRC that it had information from NEI and EPRI that Units 1, 2, and 3 had both aluminum storage racks and borated aluminum storage racks while Unit 4 has only non-borated stainless steel storage racks
3/29/2011	318	NRC Operating Experience Community report stated that "...it is believed that the Unit 3 and 4 SFPs may have been compromised resulting in at least some degree of fuel uncovering."
3/29/2011	759	NRC email expressed concern about 204 fresh fuel assemblies in pool; storage racks are not borated; racks may have shifted
3/29/2011	1717	NRC distributed NISA/NRC assessment prior to NRC / TEPCO meeting tomorrow morning. NISA concludes "No evidence supporting fuel damage." NRC concludes "Damaged - H2 generated from zirconium-steam reaction"
3/30/2011	1404	Workers began spraying fresh water into the spent fuel pool using a concrete pump truck with a flow rate of 50 tons per hour
3/30/2011	1404	Workers began spraying fresh water into the spent fuel pool using a concrete pump truck with a flow rate of 50 tons per hour
3/30/2011	1833	Workers began spraying fresh water into the spent fuel pool using a concrete pump truck with a flow rate of 50 tons per hour after delivering about 140 tons of water
4/1/2011	825	Workers began spraying fresh water into the spent fuel pool using a concrete pump truck
4/1/2011	1414	Workers stopped spraying fresh water into the spent fuel pool using a concrete pump truck after delivering 180 tons of water

4/3/2011	1708	Workers began spraying fresh water into the spent fuel pool using a concrete pump truck
4/3/2011	2216	Workers stopped spraying fresh water into the spent fuel pool using a concrete pump truck after delivering about 180 tons of water
4/5/2011	1735	Workers began spraying fresh water into the spent fuel pool using a concrete pump truck
4/5/2011	1822	Workers stopped spraying fresh water into the spent fuel pool using a concrete pump truck
4/7/2011	1823	Workers began spraying water at the spent fuel pool using a concrete pump truck
4/7/2011	1940	Workers stopped spraying water at the spent fuel pool using a concrete pump truck after delivering about 38 tons of water
4/9/2011	1707	Workers began spraying water at the spent fuel pool using a concrete pump truck
4/9/2011	1924	Workers stopped spraying water at the spent fuel pool using a concrete pump truck after delivering about 90 tons of water
4/15/2011	24	TEPCO released results from water samples drawn from the spent fuel pool that indicate little damage to the fuel in the pool

***An Evaluation of the NRC
Response to the Fukushima
Nuclear Accident***

August 7, 2012

**Christopher Paine
Nuclear Program Director
Natural Resources Defense Council
(NRDC)**

Charge from the Commission

- **Provide “public interest perspective on NRC Actions and stakeholder involvement in response to Fukushima accident”**
- **Full 56 slide presentation reviews NRC’s modification/disposition of all 12 of the Near-Term Task Force (NTTF) overarching recommendations**
- **In the allotted 10 minutes I cannot possibly cover every point in the presentation, but will try to convey our top-line concerns.**

Table of Acronyms

ACRS	Advisory Committee on Reactor Safeguards
AEA	Atomic Energy Act
ANPR	Advance Notice of Proposed Rulemaking
BWR	Boiling Water Reactor
CFR	Code of Federal Regulations
EP	Emergency Plan
EPZ	Emergency Planning Zone
EU	European Union
FLEX	Diverse and Flexible Coping Strategies (for “beyond-design-basis” external events)
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act
NPP	Nuclear Power Plant
NTTF	Near -Term Task Force (produced July 12, 2011 NRC review of Fukushima accident)
PRA	Probabilistic Risk Analysis
RCS	Reactor Cooling System
RHV	Reliable Hardened Vent (of reactor primary containment)
ROP	Reactor Oversight Process
SAMG	Severe Accident Management Guidelines
SBO	Station Black Out (loss of offsite and fixed onsite AC electrical power sources)
SFP	Spent Fuel Pool
TMI-2	Three Mile Island Unit 2 (site of 1979 nuclear reactor accident near Harrisburg, PA)

NRC has strayed from the intent of its statutory framework

- **Under the Atomic Energy Act (AEA), primary vehicle for “Stakeholder Involvement” in nuclear safety is supposed to be the licensing process**
- **In compensation for a Federal monopoly on regulating nuclear power, AEA granted states/citizens the right to challenge each and every licensing decision**

Citizen Safety Concerns Should Be Adjudicated in Licensing Proceedings

- **By steady accretion of exclusionary rules, NRC has insulated the licensing process from citizen nuclear safety concerns, including *post-Fukushima safety concerns***
- **Structured “discussion” and “information” sessions like the present one are now NRC’s preferred mode for dealing with the public**

Large Gap Between Internal vs. External Views of NRC Efficacy

- **Internal NRC view is typically “We’re rated the Number One place to work in the federal government!”**
- **NRC Senior Staff briefings rarely fail to convey aura of confidence that its efforts represent the best achievable “within currently available resources.”**
- **What public sees, however, is an ostensibly “impartial” NRC Staff that is almost always *perfectly aligned* with industry’s opposition to 100% of contentions in citizen petitions to intervene in licensing proceedings.**

Do state/public interveners really offer nothing of value?

