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Adequate protection after the Fukushima Daiichi accident

A constant in a world of change

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Adequate protection after the Fukushima Daiichi accident: A constant in a world of change

By Commissioner William C. Ostendorff and Kimberly A. Sexton*

Introduction

The tragic accident at the Fukushima Daiichi nuclear power plant (NPP) will long be seen as a seminal event in the history of commercial nuclear power. Within the United States, not since the accident at Three Mile Island in 1979 has the US Nuclear Regulatory Commission (NRC) been confronted with as many important issues, so central to the core of its mission, as have arisen following the Fukushima Daiichi accident. While much of the agency's attention has rightfully been on the technical merits of the NRC's Near-Term Task Force (NTTF)[1] Report recommendations, the long-term regulatory implications of our post-Fukushima Daiichi actions have not always received similar scrutiny. Now that sufficient time has passed, I believe it is appropriate to take a step back and at a high level see what impact implementation of all these actions will have on our regulatory framework and our approach to adequate protection.

I have borne witness to the practical application of the NRC's "adequate protection" standard over my three years of NRC decision making. From my perspective as an individual Commissioner, I strongly believe that the NRC's long-standing framework and regulatory approach has served the American public well, should be faithfully adhered to, and does not need to be changed in light of the

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1. The NTTF was a body of senior agency experts assembled in short order following the Fukushima Daiichi accident to determine lessons learnt and initiate a review of NRC regulations to determine if additional measures needed to be taken immediately to ensure the safety of US plants. Their resultant report, issued on 12 July 2011, is known as the NTTF Report and the recommendations contained therein are known as the NTTF recommendations. The NTTF, its report, and recommendations will be discussed further throughout this article.

Fukushima Daiichi accident (or other foreseeable future events). The adequate protection standard, however, is not always perfectly understood by all. To help shed light on this important concept, this article will discuss the history of the adequate protection standard, its ties to the Fukushima Daiichi events, and its relationship to the critical decisions before the Commission. By the end of this article, I hope to have demonstrated how the adequate protection standard ensures public health and safety as well as provides for regulatory stability, even amidst great change.

Adequate protection

America's regulatory standard

The NRC is an independent federal regulatory agency responsible for licensing and overseeing the safe operation of civilian nuclear installations and the safe use of specified radioactive materials in the United States.[2] The NRC does not report to any other agency within the executive branch, but it is subject to oversight by the US Congress. In the United States, independent federal agencies operate only within the limits of the authority given to them by Congress. For the NRC, this authority primarily derives from its enabling statute, the Atomic Energy Act of 1954, as amended (AEA).[3] One of the most important aspects of the substance of the AEA is the adequate protection mission entrusted to the NRC. Specifically, applicants for licences must provide information deemed necessary by the NRC so that it is enabled:

> to find that the utilization or production of special nuclear material will be in accord with the common defense and security and *will provide adequate protection to the health and safety of the public*.[4]

Adequate protection is the statutory minimum safety standard – the floor below which safety standards may not fall – to be ensured by the NRC before allowing licensed activities to take place. The NRC has stated that adequate protection is provided presumptively through compliance with the NRC's regulations.[5]

Not all matters within the NRC's purview, however, have adequate protection implications. Section 161b of the AEA gives the Commission authority to "establish by rule, regulation, or order, such standards and instructions ... as the Commission *may deem necessary or desirable* to promote the common defense and security or to protect public health or to minimize danger to life or property."[6] Section 161i(3) provides a similar authority. Two federal appellate cases speak directly to this issue, describing the AEA's radiological protection system as a "two-tier structure": the first tier – the Section 182 mandatory tier – provides assurance of adequate protection

