



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
P.O. Box 15316
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.

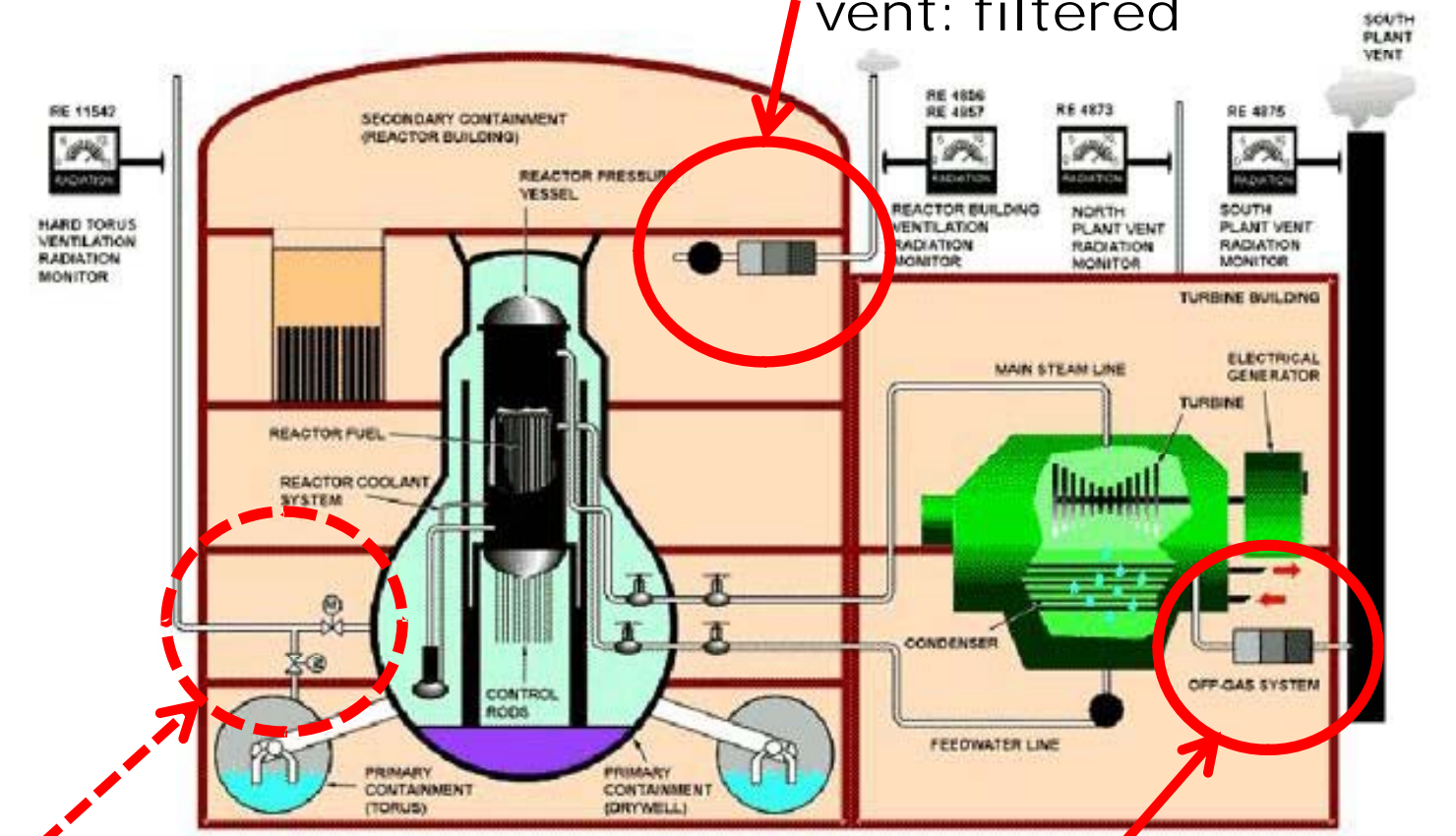
Lesson: Hydrogen Control

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



Beyond design basis accident vent: unfiltered?

Normal 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).

