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Nuclear Safety Deferred:
The U.S. Nuclear Regulatory Commission's Inadequate Response to the Lessons of the Fukushima Dai-ichi Nuclear Accident

AUTHOR
Jordan Weaver
Natural Resources Defense Council

On March 11, 2011, Japan was hit by a devastating 9.0-magnitude earthquake and a series of destructive tsunamis. To make matters worse, these extreme natural events helped initiate a third crisis in Japan, which took the form of the crippled Fukushima Dai-ichi nuclear power plant. Immediately following the accident, the NRC established a Near-Term Task Force to review the accident and determine what actions are needed to improve the safety of U.S. reactors. While the NRC taskforce provided more than 30 safety recommendations, to date they have not acted on any of them, including actions that were identified as top priority. The Natural Resources Defense Council's (NRDC) nuclear program is releasing this report to discuss the details of the U.S. Nuclear Regulatory Commission's (NRC) response to the lessons learned from the Fukushima Dai-ichi nuclear disaster, in time for the one-year anniversary of last year's events.

Natural Resources Defense Council - Nuclear Program
1152 15th Street NW, Washington, D.C.
www.nrdc.org/nuclear

NUCLEAR SAFETY DEFERRED

THE U.S. NUCLEAR REGULATORY COMMISSION'S INADEQUATE RESPONSE TO THE LESSONS OF THE FUKUSHIMA DAI-ICHI NUCLEAR ACCIDENT

March 2012

DEDICATION: Natural Resources Defense Council (NRDC) offers our deepest condolences to the people of Japan. Many have been irreversibly affected by this tragic event, and many continue to suffer from the consequences of the tsunami and radiological conditions that prevent them from returning to their homes and livelihoods, possibly forever. Our hearts go out to these individuals as they recover and rebuild from this tragedy.

The Natural Resources Defense Council (NRDC) is a national non-profit membership environmental organization with offices in Washington, D.C., New York City, San Francisco, Chicago, Los Angeles and Beijing. NRDC has a nationwide membership of more than 1.3 million members and online activists. NRDC's activities include maintaining and enhancing environmental quality and monitoring federal agency actions to ensure that federal statutes enacted to protect human health and the environment are fully and properly implemented. Since its inception in 1970, NRDC has sought to improve the environmental, health, and safety conditions at the nuclear facilities licensed by the U.S. Nuclear Regulatory Commission (NRC) and its predecessor agency.

For more information about NRDC's Nuclear Program, please visit:
http://www.nrdc.org/nuclear

For more information regarding this report, please contact the author:

Jordan Weaver
Nuclear Program Science Center Fellow
jweaver@nrdc.org
switchboard.nrdc.org/blogs/jweaver

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"For a successful technology, reality must take precedence over public relations, for nature cannot be fooled."

Richard Feynman

Rogers' Commission Report into the Challenger Crash Appendix F - Personal Observations on Reliability of Shuttle (June 1986)

INTRODUCTION

Closing in on the one-year anniversary of the largest nuclear accident since the 1986 Chernobyl disaster, many people are reflecting on the events of last year's Fukushima Dai-ichi disaster. Those in the United States may wonder: Has anything changed here? What have we learned from Fukushima, and is the U.S. nuclear industry safer than it was a year ago? Should Americans be confident in our nuclear regulators? And how has the situation progressed in Japan since March 2011? What has been the impact of the Fukushima catastrophe on the global nuclear industry?

Fukushima Disaster Recap

The Fukushima Dai-ichi nuclear plant consists of six boiling water reactors designed by General Electric and owned by the Tokyo Electric Power Company (TEPCO). At the time of the accident, Units 4, 5, and 6 were down for routine maintenance and refueling activities.

After the 9.0-magnitude Great Tōhoku Earthquake occurred, the operating nuclear reactor Units 1, 2, and 3 automatically shut down, as they were designed to do, and the entire facility lost offsite power, causing the startup of emergency diesel generators at all six units. Less than one hour later, a series of tsunamis up to 14 to 15 meters (46 to 49 feet) above mean sea level struck the facility, disabling the seawater coolant pumps for the steam condensers of Units 1 through 4 and all but one of the backup generators, in addition to causing other extensive site damages. The plant entered a full station blackout with the exception of one air-cooled generator at Unit 6. Despite the plant operators' actions, they lost the ability to cool the fuel in Unit 1 after several hours and then in Units 3 and 2 after approximately 36 and 70 hours, respectively. To make matters worse, offsite infrastructure was severely damaged and delayed outside assistance.

Over the next few days, the situation at the plant worsened and resulted in full meltdowns of Units 1, 2, and 3 despite the efforts of plant workers to cool the overheated cores, in several instances using seawater. The overheating cores in Units 1 through3 produced large amounts of hydrogen gas from the rapid oxidation of the nuclear fuel's zirconium cladding, leading to a series of hydrogen explosions that severely damaged the reactor buildings that furthered hindered plant recovery efforts, and led to fears of significant offsite radioactive releases. As these were confirmed, officials ordered a series of staggered evacuations eventually resulting in a 20-kilometer (12.4 miles) evacuation zone.

The plant and surrounding area was extensively contaminated as result of radioactive material released during deliberate venting of the reactor containments, discharge of coolant water into the sea, and numerous uncontrolled releases. Nine months later, on December 16, 2011, Japanese officials announced the situation at the plant was stable. However, decontamination efforts to the surrounding areas as well as plant decommissioning will take decades to achieve.[1]

For further details about the accident, please consult the following materials:

- Nuclear Emergency Response Headquarters—Government of Japan, "Report of the Japanese Government to the IAEA Ministerial Conference on Nuclear Safety—The Accident at TEPCO's Fukushima Nuclear Power Stations," International Atomic Energy Agency (IAEA) Ministerial Conference on Nuclear Safety, Vienna, Austria, June 7, 2011 (http://pbadupws.nrc.gov/docs/ML1117/ML11178A379.pdf)
- Institute of Nuclear Power Operations (INPO) 11-05, "Special Report on the Nuclear Accident at the Fukushima Daiichi Nuclear Power Station," Revision 0, issued November 2011 (http://pbadupws.nrc.gov/docs/ML1134/ML11347A454.pdf)
- Executive Summary of the Interim Report, Investigation Committee on the Accidents at Fukushima Nuclear Power Stations of Tokyo Electric Power Company, December 26, 2011 (http://icanps.go.jp/eng/111226ExecutiveSummary.pdf)

Impact on the Global Nuclear Industry

The Fukushima disaster elicited responses from the Japanese government, the Japanese nuclear industry and, indeed, from nations and affected entities around the world. Unfortunately, the extent of the response from the nuclear industry and government regulators, both in Japan and as we will detail, in the United States, has failed to address deep public concern. An NRDC database comparison of pre-Fukushima nuclear industry activities to more recent statistics demonstrates that the forecasted nuclear plant plans and proposals have changed little. National policy, however, has changed drastically in a few cases.

The strongest reaction occurred in Germany, which decided to phase out nuclear power by 2022 (see Table 1).[2] The events in Japan furnished new momentum to the German debate over nuclear power that first gained serious traction after the Chernobyl incident. Germany's first decision to phase out nuclear power was made in 2002, but Berlin changed course in 2010 when a business-friendly coalition extended German nuclear power stations' licenses. But immediately after the Fukushima disaster Germany passed legislation that shut down eight of its seventeen operating reactors immediately. The remaining reactors obtained licenses that will expire by 2022. In particular, Germany's reaction resulted in an 18 percent share of nuclear generation for the country, as opposed to previous year's 22.6 percent share, and mandated a 20 percent share for renewable energy sources.[3] Renewable energy generation's share crossing the twenty percent mark in Germany is therefore a direct consequence of the Fukushima disaster.