- Do they offer literally NO concerns/insights worthy of adjudication?
- Public/press perception of the NRC as a “captive agency” is cemented by high “moat” of industry-protective rules, including:
 - Prejudicial and technically demanding “contention “admissibility” standards that public must meet within 60 days of a license application being filed;
 - Wide latitude for licensing boards to interpret these pleading standards and subjectively determine when they have been met.

More sources of public disregard for NRC

- **Agency NEPA procedures violate due process and place gratuitous burdens and costs on ordinary citizens.**
- **Over-reliance on simplistic, technically erroneous, and quickly outdated “Generic” NEPA determinations -- which may then endure for 15-20 years -- to preclude site specific consideration of troublesome issues**
- **Unbalanced legal resources: Large teams of aligned NRC-industry attorneys typically face off against a single attorney representing interveners, if they can afford an attorney at all.**

Industry can literally buy the licensing results it wants

- Just getting to starting line -- e.g. “party status” with one “admitted” contention -- can cost citizen intervener in excess of \$100,000
- Path forward through adjudication in the hearing process, Commission appeals, and ultimately appellate court review, is very long and very costly
- Industry has \$400/hr attorneys on retainer, written off as a business expense, to help them navigate and manipulate the process.
- Two-against-one: NRC attorneys frequently pile-on and echo industry arguments, but seldom side with petitioners or remain neutral.

Paralyzing Penchant for Paper

- **Vast impenetrable interlocking maze of NRC Rules, “SECY Papers”, Requirements Memoranda, RAI’s, Orders, Staff Guidance, Guidelines, Policy Statements, etc.**
- **Indecipherable by concerned ordinary citizens, ordinary lawyers, and the even the industry itself (hence its ubiquitous reliance on specialty practice law firms)**
- **Fukushima response to date is consistent with this NRC penchant for churning paper, with a notable dearth of on-the-ground ACTIONS to increase the safety margin against severe accidents.**

Compelling Example of Why the NRC Engenders Public Distrust

- **Commission's first official act (10 days) after inception of the Fukushima Nuclear Accident, was to:**
- **Renew operating license of Vermont Yankee, an old (1972) GE BWR Mark I unit of the same type and vintage as the exploding Fukushima units.**

This tone-deaf action did not meet AEA “reasonable assurance” standard

- **On March 21, while accident was still ongoing, Commission could not possibly have known:**
 - **the role, if any, inherent BWR Mark 1 design flaws may have played in the accident;**
 - **the role, if any, unregulated hardened vents or other Mark 1 equipment failures may have played in the accident.**

Vermont Yankee Relicensing, cont.

- **Moreover, the Commission took this action AFTER:**
 - **Plant operators had been caught lying to Vermont state officials regarding groundwater contamination from buried pipes**
 - **State Senate had voted 26-4 in opposition to license renewal**
 - **A plant cooling tower had collapsed in 2007**

Post-Fukushima NRC Stakeholder Involvement

- **Offers little to date other than opportunity to comment and convey concerns**
- **No meaningful opportunities to adjudicate important issues**
- **As George Orwell might observe: Some “Stakeholders” are More Equal than Others**
 - **Exhibit A is March 2012 NRC “Mitigation Strategies” Order (EA-12-049) and Staff Guidance, which is completely wrapped around December 2011 NEI “Flex” Proposal**

Top Line Findings

- **Seventeen months after the accident, only 3 of 12 NTF-recommended “near-term” orders have been issued, and only one (Reliable Hardened Vents) is in the form originally intended.**
- **Only 2 of 7 recommended rulemakings have been (barely) initiated, by vague ANPR’s rather than proposed draft rules.**
- **Planned timetables for actual implementation of upgrades range from leisurely (e.g. Dec. 31 2016 for RHVs) to “indeterminate” for all issues.**

Top Line Findings - 2

- **Fuzzy, uncertain interface of post-Fukushima upgrades with ongoing reactor licensing/relicensing/power uprate processes, which remain unperturbed by accident**
- **Current NRC relicensing rules foster conservation of obsolete reactor technologies with inherent design flaws, at sites with ever larger populations and economic value at risk.**