Source: ML12080A196

Lesson: Spent Fuel Pools

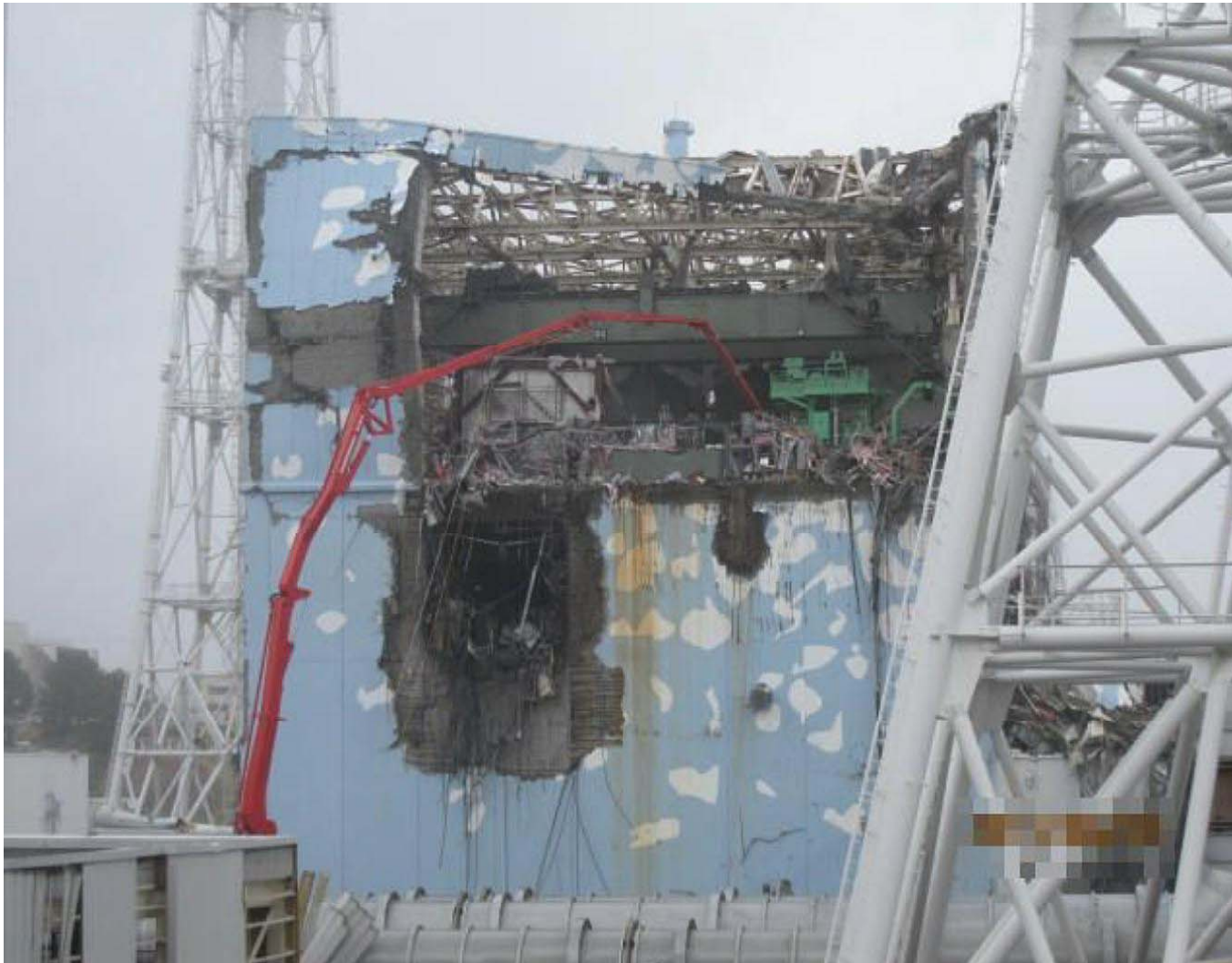
Three reactor units—in worse condition than Three Mile Island Unit 2 ever got at any time during its accident—were a lower priority in NRC's eyes than a single spent fuel pool.

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 Departement began spraying water at the spent fuel pool
3/21/2011	358	Tokyo Fire Departement 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 boiloiff. 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 tis 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 is 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 reproted "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