Table 1. Summary of the German reaction to Fukushima by the Environment Ministry

Date	Kind	Title
03/11/2011	**Fukushima Disaster**	-
April 2011	Information	Q&A for Japanese situation and possible ramifications in Germany
May 2011	Report	Brief report of the survey of the German nuclear regulatory authority
05/16/2011	Official Statement	Results of site-specific inspections of German nuclear power plants. Evaluation and Recommendation of the Reactor Safety Commission
06/06/2011	**Phase-out legislation passed**	Thirteenth amendment to the Atomgesetz (Nuclear Law) mandates phase-out
09/12/2011	Press Release	International experts consider Germany's reaction to Fukushima events commendable
09/23/2011	**Report of stress tests**	Performance of EU-Stress Test in Germany (as per European Nuclear Safety Regulators Group mandate) Link
01/02/2012	Report	Federal Government submits German national report to the European Commission.

Reactions to the disaster around the world have been varied and notable. Other European countries join an increasing anti-nuclear sentiment. As a direct result of the Fukushima Dai-ichi disaster, Switzerland and Spain have announced they will gradually phase out their nuclear plants via a ban on new nuclear facilities and refrain from any replacements for existing plants. [4] [5] In the case of Switzerland, this comes as a turnaround: World Nuclear News announced in November 2010 that three Swiss nuclear plants would be replaced and had already received licenses. [6] Italy will not pursue reintroducing nuclear power, which it had planned before the events in Japan.[7]

Post-Fukushima nuclear policy in the United Kingdom is likely to delay and possibly curtail future industry growth but for reasons that are not directly related to concerns over nuclear safety. Officially, London gave a green light for new nuclear projects beginning as early as 2009—two years before the Fukushima disaster—but the legislation includes one important caveat: the United Kingdom dedicates no public funds to any insurance scheme.[8] Nuclear power in the United States and Germany, for example, relies on legislation like the Price-Anderson Nuclear Industries Indemnity Act. The lack of a similar British measure is likely a kiss of death for new British nuclear power, given that potential investors witnessed TEPCO's massive liabilities in Japan estimated to range from the high tens to hundreds of billions of dollars. As statistics published by the World Nuclear Association show, none of the planned and proposed British nuclear plants have transitioned to the construction phase.

Amid strong public responses, France joined in international efforts to reduce safety risks posed by nuclear power. About three quarters of French electricity generation is nuclear, which exposes the country to significant nuclear and energy security risks should one of these units suffer a severe accident, thereby raising both legitimate safety concerns about similar units and broad political demands to shut them down. In response to the Fukushima accident, France's nuclear regulator, the French Safety Authority (ASN), has imposed safety upgrades across French nuclear power stations.[9]

Thus seven of the 30 countries with operational nuclear power plants, five of them being Organisation for Economic Co-operation and Development (OECD) members, altered their nuclear policy against new reactors or in favor of tighter safety measures as a direct consequence of the Fukushima accident. [10]

U.S. NUCLEAR REGULATORY COMMISSION RESPONSE TO FUKUSHIMA

Near-Term Task Force Report

In the months that followed the Fukushima disaster, Americans received numerous assurances from the Nuclear Regulatory Commission (NRC) and the nuclear power industry that the accidents in Japan, and the ever-compounding complications seen there, are extremely unlikely to occur in the United States. Nonetheless, under the leadership of its current chairman, the NRC tasked a team of its own experts to conduct a study and to report back with an assessment of the "domestic nuclear fleet," highlighting any changes in reactor safety-related systems, emergency equipment, and procedures that would be prudent to implement in light of the events at Fukushima.

On July 12, 2011, the agency released its findings in a document titled "Recommendations for Enhancing Reactor Safety in the 21st Century: The Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," (hereinafter "Task Force Report"). The NRC Chairman asked that a decision be made on the report's recommendations within three months of its release, and implement the necessary changes over the next five years. NRDC learned that there were significant efforts to either impede or slow efforts at the safety overhaul suggested by the Near Term Task Force. In response, NRDC's Nuclear Program submitted more than a dozen rulemaking and order petitions to spur the Commission into action regarding the report's recommendations. [11] A little more than a month later, the NRC began conducting public meetings to solicit comment from industry and external stakeholders, NRDC among them, on the conclusions reached in the report and what the next steps should be for the agency.

Even before the Task Force began its work, the NRC Chairman stated that there would be a two-step process: a near-term review spearheaded by the agency (with industry involvement) and a longer-term review that would be chartered to include a wide array of organizations and individuals that would focus on far-reaching nuclear safety improvements that would only become apparent after further study of the Japanese accident. Ideally, the NRC Near-Term Task Force report was to be the agency's answer for crucial safety upgrades warranted immediately, and the longer term review would address just those issues not conducive to an immediate fix.

The results that should have come from both reviews have not fared well. The actions to be taken from the near term review have either been slowed or placed into the bin of the longer term review. The NRC recently released a six-month status update on various changes and activities where this became apparent. Actions that were identified as part of the near-term review were broken up into various pieces and tiers, with many of the suggested items taking the place of the longer-term post-Fukushima nuclear safety review. We do not believe this was the original intent of the NRC Chairman and we share concern that several immediate safety upgrades were not acted upon. Moreover, the longer term review will, unquestionably, take years. This is inappropriate and a significant failure in light of the most significant nuclear disaster since Chernobyl.

Prioritizing Safety

To understand the underwhelming level of effort currently proposed by the NRC and industry in response to Fukushima, a clear understanding of what was initially envisioned by the NRC's Near-Term Task Force is needed. This will help shed some light on the industry-commission slow-down over the past year of an initially promising nuclear power initiative. The Near-Term Task Force provided more than 30 items to be considered and, preferably, acted upon promptly. The list included proposals for eleven Commission orders, seven rulemakings, and more than a dozen other key suggestions such as improving our state of knowledge about hydrogen explosions and protecting against seismically induced fires and floods (see Appendix Tables A.1 through A.4).

During stakeholder meetings, a majority of the Commissioners and senior NRC staff decided to "prioritize" the recommendations and identify a subset that should be undertaken "without unnecessary delay," implicitly leaving the rest to be dealt with on a more relaxed timetable, or possibly not at all.[12] In this prioritization by the NRC staff, recommendations were broken up into three tiers, with Tier 1 containing those that should be addressed *immediately.* The remaining two tiers unfortunately were given no particular timelines tied to them, but nonetheless contain key recommendations that are needed now. As will be shown below, even those recommendations in Tier 1, despite the issuance of draft orders and letters in time for the Fukushima anniversary, are going to experience a painfully drawn out implementation (see Table 2 and Figure 1: Timeline Insert). [13] If we are to assume these changes are needed to make our nuclear plants safer, then the plants that agree they are required to conduct these changes will not be safer for years to come.

The majority of this report will focus on the details, timelines, and the NRC's implementation plans associated with those actions contained in Tier 1. A status update on Tier 2 items is expected to come in July 2012, with the possibility of a rulemaking regarding spent fuel pool instrumentation and water makeup capability coming supposedly in late calendar year 2012. NRDC would like to be clear that it objects to the demotion of many items to the very uncertain Tier 3 category, for which no action is expected until those actions regarding Tiers 1 and 2 are completely scoped. Because we feel the recommendation pertaining to hydrogen gas control to be one of the more unfortunate casualties of the staff's prioritization, we discuss this issue later along with our evaluation of the Tier 1 actions.