Top line findings -3

- **NRC response to Fukushima is diffuse and excessively segmented, lacks urgency and focus.**
- **Interlocking architecture of original NTTF recommendations has been lost**
- **Implementation schedules are receding, paper studies are proliferating**

Top line findings - 4

- **NRC has some 4200 employees, an average of about 66 staff per regulated nuclear plant site.**
- **Surely, Commission has nominal capacity to do more than simply incorporate wholesale in its Orders plans for industry self-regulation written for it by NEI.**
- **NEI “Flex” Plan compounds current unwieldy “patchwork” of voluntary and partial regulatory initiatives that guide mitigation of severe accidents.**

Top-line Recommendations:

- Create “Extended Design Basis” Regulatory Framework NOW for SBO/Severe Accident Mitigation, and make it part of the Reactor Oversight Process to guide subsequent efforts
- Require high capacity filters for Reliable Hardened Vents
- Reinstate NTTF emphasis on early implementation of extended minimum initial coping time for SBO events, and include self-powering options to maintain control of steam-turbine-driven emergency cooling pumps and valves.

Top-Line Rec's - 2

- **Reinstate original NTTF proposal on spent fuel instrumentation and pool makeup capability**
- **Satisfy ACRS concerns with draft staff guidance on this issue**
- **Pursue swift implementation of ACRS proposal to ensure current reactor and containment instrumentation remains functional under severe accident conditions**
- **Augment this capability via addition of in-core thermocouples to monitor fuel cladding temperature.**

Consider Risk Factors Beyond Achievable Dose Savings

- **Reform licensing process to require consideration of risk factors beyond achievable dose savings via evacuation—e.g.:**
 - **total population at risk**
 - **land and water contamination**
 - **property losses**
 - **reduction in economic activity**
- when assessing severe accident risks arising from reactor siting and licensing actions**

Evaluation of NRC Actions on Each Major Fukushima Near Term Task Force (NTTF) Recommendation

NTTF Rec. 1: Create an Extended Design Basis

- **Establish “logical, systematic and coherent regulatory framework” for ensuring adequate protection against severe events now seen as “beyond-design-basis.”**
- **“Extended Design Basis” regulation would lend coherence and enforceability to NRC’s post-Fukushima actions.**

Extending Design Basis, cont.

- **Commission failing to implement this critically important recommendation.**
- **In fact, Commission policy is heading in the opposite direction.**
- **Acceptance of industry-devised FLEX approach to mitigate effects of prolonged SBO just thickens informal “patchwork” of unenforceable protections.**

NTTF Rec. 2: Seismic and Flood Protection

- **“Require licensees to reevaluate and upgrade...design basis seismic and flooding protection”**
- **Relaxed timetables, with paper study due dates of 3-5 years after the accident, suggest NRC does not take these threats seriously.**
- **Flooding hazard revaluations (i.e. paper studies) to be completed by March 2015 (4 years after accident)**

Reevaluating Seismic and Flooding Hazards

- **Seismic hazard reevaluation deadline is May 30, 2014 for Eastern US plants, and November 2015 for Western US plants.**
- **These dates, and any regulatory actions taken in response to these reevaluations, are too late to meaningfully inform the baseline data for FLEX contingency planning and procurement.**

NTTF Rec. 3: Enhance Mitigation of Seismically Induced Fires & Floods

- **In October 2011 NRDC recommended folding review of this hazard into the seismic/flood walk-downs and reevaluations, rather than postponing consideration.**
- **Obvious seismic weaknesses in plant electrical and fire protection systems, including potential for cascading negative interactions – should be addressed now, without waiting 7-8 years (!) for detailed PRA analyses.**

NTTF 4: Require Licensees to strengthen SBO mitigation

- **This was a two-part recommendation**
- **Short term order (4.2) to provide:**
 - **“reasonable protection” for 10 CFR 50.54 (hh) (2) emergency equipment;**
 - **additional equipment to address “multi-unit events;”**
 - **conforming changes to rule.**
- **Initiate rulemaking (4.1) to revise 10 CFR 50.63 to establish:**

NTTF's SBO Mitigation, cont.

