Lessons from Fukushima

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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.

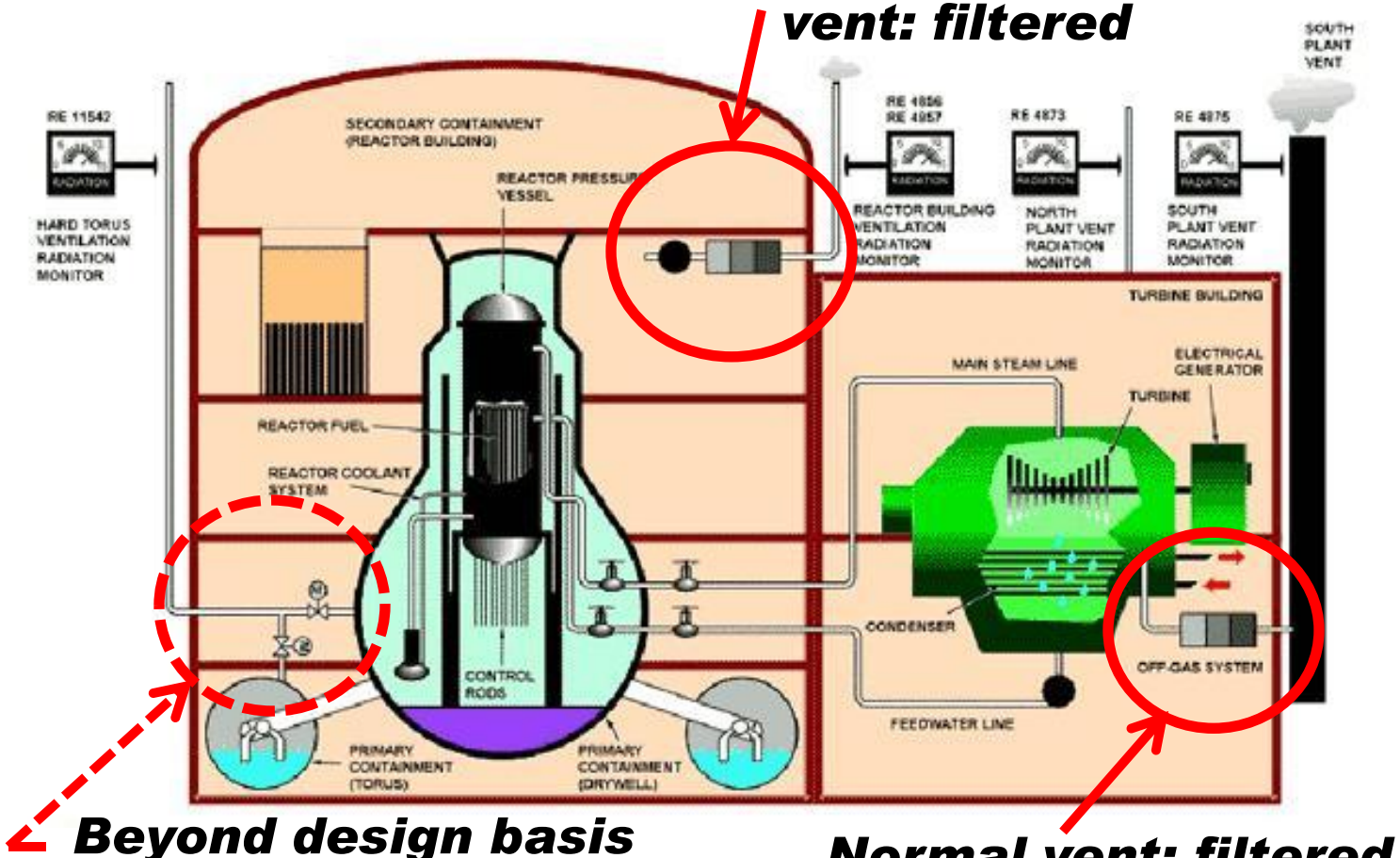
Therefore, Fukushima's fixes should include margin analyses as reality checks.

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



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

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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.