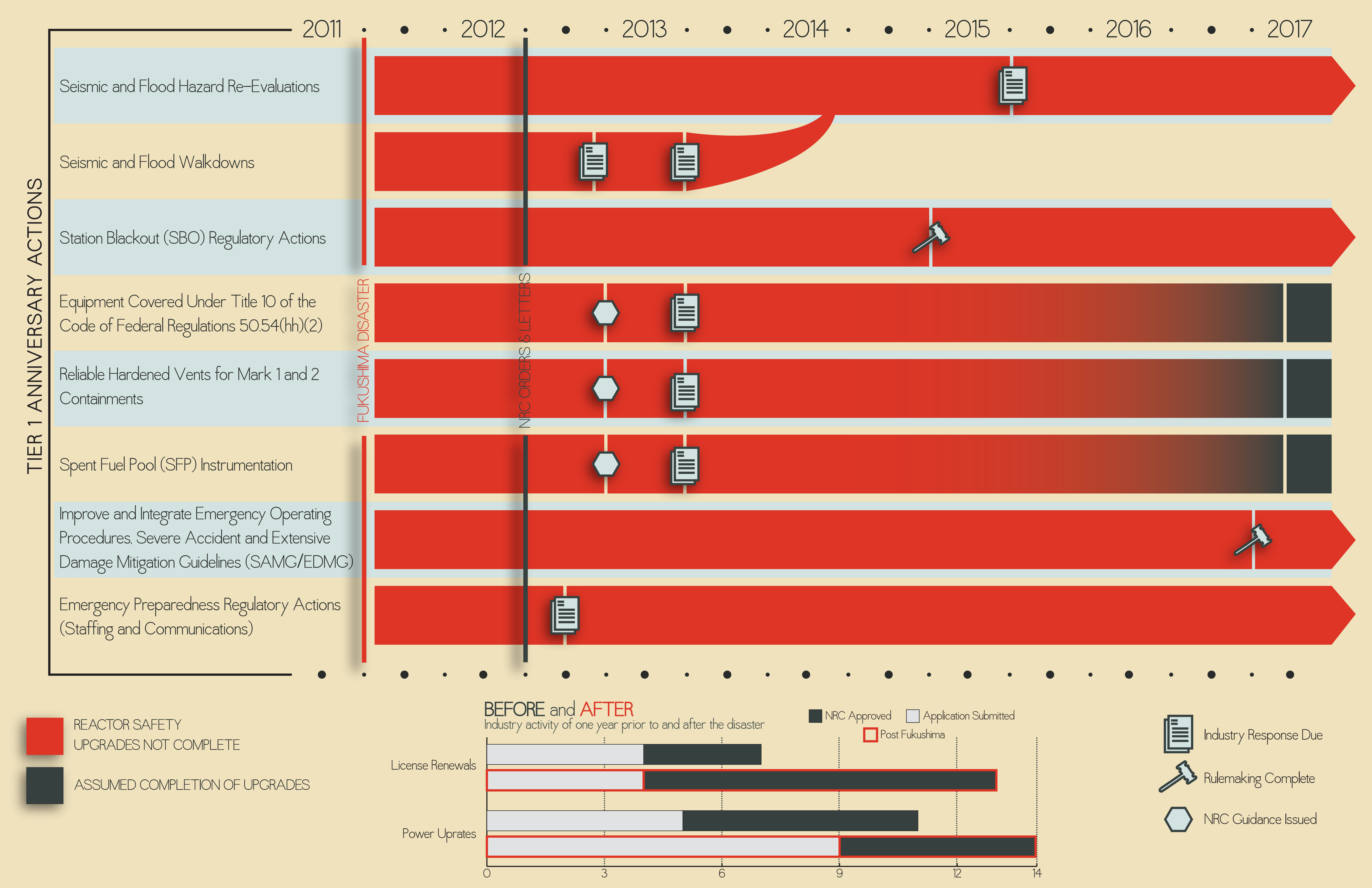
Table 2. Staff-prioritized recommendations to be undertaken without unnecessary delay (Tier 1).

Original Action	New Action	Description	Date of Completion
ORDER	50.54(f) RAI	Seismic and flood hazard reevaluations	Approx. 2019*
ORDER	50.54(f) RAI	Seismic and flood walkdowns	March 2013*
Rulemaking	Rulemaking	Station blackout regulatory actions	September 2014*
ORDER	ORDER	Equipment covered under Title 10 of the Code of Federal Regulations (10 CFR) 50.54(hh)(2)	December 2016
ORDER	ORDER	Reliable hardened vents for Mark 1 & 2 containments (possibly without filters)	December 2016
ORDER	ORDER	Improve spent fuel pool instrumentation	December 2016
ORDER	Advanced Notice of Proposed Rulemaking	Strengthening and integration of emergency operating procedures, severe accident management guidelines, and extensive damage mitigation guidelines	September 2017*
ORDER	50.54(f) RAI	Emergency preparedness regulatory actions	June 2012*

* Completion does not necessarily imply plant updates were performed.

Fortunately, the NRC staff has listened somewhat to the external stakeholder input that pointed out how grossly inefficient it was to address the issue of seismic and flooding vulnerabilities (Tier 1) independent of the need to abate the ensuing fire risks (seismically induced fires and floods had been given Tier 3 status). The staff is now planning to begin the development of a new probabilistic risk assessment (PRA) methodology to address these externally induced risks. They expect to deliver a status report on planning activities by July 2012. Considering that fire risks and industry compliance are still largely unresolved even within the current regulatory framework, NRDC hopes that the staff will move quickly on requiring plant's to examine these fire and flooding risks and, eventually, impose regulatory actions that demand compliance with not only a 30-year old rule but any new requirements to minimize the highlighted risks.

So here we are, one year following the accident. The NRC states openly that as of December 6, 2011 they had not required any plant modifications or changed any regulatory requirements as a result of the Fukushima disaster. They also acknowledged that they are not aware of any significant plant modifications made by the industry.[14] Recently, the NRC has issued a Notation Vote paper and published drafts of the orders and requests for information (RAIs or "50.54(f) Letters") relating to the issues within Tier 1.[15] The Commission is expected to issue those items before March 11, the anniversary of the disaster. What this boils down to is that the Commission and industry are now finally happy with the wording of how the NRC staff should ask for the information (which in many cases the NRC already has) to inform the Staff's subsequent specific formulation of the regulatory actions needed to improve safety (which the Commission may or may not finally make mandatory). In many cases, the public will wait years just to arrive at the starting line for implementing any nuclear plant safety modifications.



TIER 1 ANNIVERSARY ACTIONS
2011
2012
2013
2014
2015
2016
2017
FUKUSHIMA DISASTER
NRC ORDERS & LETTERS
Seismic and Flood Hazard Re-Evaluations
Seismic and Flood Walkdowns
Station Blackout (SBO) Regulatory Actions
Equipment Covered Under Title 10 of the Code of Federal Regulations 50.54(hh)(2)
Reliable Hardened Vents for Mark 1 and 2 Containments
Spent Fuel Pool (SFP) Instrumentation
Improve and Integrate Emergency Operating Procedures, Severe Accident and Extensive Damage Mitigation Guidelines (SAMG/EDMG)
Emergency Preparedness Regulatory Actions (Staffing and Communications)
REACTOR SAFETY UPGRADES NOT COMPLETE
ASSUMED COMPLETION OF UPGRADES
BEFORE and AFTER
Industry activity of one year prior to and after the disaster
NRC Approved
Application Submitted
Post Fukushima
License Renewals
Power Uprates
0
3
6
9
12
14
Industry Response Due
Rulemaking Complete
NRC Guidance Issued

Description of Timeline Insert

The graphic above depicts the NRC timelines associated with their implementation of the Tier 1 actions, defined to be those actions to be started *without unnecessary delay*. The actions are listed on the left side. A progress bar shows the status of U.S. reactors versus time with regard to each particular action. Where the NRC has stated the completion of a *milestone*, such as an industry response or final report, issuance of guidelines, or completion of rulemaking, appropriate markers are placed on the progress status bar. The color of the progress status bar indicates whether any actual plant modifications, safety procedures upgrades, or other activities have or have not occurred. The color is DARK BLUE when these implementing actions have indeed been carried out and plant safety is now actually upgraded as a result of these actions. The color is RED so long as planning activities and rule formulations are being conducted, as this does not represent a change in the plant's safety systems.

Additionally, the graph at bottom-center compares the pre- and post-Fukushima levels of industry and Commission activity in terms of number of 20-year reactor license renewals as well as reactor power uprates (both approved and applied for). This does not include the recent licensing of two new AP-1000 reactors, the Vogtle Electric Generating Plant Units 3 and 4.

Tier 1 Anniversary Actions

Reliably Hardened Vents, Hold the Filters?