- (1) minimum coping time of 8 hours for loss of all ac power;**
- (2) equipment, procedures and training necessary to implement extended coping time of 72 hours for core and spent fuel cooling and assurance of RCS/primary containment integrity, and**
- (3) Offsite resources to support these functions deliverable to site in the time period for extended coping under degraded transport conditions**

NRC “Mitigation Strategies” Order (EA-12-049) abandons coherent regulatory approach

- **NTTF emphasis on early improvement of initial coping time has been lost**
- **Scope of industry-devised and mostly unaccountable “FLEX Program” infringes on, and may be intended to supplant or predetermine outcome of NTTF’s recommended rulemaking**

FLEX Approach Devoid of Firm Binding Requirements

- **Minimum required initial and extended coping times (8- and 72-hours) have been jettisoned**
- **No minimum standards required for equipment, procedures and training necessary to achieve extended coping times, whatever these may turn out to be at any given site.**

More FLEX Concerns

- **FLEX purports to be severe event/prolonged SBO mitigation strategy, but planning baseline assumes no damage to core safety system functions other than extended loss of AC onsite and offsite power**
- **(e.g. all critical pumps, valves, and control circuits are assumed to remain operable during and after “severe event”).**
- **How realistic is this assumption, given known daily impairments to safety systems at operating US reactors (e.g. leaky RCS valves and tanks, short-circuits, electrical bus failures, stuck valves, unreliable ECCS turbine speed controls, etc.)**

More FLEX Concerns

- **How will FLEX credibly incorporate “extended design basis” revisions if these are unlikely to be established in regulation for many years, if ever?**
- **Without common performance, standards and inspection criteria, how will the NRC credibly evaluate and enforce the efficacy of some 64 discrete and unique FLEX SBO response plans?**
- **Is EA-12-049 erecting a “Potemkin Village” approach to mitigating “beyond design basis” external events?**

NTTF #5: Reliable Hardened Vents (RHVs)

- **NRDC supports prompt installation of High-Capacity Filtered RHVs in all US PWR's, starting with GE BWR Mark I and II units.**
 - **Sweden installed high capacity filtered vents in all NPPs by the end of 1988**
 - **All French PWRs were similarly equipped in mid 1990s.**

High-Capacity Filtered RHVs afford maximum flexibility

- All German BWR's have high capacity filtered vents**
- Why has the NRC lagged behind?**
- 8-inch diameter "Reliable Hardened Vents," intended solely to protect primary containment prior to onset of core damage, offer insufficient protection under the plausible range of conditions likely to be found in a severe accident.**

Why High Capacity Filtered Vents?

- **Not all severe accident scenarios are slow-moving, SBO-based events**
- **Potential need in fast-moving, large-break accident for early venting (within minutes) of possibly damaged core BEFORE at-risk population can be evacuated**
- **Uncertain fission product scrubbing in Mark I “wetwell” – noble gases and potentially explosive hydrogen not condensed**

Case for Filtered Vents, cont.

- **In 1988 ORNL suggested high-capacity filtered vent systems for BWR-Mark II's because operation of simple hard vents in these units would more likely result in discharge of radioactive aerosols directly into the environment.**
- **Long Island Lighting Co. planned hardened high-capacity filtered vent similar to Swedish FILTRA, for the Shoreham Plant, a BWR Mark II.**

Transition from Preventing Core Damage to Severe Accident Mitigation is Inherently Uncertain

- **NEI position (April 12, 2012) – “there are (other) modifications... more beneficial than filtration” is predicated on three dubious assumptions:**
 - **(1) Current computer modeling can accurately predict progression of core damage under different accident scenarios;**

NEI's Flawed Premises Regarding High-Capacity Filtration

- (2) plant operators can ascertain real-time condition of the core throughout stages of a severe accident**
 - (3) operator errors would not make a severe accident far worse**
- These assumptions are neither realistic nor appropriately conservative:**
 - (1) Current computer models under-predict the rates of hydrogen production empirically demonstrated in European severe accident experiments**

Filtered Vents are a Prudent Real-World Tool

- (2) As shown at TMI-2 and Fukushima, plant operators not likely to understand condition of core during progression of a severe accident;
- (3) As shown in these and other nuclear accidents large and small, operator errors can suddenly make matters worse:
- In a severe accident, avoiding uncontrolled loss of containment and restoring cooling to damaged core(s) could require swift high-capacity venting of contaminated gases and aerosols to the local environment.

A Prudent Hedge Against Possible/Probable Failures

- **High Capacity Filtered RHVs are also a Prudent Hedge Against:**
 - **Delayed/Botched Evacuations in Densely Populated Areas**
 - **Failure of Other Systems for Managing Damaged Core**
 - **Failure of Timely External SBO Mitigation Measures**

NTTF #6: Hydrogen Control and Mitigation Inside Containment

- **NRDC supports heightened NRC attention and regulatory action on this issue:**
- **Need to better understand safe performance envelopes and inadvertent risks of various hydrogen igniter and passive recombiner systems;**
- **Need to reconcile technical bases for conflicting EU/NRC requirements for hydrogen mitigation.**