2. The NRC was created under the Energy Reorganization Act of 1974, 42 USC §§ 201-209, when Congress abolished the Atomic Energy Commission (AEC) and split its regulatory, development, and promotional functions between the newly-created NRC and the Energy Research Development Agency (ERDA), the predecessor to today's US Department of Energy (DOE). The AEC's regulatory functions were transferred to the NRC while the development and promotional functions were transferred to the ERDA, and now lie with DOE. The NRC is headed by a five-member commission, the members of which are appointed by the President of the United States and confirmed by the US Senate for staggered five-year terms. The commissioners are responsible for policy, rulemaking, and adjudication, and are supported in this regard by a staff of about 3800 employees.
3. Atomic Energy Act of 1954, 42 USC §§ 2011 et seq.
4. Atomic Energy Act of 1954, sec. 182a., 42 USC § 2232(a) (emphasis added).
5. See e.g. Revision of Backfitting Process for Power Reactors, Final Rule, 53 Fed. Reg. 20603, 20606 (1988).
6. Atomic Energy Act of 1954, sec. 161b., 42 USC § 2201(b) (emphasis added).

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without regard to cost while the second tier – the Section 161 discretionary tier – provides "'extra-adequate' protection," based upon consideration of costs to licensees and societal benefits.[7] Thus, while the NRC *must* provide adequate protection of public health and safety, the NRC *may* provide protection above and beyond adequate protection, if certain conditions are met.

The NRC has interpreted this to mean that in order to promulgate requirements for measures that go beyond adequate protection, the NRC must find that such a requirement would provide "a *substantial increase in the overall protection* of the public health and safety or common defense and security" that satisfies a cost-benefit analysis.[8] The NRC has defined "substantial" as "important or significant in a large amount, extent, or degree."[9] To clarify the matter even further, the "Regulatory Analysis Guidelines," which outlines the NRC's policy for the preparation and the contents of its regulatory analyses, provides that:

> Applying such a standard, the Commission would not ordinarily expect that safety-applying improvements would be required as backfits that result in *an insignificant or small benefit to the public health and safety, regardless of costs*.[10]

Although there are alternatives to imposing requirements when neither of those standards is met, the agency does not often make use of such alternatives. One of those alternatives, to be discussed later in the article, is the use of an administrative exemption, which the Commission can employ to exclude a regulatory action from the requirements of the backfit rule.

The Atomic Energy Act does not define the term "adequate protection" nor does it clarify the concept of "adequacy." Similarly, the NRC and the courts have repeatedly abstained from defining "adequate protection" in concrete terms. The NRC does, however, frame adequate protection as a requirement that the agency provide *reasonable assurance* of adequate protection.[11] This interpretation was affirmed over 50 years ago in a landmark 1961 US Supreme Court decision.[12]

There are, however, four generally accepted principles that provide guidance as to how the concept of "adequate protection" is understood. First, the NRC's authority under the adequate protection mandate is extremely broad, and the NRC has significant discretion in determining whether the adequate protection standard has been met. In fact, over the years, the courts have been consistent in holding that defining "adequate protection" is almost entirely left to the expert scientific judgment of the NRC, and therefore have generally deferred to the Commission's decisions. One of the strongest endorsements of deferential review of the NRC's adequate protection determinations came in 1989 when the DC Circuit Court noted that "the determination of what constitutes 'adequate protection' under the [AEA],

7. Union of Concerned Scientists v. NRC, 824 F.2d 108, 114, 118 (DC Cir. 1987) (UCSI); Union of Concerned Scientists v. NRC, 880 F.2d 552, 556-557 (DC Cir. 1989) (UCSII).
8. 10 CFR § 50.109(a)(3), Backfitting (emphasis added). This requirement is the basis of the NRC's so-called "backfit rule". 10 CFR § 50.109. The "backfit rule" forces the agency to undertake a reasoned and informed decision-making process, and ensures stability and transparency, in the event of a change in a prior Commission or NRC staff position on a measure to improve the safety of the applicable licensed facility. The new or amended provision or change in NRC staff position is termed a "backfit".
9. See e.g. NRC (2004), "Regulatory Analysis Guidelines of the US Nuclear Regulatory Commission", NUREG/BR-0058, Rev. 4, September, p. 4 n. 3, available at: www.nrc.gov/reading-rm/doc-collections/nuregs/brochures/br0058/br0058r4.pdf.
10. Ibid. (emphasis added).
11. See e.g. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities", (emphasis added).
12. Power Reactor Development Co. v. International Union of Electrical, Radio and Machine -Workers, 367 US 396, 408 (1961).