During the days that followed the Fukushima Dai-chi station blackout, significant complications arose when the containment pressures at Units 1, 2, and 3 grossly exceeded their design limits. The operators encountered further problems in venting the reactor containments due to the prolonged station blackout (SBO) conditions and the harsh working environments the accident had created. The concept of containment venting, in this case, refers to allowing the built-up pressure and heat within the primary containment to be vented into the plant's tall stacks, eventually ending up outside through "controlled releases," to help prevent containment failure that could result in uncontrolled radioactive releases to the environment. In 1990, the NRC had identified the boiling water reactor (BWR) Mark 1 containment design as having a high probability of failure in the event of core damage, thus necessitating some form of pressure stabilization during an accident. [16] The Near-Term Task Force concluded that Mark 2 designs would likely encounter the same fate because their containment volumes are only 25 percent larger than those of the Mark 1.

As a result of the 1990 study, the NRC eventually decided that, instead of formally requiring all BWR Mark 1 plants to incorporate a hardened vent, they would allow licensees, *on their own initiative*, to possibly take an appropriate action. This resulted in all of the BWR Mark 1 plants eventually incorporating some form of wetwell venting and three (out of eight) Mark 2 units installing them as well. Unfortunately, these designs vary widely in their implementation and their capability under certain severe accident conditions. Some vents still rely on alternating current-operated valves, which would obviously be compromised in an SBO scenario, but the main point is that even after all of this *effort* the hardened vent is still not a required design feature that is inspected regularly for its continuing operability in the event of a severe accident.

So when the Task Force recommended that all Mark 1 and 2 licensees finally be required to install a reliable venting system (i.e., one that would operate under the conditions that necessitate its usage in the first place), the industry-senior NRC staff responded that there was not enough information on the subject to immediately impose such a requirement. Oddly enough, after nearly 8 months of discussion, the order that is expected to come from the NRC by March 11, 2012 will likely look exactly as it had at the beginning of this process, and they will have wasted that time arguing the merits of venting when they could have been discussing how to expedite the implementation of this recommendation. One problem with venting the containment is preventing the radionuclides that are present in the vent stream from entering the reactor secondary containment or from reaching the outside environment, as seen in Japan when the secondary containment was destroyed by hydrogen explosions.

One way to reduce this threat is to install a vent filter designed to capture the radioactive particulates as the containment is vented. Containment vent filtration systems can be retrofitted to any U.S. nuclear plant design and provide very high radioactive particle removal efficiencies using passive components. In other words, highly capable filtered vent systems are available today and require no emergency alternating current (AC) or direct current (DC) power. Remarkably, the NRC has agreed with the industry that this common-sense design feature, of which there are currently several commercially available designs, will *not* be required under the new draft order, but that the requirement for filtered vents will continue to be reviewed further as the planning actions are being conducted. The staff is expected to send a policy paper to the Commission in July 2012 that will outline considerations for the addition of filters to the hardened vent designs. Here the NRC may once again miss a valuable opportunity to move forward on a much-needed safety improvement: an improvement countries like France and Germany have already implemented. Because the United States is often cited as setting a safety example, the Commission should not waste any time debating the obvious because this only manages to cast doubt on a safety feature that could be taken up by other countries that emulate US regulatory requirements, and could therefore contribute to preventing devastating radioactive releases in future accidents both here and abroad.

Despite initial estimates of completion by March 2015, the NRC's revised plan is now to have all actions related to this venting order completed by no later than the start of 2017. The NRC blames this delay on, among other things, an unresolved *policy issue* of whether containment vents with or without filters, should be required to operate under severe conditions. This policy debate seems counterintuitive because it should be obvious that a *severe accident* mitigation technique must be capable of operating under *severe accident scenarios*.

NRDC urges the NRC to follow through not only on those good insights present in the order's current wording, such as passive operation and the use of permanently installed SBO-tolerant equipment, but also the concepts of minimizing the danger to public health through the installation of robust filtration systems. Delaying or ignoring this upgrade does not reassure the public of NRC's commitment to the important role of filtered vents in mitigating the consequences of severe nuclear accidents, and also sends a negative message to other nuclear nations.

Seismic and Flooding Hazards

What we have seen over the last year is the consistent watering-down of the Task Force's recommendations, both in terms of urgency and method, through industry influence at the expense of making meaningful near-term progress on improving the NRC's approach to safety. Seismic and flood vulnerabilities will remain largely unaddressed due to cries of limited industry resources to handle the agency's requests. The staff recommended that the plant licensees should perform two somewhat concurrent *near-term* actions. The first, seismic and flooding hazard re-evaluations, involve requests for information that the NRC claims it needs to develop appropriate regulatory actions. These re-evaluations will also incorporate the results of plant-wide *walkdowns*, or inspections, that aim to identify seismic or flooding vulnerabilities in structures and safety-systems. Ideally, this action will help to inform the re-evaluations. While the information request for the re-evaluations covers many aspects of site-specific seismic and flood risk, the NRC claims that, without this information, any binding regulatory requirements to update safety systems at this point would be rushed and uninformed.

Yet, the NRC continues to state they have enough information to validate the design basis and adequacy of safety systems for *new* nuclear plants. Even more confusing is the fact that some of the reactors that they are requesting information from are located at the same sites as these new applications. The agency cannot have it both ways: either they must require licensees to take action quickly to identify and remove plant vulnerabilities with regard to currently-known seismic and flood hazards, or they must halt actions such as license approvals that imply they have the information they are claiming they do not have in the previous case.

The initial concept was for the industry to respond to the NRC's information request by 2015, and then hopefully some sort of regulatory action would be issued. Now, the NRC is estimating that it could take approximately **seven years** to receive responses from all plants. Unfortunately, a plant's seismic and flooding vulnerabilities are not sympathetic to supposed resource problems and, therefore, will not take a rain check for the next 10 years. Just this year, the North Anna Nuclear Generating Station experienced a 5.8 magnitude earthquake and lost offsite power for nine hours, necessitating the use of diesel generators, of which one experienced a cooling water leak and had to be shut down an hour into the event. An NRC Augmented Inspection Team sent in after the event found two additional generators with cooling water leaks sufficient to degrade their performance. [17]

NRDC agrees with the Chairman in his recent vote that, while these issues are indeed complex, any solution that puts off a Near-Term Task Force issue to nearly the end of this decade is unacceptable and we hope that the NRC can complete this activity in the next five years, as requested by the Chairman.

Station Blackouts

The occurrence of a station blackout was one of the most detrimental aspects of the Fukushima nuclear disaster, from which most other problems originated. Losing offsite power followed by the disabling of all backup power sources for Units 1 through 4 presented a dire situation for plant workers, amplified confusion over emergency priorities, and eventually caused the failure to contain the radiological impacts of the accident. The Near-Term Task Force suggested the initiation of a rulemaking that would eventually codify, through changes to 10 CFR 50.63, the minimum requirements for equipment, procedures, and training to cope with the loss of AC power, employing a system of tiered coping times. The idea is that plants should be able to sustain safety-functions without AC power for a minimum of eight hours, followed by a 72-hour period using additional measures that are established in the first eight hours.

With regard to coping times, the current regulations leave a gap when compared to the Task Force recommendations, possibly allowing as little as a 2-hour window, and have resulted in some plants only meeting a 4-hour minimum coping time. Therefore, the Task Force also suggested an order to require improvements to the existing post-9/11 emergency equipment and strategies designed to respond to the consequences of a terrorist attack. These efforts were not designed or intended to handle a multi-unit event, like that seen at Fukushima, and the additional equipment would still require protection from the effects of beyond-design-basis external events if it were to be relied upon to survive such events and play a role in combating the consequences of a severe nuclear accident.

The mitigation strategies described above are meant to ensure that each nuclear power plant is adequately prepared, in terms of equipment, procedures, and training, to handle a beyond-design-basis external event affecting all the reactor units on the site. The NRC defines beyond-design-basis events as accident sequences that are possible but not fully considered in the design process, and examples could be exceedingly large earthquakes, tornadoes, or flooding that surpasses historic levels. The Task Force's intention was to provide some intermediate measures for handling severe accidents and station blackouts until the completion of the SBO rulemaking, which is part of the Tier 1 actions. However, the final rule is not expected for another 2 to 3 years and, therefore, any changes to plants based on this rule would take even more time.