Hydrogen Monitoring

- **In 2003 NRC reclassified oxygen and hydrogen monitors as “non-safety related” equipment: i.e. no seismic and other endurance qualification, no redundancy, and no on-site backup power required.**
- **In light of Fukushima hydrogen detonations, this error should be corrected.**

NRC Relaxed Hydrogen Monitoring Interval

- **In 1983, NRC issued an order requiring that hydrogen concentrations in containment be monitored within 30 minutes of emergency cooling injection**
- **In 1998, NRC extended this timeframe to 90 minutes after coolant injection – too late to be of use in a large break loss of coolant accident.**

NRDC Supports UCS Hydrogen Monitoring Proposal

- **Safety-qualified monitoring instrumentation with prompt availability should be installed in:**
 - **BWR Mark I and II secondary containments**
 - **Fuel handling buildings of PWRs and BWR Mark IIIs**
 - **Any other NPP structure where it would be possible for hydrogen to migrate**

NTTF #7: Require enhanced spent fuel pool makeup capability and instrumentation

- Commission unwisely narrowed scope of NTTF instrumentation recommendation to gross measurement of water level only
- EA-12-051 omits monitoring for SFP temperature and radiation levels
- ACRS guidance review calls for greater resolution in SFP water level measurements, and would restore temperature monitoring.

Spent Fuel Instrumentation

- **NTTF recommended an Order providing for “safety-related” instrumentation (i.e. subject to the quality-assurance requirements of Appendix B to 10 CFR Part 50.)**
- **Staff guidance appears to make quality assurance a site-by-site self-determination by industry.**

Spent Fuel Pool Makeup

- **Commission has unwisely deferred NTF-recommended orders that would have ensured:**
 - **Safety-related ac electrical power for the SFP makeup system (7.2)**
 - **A train of onsite emergency power – not currently required -- for SFP makeup and instruments when reactor is not operating and irradiated fuel is present (7.3)**

Ensuring SFP Monitoring and Makeup Capability, cont.

- A seismically qualified means to spray water into the SFP, including an easily accessible connection to supply the water
- Possible future rulemakings on these three issues demoted to “Tier 2” priority
- Recent NRC actions reference less stringent industry plans via NRC Staff “guidance:”
- These incorporate NEI “guidance” on Flex (NEI 12-06) and SFP instrumentation (NEI 12-02), both of which now serve as proxies for the NRC’s own regulatory work product.

NTTF #8: Strengthen and Integrate On-Site Emergency Response Guidelines and Training

- **Clear operator understanding of emergency guidance regimes -- their essential tasks, qualifications, training and decision-makers -- is a crucial facet of defense-in-depth strategy**
- **To date, only Commission action has been, not prompt “Orders,” but issuance of a dilatory ANPR on April 18, 2012, more than a year after the accident**
- **Delay in implementing this recommendation undermines reasonable assurance protection against the threat of severe accidents**

NTTF #9: Emergency Plan Revisions for Prolonged SBO/ Multi-Unit Events

- **NTTF flagged issue for both near-term orders (9.3) and rulemaking (9.2)**
- **Commission initially demoted recommended 9.3 orders to future Tier 2 “regulatory actions”**
- **All that now means is eventual issuance of a “Tier 3” ANPR, beginning some time in 2014, and completing a final rule “4.25 years later.”**

NTTF #10-11: Additional EP Topics:

- **Protective Equipment for Emergency Responders in light of Fukushima**
- **Command and Control Structure for Long-Term SBO/Multi-unit Events**
- **Enhancements to EP decision-making framework based on Fukushima experience**
- **Real-time radiation monitoring on-site and within EPZs, training on appropriate KI use**

NTTF #10-11, cont.

- **These issues designated Tier 3, put in same 2014 “do nothing now” ANPR bin as NNTF #9.**
- **No resources allocated to Tier 3 issues in FY 12 or proposed FY 13 NRC budgets**
- **Might be addressed in “FY 14 and beyond” (if resources are made available)**

NTTF #12: Modify ROP to Encompass “Defense-in-Depth” Measures

- **This important recommendation consigned to “Tier 3.”**
- **Includes enhanced training for NRC staff and resident inspectors on managing severe accidents**
- **Current “risk-informed” Reactor Oversight Process (ROP) does not inspect for compliance with voluntary SAMG’s, or consider possible challenges to a facility’s licensing basis.**

Additional Staff/ACRS Recommendations (Tier 3)

- ***Emergency Planning Zone Size --***
NRDC supports proposed review of the basis for EPZ size, in light of:
 - **Fukushima real world contamination and evacuation experience**
 - **massive growth in population, property values, and economic activity at risk in a severe nuclear accident.**