Commission action on the SBO issue, whether by orders or by rulemaking, should also ensure that both emergency on-site and off-site equipment, to be used within and beyond the 72-hour coping period, be subject to the same maintenance, availability, training, and inspection rules as apply to all other systems, structures, and components. Mere proof-of-purchase and stashing of equipment in some seldom-visited warehouse should not be accepted as evidence of meeting SBO requirements.

Spent Fuel Pool Safety Shortcuts

After further study of the accident's events, reports have shown that even though the spent fuel pools at the Fukushima plant survived relatively unharmed, without the necessary means to verify their condition, operators became concerned over the actual state of the pools. Critical manpower and cooling water supplies were diverted to ensure that spent fuel pool cooling was maintained, while in hindsight other critical systems suffered. The Task Force felt this was a valuable lesson and recommended that reactor sites install reliable safety-related instrumentation to monitor key pool parameters such as water level, temperature, and area radiation levels from the control room. They also recommended that three other orders were necessary to ensure reliable pool makeup water systems, reliable both in terms of AC-power independence and seismic event tolerance. Regardless, only the first item—instrumentation requirements—received Tier 1 status.

With regard to these instrumentation upgrades, the NRC is backpedaling on their initial recommendation to require a suite of *safety-related* instrumentation that included improved water level and temperature indicators as well as reliable area radiation monitors. These recommended installations would be required to withstand severe accident initiators like earthquakes and floods and then continue to operate under the ensuing severe accident conditions. Instead of *safety-related*, which ensures certain safety-engineering requirements are met, they would rather this equipment just be *reliable*. Instead of having layers of potentially useful information (water level, temperature, radiation levels), they reasoned that knowing only the water level should be sufficient.

Rather than follow through on their espoused concept of defense-in-depth and layered insurance that prevents confusion during an accident, the NRC staff listened very closely to the industry's suggestion that the only type of permanently installed instrumentation should be water level monitors and everything else could be handled by portable equipment.[18] This portable equipment would need to be staged and operated by plant personnel during the accident, possibly diverting necessary resources away from more pressing matters and exposing the workers to unnecessary risk.

NRDC would have preferred the agency to not relax these requirements, but we also note that we would like to see a more balanced approach to reducing the risk of spent fuel stored in vulnerable pools, one that reduces both the risk of fuel damage through assured cooling in an emergency and the radiological consequences should loss of cooling nonetheless occur. While the heat load emanating from recently irradiated fuel placed in a pool is obviously a key factor, we disagree with the Task Force's initial technical claim that increased pool loads do not contribute to pool cooling issues. The ability of the water in the pool to dissipate heat and resist boiling is proportional to its volume relative to the volume of spent fuel, and its ability to flow through the pool. Both are adversely affected by the amount of spent fuel packed into the pool.

Additionally, in the event of an accident the source term for the spread of radioactive material is directly related to both the amount and the activity level of material in the pool. In parallel with ensuring adequate pool cooling under emergency conditions, further attention needs to be given to pool unloading and ways to reduce the hazards associated with spent fuel pools through accelerated dry cask storage. With support from numerous organizations that both support and oppose nuclear power, it is unfortunate that this widely-sought solution is still not being considered as a near-term enhancement to nuclear plant safety.

Improving and Integrating Emergency Operating Procedures

After observing the discord and struggles of the plant operators during the accident response, the Task Force stated that is vital to have trained personnel who are well prepared to handle an emergency situation by having validated procedures, guidelines, and strategies in place before an accident. A clear line of command and informed decision-making are essential during a severe accident scenario. At plants in the United States, various programs are in place that address these issues, but often in an inconsistent manner, due to factors such as when they were created and the specific purpose they were designed to serve. Licensees variously rely on Emergency Operating Procedures (EOPs), Extensive Damage Mitigation Guidelines (EDMGs), and Severe Accident Mitigation Guidelines (SAMGs) to form the basis of their response to these types of events. Where these various programs overlap or transition from one to another, is often not clear. The NRC's history of allowing voluntary industry initiatives to handle formulation and compliance with these guidelines, along with weak regulatory presence in validating them, results in little attention being paid to determining the safety gaps that could end up presenting themselves at the worst possible time—in the midst of a severe plant emergency.

In light of these problems, the Task Force recommended two orders that would require licensees to begin the process of integrating these various programs, and establish appropriate training and qualification programs for those in charge of decision-making during an emergency. They also recommended initiating a rulemaking to require more realistic, hands-on training in applying this new system of emergency guidelines. They asked that plant owner groups undertake these activities, as opposed to individual plants, so that the current large site-to-site variability in these programs is reduced to a more unified, transparent and enforceable set of guidelines that reactor operators and other employees with critical emergency response roles bring with them when they change jobs.

Naturally, one would expect that the U.S. nuclear industry, with all of its engineers, project managers, and trade groups, should be able to handle a request asking them to coordinate amongst themselves to develop best practices and a more cohesive set of guidelines. With the addition of some NRC oversight, this would have been a good first step that could have produced a solution within a couple of years, allowing the industry to be better prepared for emergency situations and bringing them all under a single regulatory tent.

However, the current plan is to fold all of the associated orders into a lengthy rulemaking activity and not require any action at this time. This requires waiting for the NRC to develop and issue an advanced notice of proposed rulemaking (ANPR) to obtain stakeholder input, which would then be incorporated in a proposed draft rule issued for public comment, followed by further revisions and issuance of a final rule. If we skip to the end of Phase 1, more than four years will have elapsed and we will still be at the starting line for actually requiring plants to adhere to the new regulation. Despite the fact that licensees will have helped develop this rule, it is likely that changes in the plant's emergency operating procedures will still be years away from effective implementation at all sites.

Emergency Preparedness: Staffing and Communications

The last issue concerns the NRC's request for information from each licensee about the availability of adequate communications and staff to respond to a multi-unit event that involves an extended loss of all AC power and impeded access to the reactor units. The only objectionable aspect to the suggested actions needed to implement this recommendation is that the Commission has to ask for them in the first place. Among numerous other objectives, an original intent of this Task Force recommendation was to determine and then order the filling of the staff positions needed to respond to a multi-unit event, The current objective appears limited to acquiring an assessment and potential plans for augmenting existing capabilities, but with no guarantee that final action will be taken.

Because the regulations and operating procedures rarely address multi-unit events, not to mention those events coupled to a loss of AC power, it is likely that there *will* be gaps discovered in plant capabilities. These gaps are obvious in their importance following Fukushima and should never have been allowed to develop in the first place. The Commission's dereliction in never requiring adequate staffing and communications capability during these events has yet to be explained.

Additionally, the use of the 50.54(f) letter, or request for information, seems very inefficient when compared to the original concept of issuing this request as an order. The information contained with the letter presents a clear enough set of recommendations and guidelines on which the Commission could base an order and, therefore, could effectively remove an unnecessary step in achieving some goals of the Task Force's recommendation. On the plus side, responses to this request for information are expected to come within the next three to four months. We may then get to see what the industry is willing to admit in terms of their limited capacity to handle these types of events and what the NRC is willing to do about it.

Other Issues

Neglecting Hydrogen Control

One would think that the issue of hydrogen control during a severe accident would be a top priority for the NRC. This priority seems obvious when one considers that three of the reactors at the Fukushima Dai-ichi site experienced hydrogen-induced explosions, leading to increased releases of radioactive material to the surrounding environment and disastrous complications for the already difficult recovery effort. However, the NRC has chosen to relegate this key recommendation to its least certain subset of actions, Tier 3. This tier has no associated timeline for consideration or implementation. In other words, one of the more destructive events in the evolution of Japan's nuclear disaster is mostly being ignored.

Hydrogen is a highly flammable gas that can accumulate in the reactor vessel following a loss of coolant accident (LOCA) through an interaction between large quantities of high-temperature steam and the fuel's zirconium metal sheath or *cladding*. If the concentration of hydrogen becomes too high, the gas can ignite and result in detonations and flame accelerations that could destroy vital safety systems or expose the surrounding environment to the plant's already debilitated interior.

To reduce the risks associated with hydrogen production, plants can take a number of measures to attempt to control the concentration of hydrogen at various locations within the reactor system. The plant may choose to use a non-flammable gas to make the containment volume inert, which helps to dilute the oxygen and hydrogen to levels below the flammability limit. The plant might also decide to employ hydrogen recombiners or igniters. These two types of safety equipment operate exactly how they sound. The recombiner attempts to recombine the hydrogen and oxygen to produce water vapor through passive operation, and this method requires dozens of recombiner units to keep pace with the hydrogen produced in a severe accident. The igniter system is used to perform a controlled burn of the hydrogen to prevent an unintended deflagration (slowly propagating explosion) or detonation (supersonic explosion). The weakness of the igniter method lies in how difficult it is for the nuclear plant operator to know when the atmospheric threshold for safe use of the igniter has been reached, so as not to accidently cause an explosion when concentrations have become too high.

Regardless of how much more information we may obtain from further study of the Fukushima accident, the underlying problem is that the United States currently does not require an adequate level of back-up hydrogen mitigation measures and, therefore, the NRC is disingenuous when it implies that the dangers of hydrogen explosions *during a severe accident* are low. The NRC's complacency comes from their assumption that severe accidents are rare and that they are addressing this issue via the containment venting recommendation. As to how this solves the problem, the logic is a bit unclear. It is true that removing the hydrogen (and excess pressure) in the primary containment through venting could lower the possibility of an explosion occurring in this containment volume, but not elsewhere.

Since the NRC relies almost solely on inerting systems or large containment volumes, they no longer require follow-up control measures if hydrogen escapes into the secondary containment. The NRC also does not require any equipment that could preclude hydrogen concentrations at various locations within the containment volumes. As seen graphically in Fukushima, explosions can be the direct result of hydrogen accumulation in unintended regions of the plant, including hydrogen migration in the piping or other pathways that may connect reactor buildings.

NRDC urges the Commission to acknowledge that the hydrogen control issue warrants an immediate comprehensive review of the technical problems, in addition to formulating recommendations regarding the conduct of further cladding oxidation experiments and equipment validations to resolve this problem. Furthermore, the NRC should implement conservative operating protocols at existing reactors while these technical issues are under review, such as suspending further power uprates, especially for those reactor designs that are similar to those at Fukushima Dai-ichi.[19]

Risk Analysis Run Amok

The world has now witnessed another severe nuclear accident, with the full weight of the disaster still being tallied. But it is clear that there will be long-felt repercussions for the Japanese economy, the physical and emotional health of the affected population, the future environmental quality of the contaminated areas, and more widely, the global energy industry. Japan faces large projected financial and technical burdens related to the nuclear accident, with various estimates regarding the overall cost and time required for recovery, all dauntingly large with ranges in the tens to hundreds of billions of dollars and possibly decades for completion. The task is not simple, with many unknowns that are still being debated. However, the world is beginning to understand the true magnitude of a modern-day nuclear accident.

Unfortunately, there is no discussion in any of the NRC recommendations of what would be considered intolerable or unacceptable consequences if the worst case accident were to occur at a U.S. nuclear plant. What the Commission must now consider is the sum total of economic damage and social disruption that might be inflicted by a Fukushima-scale accident occurring in a much more densely populated area, and what additional safety measures, if any, could reliably mitigate these potentially disastrous consequences. This is a critical near-term question, for example, for communities in the New York City, Philadelphia, and Los Angeles areas (the Indian Point, Limerick, and SONGS reactors, respectively, face license extension proceedings).

The NRC and the nuclear power industry need to present realistic accident scenarios showing the full range and weight of environmental, economic, and health risks posed by these accidents. This type of study should model site-specific severe accidents and illustrate the detailed consequences of a range of severe accident scenarios so that the public and their policy makers can make informed decisions. These decisions could be whether to continue plant operations after the existing licenses expire, whether to require investment in additional accident mitigation capabilities, or alternatively, whether to avoid these risks altogether by relying on a portfolio of other low carbon electricity alternatives that could meet future electricity service needs over the license extension period.

Nearly all forms of analyses conducted by the NRC or the nuclear power industry are inadequate in this regard because these analyses generally only address isolated issues in a cost-benefit framework that discounts cumulative impacts—such as those on displaced populations, regional economic losses, and environmental cleanup—and are based on a hypothetical very small frequency of occurrence of the accident scenario, which the industry itself is usually responsible for calculating. These types of calculations do not present a clear picture of the potential hazards or costs experienced in the event of a severe accident. Instead they tend to mask the full range of accident consequences that policy makers may wish to avoid. NRDC has produced an analysis (see Figure 2), of the type we believe should be included in any discussion on actions that need to be taken, that models a severe nuclear accident occurring over March 11 and March 12, 2011 for each of the U.S. nuclear plants (http://www.nrdc.org/nuclear/fallout). To be clear, NRDC makes no assertion as to the relative likelihood of such an accident, but feels these risks must be openly discussed in a transparent manner.

The NRC and industry use metrics such as the Core Damage Frequency (CDF) to estimate a site-specific measure of the probability of a core damaging event. NRDC agrees that these estimates can be useful in determining the relative risk among a variety of severe accident precursors, such as seismically-induced fires or floods; however, we object to the use of these metrics to define the consideration of the overall impact of a severe accident. Often, a study is performed by the industry or NRC or both that sets out to determine the *likelihood* of a severe accident, sometimes to inform decisions on whether a particular improvement should be required at a plant. Even though these studies are proposed to highlight methods and modifications that would reduce the impact of severe accident, the calculations often conflate the necessity of a plant improvement (and their cost relative to the damages in the unmitigated case) with the frequency with which they think the postulated accident will occur.

This obtuse treatment of severe accidents allows two disservices to be performed simultaneously. First, any plant modification—either physical or procedural—stands virtually no chance against the industry-concocted probability weighting factors and, therefore, usually never gets implemented. In other words, measures to counter very damaging but highly unlikely events are dismissed as not being *cost effective*, because the estimated financial costs are multiplied by an assumed tiny probability of their occurrence. Second, this narrow cost-benefit tradeoff is the only context in which a severe accident's consequences are presented to the public and considered as part of a plant's relicensing process. Despite adequate methods for estimating the overall cost both in terms of public health and economic damage, the industry and the Commission do not feel that a fully-envisioned accident scenario would be of interest to a nearby resident or state official.

In order to illustrate the full extent of a major accident, the NRDC analysis used the U.S. Department of Defense computer model HPAC (Hazard Prediction and Assessment Capability) to calculate site-specific radiological release "source-terms," resulting fallout plumes, and data on the effects on nearby populations. The results were compared to similar modeling of the Fukushima disaster to provide a sense of scale, and to estimate the rough magnitude of financial and economic damages that would be incurred if a severe accident were to occur at any one of the plants in the U.S. fleet. Having access to this information helps to open a dialogue on what we as a society consider to be a reasonable level of risk in meeting our energy demands. This discussion and examination is not a hypothetical issue. Policy