Staff Recommendations, cont.,

- **Review pre-staging of Potassium Iodide (KI) Beyond 10 miles**
 - **NRDC supports NRC review of this issue.**
- **Review of Expedited Transfer of Spent Fuel to Dry Cask Storage:**
 - **While disagreeing with Staff's current views on SFP safety, we support NRC review of this issue -- appears legally required in any event in light of the D.C. Appeals Court "Waste Confidence" NEPA compliance ruling.**

ACRS Proposal to Enhance Reactor and Containment Instrumentation

- **Current reactor and containment instrumentation is not required to remain functional under severe accident conditions**
- **NRDC supports the ACRS proposal to add this capability**
 - **We recommend inclusion of in-core thermocouples to monitor fuel cladding temperature at various elevations and radial positions.**
 - **Key to detecting, forecasting hydrogen formation, transitioning to SAMGs.**
- **This effort needs higher prioritization and implementation schedule.**

END

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**Status of Lessons Learned
from the Fukushima
Dai-ichi Accident**

Michael R. Johnson

**Deputy Executive Director for
Operations**

August 7, 2012

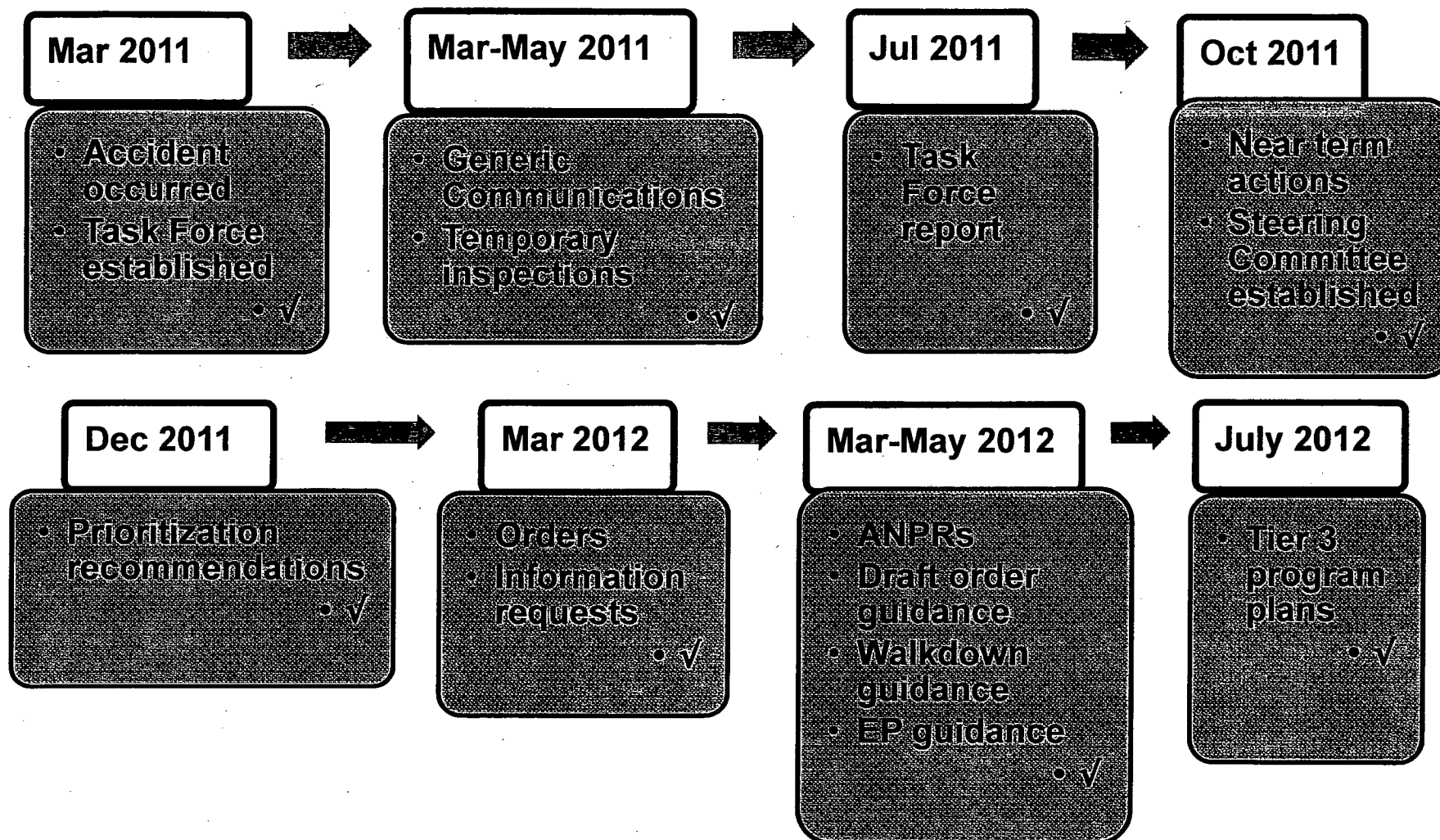
Agenda

- ***Purpose***
- ***Status of lessons learned***
 - ***Tier 1***
 - ***Tier 2***
- ***Tier 3 approach and plans***