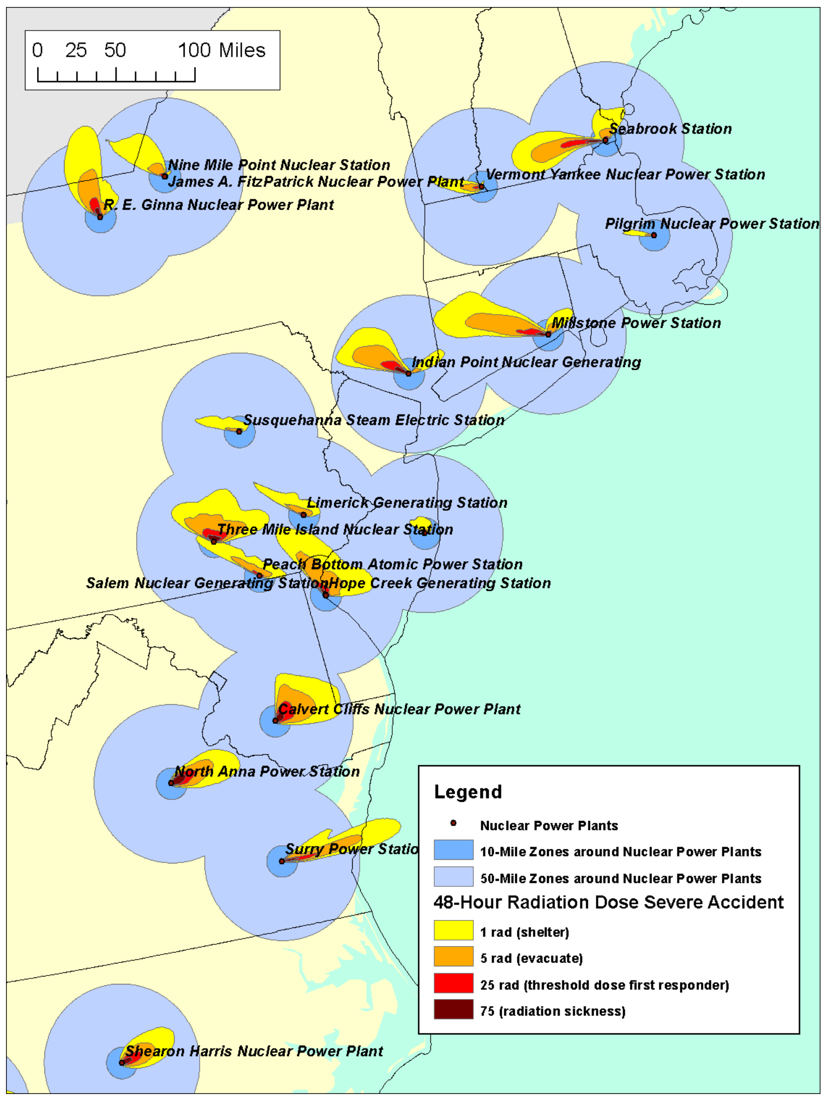


Figure 2. Hazard Prediction and Assessment Capability Hypothetical Accident Plume Modeling for Northeast U.S. Nuclear Power Plants on March 11, 2011

makers in several countries, including Germany and Switzerland, have made decisions not to grant nuclear plant license extensions to avoid having to endure the continuing risk of severe nuclear plant accidents.

Regardless of the industry's corporate understanding of its obligations to the public in highlighting the potential risk of a nuclear accident, the National Environmental Policy Act (NEPA) is clear in its well-established mandates and what it requires of the NRC. NEPA requires that federal agencies characterize environmental impacts broadly to include not only ecological effects, such as physical, chemical, radiological, and biological effects, but also aesthetic, historic, cultural, economic, and social effects. Additionally, the full cumulative effect of severe accidents must be studied and presented in a manner that informs the external stakeholder (i.e., the taxpaying citizen) as to whether the relicensing of a nearby power plant is in the community's best interest. These analyses must make every effort to meet the current expectations of what these studies should encompass and use the necessary guidance and tools commonly utilized by the industry and NRC.

CONCLUSIONS

As we have seen, the NRC's attenuated and still lengthening process for moving forward on post-Fukushima nuclear safety issues has been characterized by stall tactics and inaction for which the Commission, as well as the industry, are to blame. The upcoming release of NRC orders and requests for information only marks the beginning of the beginning. Those issues that the NRC decided require action *without unnecessary delay* will in fact see a fair measure of delay caused by bureaucratic back-and-forth before our regulators mandate any real change. The graphic found in the insert represents the current timeline described throughout the various NRC proceedings and papers. From the timeline, we can see a number of reports, status updates, interim guidance and rulemakings hypothetically being issued over the next four years. However, only three of the total seven are likely to see any real improvements committed within the decade.

What we have seen over the last year is the consistent watering-down of the Task Force's recommendations, both in terms of urgency and method, through industry influence at the expense of making meaningful near-term progress on improving the NRC's approach to safety.

Since the accident in Japan, numerous other countries have enacted moratoriums on nuclear power production, slowed progress on construction, or decided to phase out nuclear energy entirely. Amidst all of the complaints of limited resources and urgings to proceed *carefully* (usually meaning slowly), how else have the NRC and the nuclear power industry been using their resources over the past year?

Since the accident in March 2011, the Commission has approved nine license renewals (versus three in the 12 months prior) and accepted an additional four applications. Additionally, the NRC approved five power uprates (versus six in 2010) and the industry submitted nine applications for uprates, compared to the five in 2010. This is surely an obtuse, ostrich-like response to the undeniable fact that the one of the most technologically developed countries in the world experienced a catastrophic failure of its safety systems, resulting in multiple meltdowns and widespread contamination of the surrounding environment. In addition to lacking caution and sensitivity to heightened public concern over nuclear safety, the actions of the U.S. nuclear industry reflect an effort to sidestep any responsibilities to improve safety, and instead continue business as usual, or apparently, even faster than usual.

APPENDIX A – DETAILED LIST OF ALL NEAR-TERM TASK FORCE RECOMMENDATIONS AND TIME HORIZONS

Note: Unless otherwise specified, "Completion Estimate" dates assume completion of required activities and do not necessarily imply changes made to regulations or reactor plant systems.

Table A.1. List of Detailed Near-Term Task Force Recommendations for Rulemakings (see Task Force Report, Appendix A)

Item Description	Completion Estimate
Initiate rulemaking to implement a risk-informed, defense-in-depth framework that embraces preparations to counter "beyond design basis events," consistent with a recommended Commission policy statement on this issue. (Section 3—detailed recommendation 1.2)	NOT AVAILABLE (Tier 3)
Initiate rulemaking to require licensees to confirm seismic hazards and flooding hazards every 10 years and address any new and significant information. If necessary, update the design basis for systems, structures, and components (SSCs) important to safety to protect against the updated hazards. (Section 4.1.1—detailed recommendation 2.2)	NOT AVAILABLE (Tier 3)
Initiate rulemaking to revise 10 CFR 50.63 to require each operating and new reactor licensee to (1) establish a minimum coping time of eight hours for a loss of all AC power, (2) establish the equipment, procedures, and training necessary to implement an "extended loss of all AC" coping time of 72-hours for core and spent fuel pool cooling and for reactor coolant system and primary containment integrity as needed, and (3) preplan and prestage offsite resources to support uninterrupted core and spent fuel pool cooling, and reactor coolant system and containment integrity as needed, including the ability to deliver the equipment to the site in the time period allowed for extended coping, under conditions involving significant degradation of offsite transportation infrastructure associated with significant natural disasters. (Section 4.2.1—detailed recommendation 4.1)	September 2015 (completion of rulemaking only)
Initiate rulemaking or licensing activities or both to require the actions related to the spent fuel pool described in detailed recommendations 7.1 through 7.4. (Section 4.2.5—detailed recommendation 7.5)	March 2016 (completion of rulemaking only)
Initiate rulemaking to require more realistic, hands-on training and exercises on Extensive Damage Mitigation Guidelines (EDMGs), and Severe Accident Mitigation Guidelines (SAMGs) for all staff expected to implement the strategies and those licensee staff expected to make decisions during emergencies, including emergency coordinators and emergency directors. (Section 4.2.6—detailed recommendation 8.4)	September 2016 (completion of rulemaking only)
Initiate rulemaking to require Emergency Operating Procedures (EOP) enhancements for multiunit events in the following areas: personnel and staffing, dose assessment capability, training and exercises, and equipment and facilities. (Section 4.3.1—detailed recommendation 9.1)	NOT AVAILABLE (Tier 3)
Initiate rulemaking to require Emergency Preparedness (EP) enhancements for prolonged station black outs (SBO) in the following areas: communications capability, ERDS capability, training and exercises,	NOT AVAILABLE (Tier 3)

and equipment and facilities. (Section 4.3.1—detailed recommendation 9.2)	

Table A.2. List of Detailed Near-Term Task Force Recommendations for Orders (see Task Force Report, Appendix A)

Item Description	Completion Estimate
Order licensees to reevaluate the seismic and flooding hazards at their sites against current Nuclear Regulatory Commission requirements and guidance, and, if necessary, update the design basis and SSCs important to safety to protect against the updated hazards. (Section 4.1.1—detailed recommendation 2.1)	Approx. 2019 for all responses
Order licensees to perform seismic and flood protection walkdowns to identify and address plant-specific vulnerabilities and verify the adequacy of monitoring and maintenance for protection features such as watertight barriers and seals in the interim period until longer term actions are completed to update the design basis for external events. (Section 4.1.1—detailed recommendation 2.3)	March 2013
Order licensees to provide reasonable protection for equipment currently provided pursuant to 10 CFR 50.54(hh)(2) from the effects of design-basis external events and to add equipment as needed to address multiunit events while other requirements are being revised and implemented. (Section 4.2.1—detailed recommendation 4.2)	December 2016
Order licensees to include a reliable hardened vent in boiling-water reactor (BWR) Mark I and Mark II containments. (Section 4.2.3—detailed recommendation 5.1)	December 2016
Order licensees to provide sufficient safety-related instrumentation, able to withstand design-basis natural phenomena, to monitor key spent fuel pool parameters (i.e., water level, temperature, and area radiation levels) from the control room. (Section 4.2.5—detailed recommendation 7.1)	December 2016 (no temperature or radiation instrumentation)
Order licensees to provide safety-related ac electrical power for the spent fuel pool makeup system. (Section 4.2.5—detailed recommendation 7.2)	NOT AVAILABLE (Tier 2)
Order licensees to revise their technical specifications to address requirements to have one train of onsite emergency electrical power operable for spent fuel pool makeup and spent fuel pool instrumentation when there is irradiated fuel in the spent fuel pool, regardless of the operational mode of the reactor. (Section 4.2.5—detailed recommendation 7.3)	NOT AVAILABLE (Tier 2)
Order licensees to have an installed, seismically qualified means to spray water into the spent fuel pools, including an easily accessible connection to supply the water (e.g., using a portable pump or pumper truck) at grade outside the building. (Section 4.2.5—detailed recommendation 7.4)	NOT AVAILABLE (Tier 2)
Order licensees to modify the EOP technical guidelines (required by Supplement 1, "Requirements for Emergency Response Capability," to NUREG-0737, issued January 1983 (GL 82-33), to (1) include EOPs, SAMGs, and EDMGs in an integrated manner, (2) specify clear command and control strategies for their implementation, and (3) stipulate appropriate	September 2016 (only completion of rulemaking; no longer seeking "order")

qualification and training for those who make decisions during emergencies. (Section 4.2.6—detailed recommendation 8.1)	
Order licensees to modify each plant's technical specifications to conform to detailed recommendation 8.2. (Section 4.2.6—detailed recommendation 8.3)	September 2016 (only completion of rulemaking; no longer seeking "order")
Order licensees to do the following until rulemaking is complete: determine and implement the required staff to fill all necessary positions for responding to a multiunit event, conduct periodic training and exercises for multiunit and prolonged SBO scenarios, ensure that EP equipment and facilities are sufficient for dealing with multiunit and prolonged SBO scenarios, provide a means to power communications equipment needed to communicate onsite and offsite during a prolonged SBO, and maintain ERDS capability throughout the accident. (Section 4.3.1—detailed recommendation 9.3)	March 2013 (Assessment only; Staffing & Comms only; no implementation)
Order licensees to complete the ERDS modernization initiative by June 2012 to ensure multiunit site monitoring capability. (Section 4.3.1—detailed recommendation 9.4)	NOT AVAILABLE

Table A.3. List of Detailed Near-Term Task Force Recommendations for Staff Actions (see Task Force Report, Appendix A)

Item Description	Completion Estimate
Modify the Regulatory Analysis Guidelines to more effectively implement the defense-in-depth philosophy in balance with the current emphasis on risk-based guidelines. (Section 3—detailed recommendation 1.3)	NOT AVAILABLE
Evaluate the insights from the Individual Plant Examination (IPE) and Individual Plant Examination for External Events (IPEEE) efforts as summarized in NUREG1560, "Individual Plant Examination Program: Perspectives on Reactor Safety and Plant Performance," issued December 1997, and NUREG-1742, "Perspectives Gained from the Individual Plant Examination of External Events (IPEEE) Program," issued April 2002, to identify potential generic regulations or plant-specific regulatory requirements. (Section 3—detailed recommendation 1.4)	NOT AVAILABLE
Modify Section 5.0, "Administrative Controls," of the Standard Technical Specifications for each operating reactor design to reference the approved EOP technical guidelines for that plant design. (Section 4.2.6—detailed recommendation 8.2)	September 2016 (only completion of rulemaking)
Expand the scope of the annual Reactor Oversight Process (ROP) self assessment and biennial ROP realignment to more fully include defense-in-depth considerations. (Section 5.1—detailed recommendation 12.1)	NOT AVAILABLE (Tier 3)
Enhance NRC staff training on severe accidents, including training resident inspectors on SAMGs. (Section 5.1—detailed recommendation 12.2)	NOT AVAILABLE (Tier 3)

Table A.4. List of Detailed Near-Term Task Force Recommendations for Long-Term Evaluation (see Task Force Report, Appendix A)

Item Description	Completion Estimate
Evaluate potential enhancements to the capability to prevent or mitigate seismically induced fires and floods. (Section 4.1.2—detailed recommendation 3)	NOT AVAILABLE (Planning Update July 2012)
Reevaluate the need for hardened vents for other containment designs, considering the insights from the Fukushima accident. Depending on the outcome of the reevaluation, appropriate regulatory action should be taken for any containment designs requiring hardened vents. (Section 4.1.3—detailed recommendation 5.2)	NOT AVAILABLE (Tier 3)
Identify insights about hydrogen control and mitigation inside containment or in other buildings as additional information is revealed through further study of the Fukushima Dai-ichi event. (Section 4.1.4—detailed recommendation 6)	NOT AVAILABLE (Tier 3)
Analyze current protective equipment requirements for emergency responders and guidance based upon insights from the accident at Fukushima. (Section 4.3.1—detailed recommendation 10.1)	NOT AVAILABLE (Tier 3)
Evaluate the command and control structure and the qualifications of decision makers to ensure that the proper level of authority and oversight exists in the correct facility for a long-term SBO or multiunit accident or both. (Section 4.3.1—detailed recommendation 10.2)	NOT AVAILABLE (Tier 3)
Evaluate ERDS to do the following: determine an alternate method (e.g., via satellite) to transmit ERDS data that does not rely on hardwired infrastructure that could be unavailable during a severe natural disaster, determine whether the data set currently being received from each site is sufficient for modern assessment needs, and determine whether ERDS should be required to transmit continuously so that no operator action is needed during an emergency. (Section 4.3.1—detailed recommendation 10.3)	NOT AVAILABLE (Tier 3)
Study whether enhanced onsite emergency response resources are necessary to support the effective implementation of the licensees' emergency plans, including the ability to deliver the equipment to the site under conditions involving significant natural events where degradation of offsite infrastructure or competing priorities for response resources could delay or prevent the arrival of offsite aid. (Section 4.3.2—detailed recommendation 11.1)	NOT AVAILABLE (Tier 3)
Work with the Federal Emergency Management Agency (FEMA), States, and other external stakeholders to evaluate insights from the implementation of EP at Fukushima to identify potential enhancements to the U.S. decision-making framework, including the concepts of recovery and reentry. (Section 4.3.2—detailed recommendation 11.2)	NOT AVAILABLE (Tier 3)
Study the efficacy of real-time radiation monitoring onsite and within the emergency planning zones (EPZs) (including consideration of ac independence and real-time availability on the Internet). (Section 4.3.2—detailed recommendation 11.3)	NOT AVAILABLE (Tier 3)
Conduct training, in coordination with the appropriate federal partners,	NOT AVAILABLE

on radiation, radiation safety, and the appropriate use of potassium iodide (KI) in the local community around each nuclear power plant. (Section 4.3.2—detailed recommendation 11.4)	(Tier 3)

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