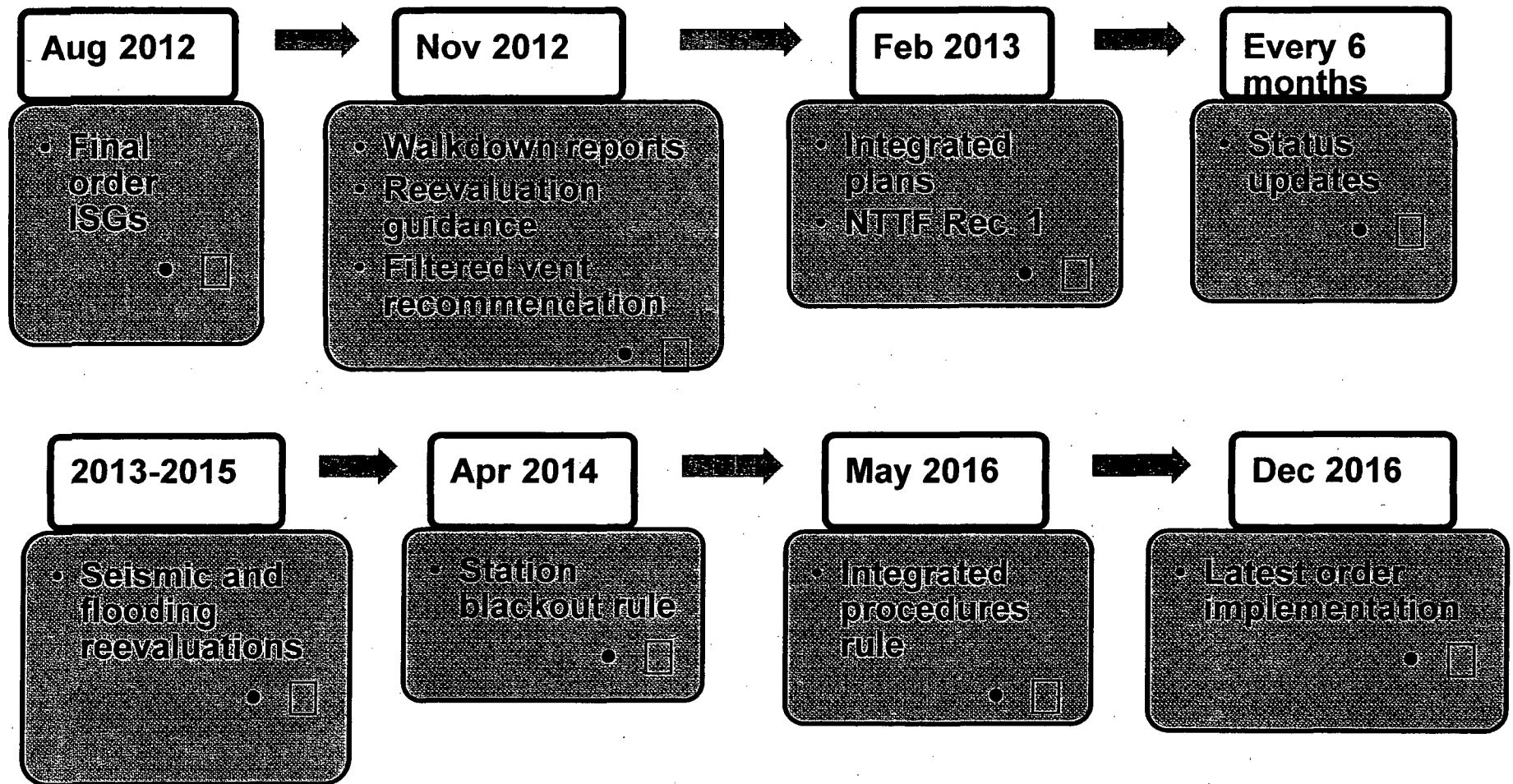
Progress Overview

- ***Safety enhancements being realized***
- ***On schedule with continued significant progress***
- ***Productive frequent stakeholder engagement***
- ***Other agency priorities continue***

Timeline



Timeline



Guiding Principles

- ***Do not distract from safety of operating facilities***
- ***Do not displace work of greater safety benefit or other high priority activities***
- ***Move forward promptly***

Tiers

- **Tier 1 - Start without delay and sufficient resources exist**
- **Tier 2 - Technical assessment needed, dependence on Tier 1 actions, or resource limitations**
- **Tier 3 – Further study or dependent on other action, critical skills, or Recommendation 1**

Ongoing Related Efforts

- ***Filtration of hardened vents for Mark I and II containments***
- ***NTTF Recommendation 1***
- ***Economic consequences***



Status of Lessons Learned

David Skeen, Director

Japan Lessons Learned Project Directorate

Brian Sheron, Director

Office of Nuclear Regulatory Research

Tier 1

- ***3 Orders***
- ***3 Requests for information***
- ***2 Advance notices of proposed rulemaking***
- ***Safety enhancements***
- ***On schedule***

Overview - Orders

	Order	Draft Guidance	Final Guidance	Operating Reactor Completion
Mitigating Strategies	✓ Mar 2012	✓ May 2012	On schedule Aug 2012	2 refueling outages or Dec 2016
Hardened Vents	✓ Mar 2012	✓ May 2012	On schedule Aug 2012	2 refueling outages or Dec 2016
Spent Fuel Pool Instrumentation	✓ Mar 2012	✓ May 2012	On schedule Aug 2012	2 refueling outages or Dec 2016

Mitigating Strategies Order

- ***Strategies/equipment for beyond-design-basis external events***
- ***Interim staff guidance***
 - ***Draft issued May 2012***
 - ***Evaluating comments received***
 - ***Considering endorsement of industry guidance document***
- ***On schedule***

Reliable Hardened Vent Order

- ***Mark I and II containment venting for core and containment cooling***
- ***Interim staff guidance***
 - ***Draft issued May 2012***
 - ***Evaluating comments received***
- ***On schedule***

Reliable Spent Fuel Pool Instrumentation Order

- ***Improved decision making***
- ***Interim staff guidance***
 - ***Draft issued May 2012***
 - ***Evaluating comments received***
 - ***Considering endorsement of industry guidance document***
- ***On schedule***

Seismic and Flooding Walkdowns

- ***Identify and address degraded, nonconforming, or unanalyzed conditions***
- ***Endorsed guidelines – May 2012***
- ***Issued temporary instructions***
- ***Walkdownslinspections underway***
- ***On schedule***

Seismic and Flooding Reevaluation

- ***Reevaluation using current seismic and flooding standards***
- ***Flooding prioritization – May 2012***
- ***Developing guidance***
- ***Considering endorsement of industry guidance document***
- ***On schedule***

EP Communications Systems and EP Staffing

- ***Power supplies for communication systems, and EP staffing during multi-unit events***
- ***Staff endorsed industry guidance – May 2012***
- ***On schedule***

Rulemakings

- ***Station blackout***
 - ***ANPR closed May 2012***
 - ***Developing rulemaking basis***
 - ***Final rule on schedule for April 2014***
- ***Integrating on-site emergency response procedures***
 - ***ANPR closed June 2012***
 - ***Developing rulemaking basis***
 - ***Final rule on schedule for May 2016***

Tier 2

- ***Spent fuel pool makeup capability***
- ***EP enhancements for multiunit and prolonged station blackout dose assessment, training and exercises, and equipment and facilities***
- ***Other natural hazards***

Tier 3

- ***Periodic seismic and flooding update***
- ***Seismically induced fires and floods***
- ***Vents for other containment designs***
- ***Hydrogen control and mitigation***
- ***EP enhancements for multiunit events and prolonged station blackout***
- ***ERDS capability***
- ***Additional EP topics***

Tier 3

- ***ROP modifications for defense-in-depth framework***
- ***Staff training on severe accidents***
- ***Emergency planning zone size***
- ***Potassium iodide beyond 10 miles***
- ***Transfer spent fuel to dry casks***
- ***Reactor and containment instrumentation***

Hydrogen Control and Mitigation

- ***Known impact on reactor safety***
- ***Assess hydrogen control measures***
- ***Evaluate accident sequences***
- ***Evaluate hydrogen migration***
- ***Assess technical basis of 50.44***

Transfer of Spent Fuel to Dry Cask Storage

- ***Confirm conclusions regarding safety of spent fuel pools***
- ***Assess whether significant safety benefits (or detriments) would occur from expedited transfer of spent fuel to dry casks***

Acronyms

- ***ANPR – Advance notice of proposed rulemaking***
- ***EP – Emergency preparedness***
- ***ERDS – Emergency response data system***
- ***ISG – Interim staff guidance***
- ***NTTF – Near term task force***
- ***RFI – Request for information***