absent specific guidance from Congress, is just such a situation where the Commission should be permitted to have discretion to make case-by-case judgments based on its technical expertise and on all the relevant information."[13] That same year, the First Circuit noted that its appellate review of NRC actions was "'at its most deferential' when it involves scientific or technical issues."[14]

The second principle is that the NRC's authority over adequate protection is bound to matters that have a reasonable nexus to radiological health and safety. This was affirmed over 40 years ago in another First Circuit decision, where the court concluded that "the responsibility of the [NRC's predecessor, the AEC] [is] confined to scrutiny of and protection against hazards from radiation."[15] Therefore, a mere nexus to health and safety is not enough; there must be a radiological aspect to the public health and safety concern.

The third principle is that the NRC has the ability to determine if adequate protection has been achieved on a case-by-case basis. Courts have refused to require the NRC to employ "a set of objective criteria for determining what level of protection is adequate."[16] Thus, in practice, there are no universal tests, checklists or quantitative data that a Commissioner uses to decide this question in the rulemaking, licensing, or policy decisions that come before the Commission. And rightfully so: aside from being nearly impossible to do generically, creating set criteria for adequate protection determinations would significantly diminish the responsibilities of the Commission by making such decision making automated. It would not allow us, as individual Commissioners, to use our own significant experiences to help guide our decisions if such a process were already so rigidly decided based on a set of pre-established criteria.

The final, and perhaps the most important principle, is that adequate protection does *not* mean zero risk. From a legal perspective, the "no risk" issue is also well-settled: the 1987 Union of Concerned Scientists decision, for instance, noted that "'[a]dequate protection,' however, is not absolute protection."[17] Many, if not all, of the issues that come before the Commission can be distilled to a determination of how much risk we are willing to accept. The risk can be from a safety, security, or even from a legal perspective. In all of these situations, the adequate protection standard puts the responsibility on Commissioners to decide how much risk is acceptable. Another way to look at this is: how much regulation is enough? Or the never-ending question for regulators: how safe is safe enough?

One commissioner's adequate protection framework

In the seminal DC Circuit case for nuclear regulation, Siegel v. Atomic Energy Commission, the court remarked that the regulatory scheme in the Atomic Energy Act is "virtually unique in the degree to which broad responsibility is reposed in the administering agency, free of close prescription in its charter as to how it shall proceed in achieving the statutory objectives."[18] The Commission has an important duty to use its "broad responsibility" judiciously, while also respecting the significant trust emplaced in it by Congress and the American public to ensure adequate protection. To strike this balance, the NRC must take a hard look at proposed regulatory actions to ensure that any new requirement has a clear nexus to the agency's goals and that any such requirement is truly necessary to achieve

13. UCSII, 880 F.2d at 558.
14. Massachusetts v. NRC, 878 F.2d 1516, 1523 (1st Cir. 1989).
15. New Hampshire v. AEC, 406 F.2d 170, 175 (1st Cir. 1969).
16. UCSII, 880 F.2d at 558.
17. UCSI, 824 F.2d at 114.
18. Siegel v. AEC, 400 F.2d 778, 783 (DC Cir. 1968).

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those goals. One way that I do this is by asking one simple question: what, if anything, is broken? Similarly one can also ask: is this a solution looking for a problem? I have found these questions to be remarkably useful in my post-Fukushima Daiichi decision making.

If there is in fact something broken, or an actual problem exists, it is essential that the Commission has a clear understanding of the exact nature of the problem that is being addressed, as well as of any risks associated with not addressing the problem. Identification and understanding of these risks is critical to making a final decision on adequate protection. As previously stated, it is well established that the adequate protection standard does not mean "zero risk." The NRC does not have a technical or legal basis to try to achieve zero risk, nor would it be a prudent use of government resources. Therefore, determining how much risk is acceptable is part of the critical function of this agency. And, because that determination inevitably requires a fair amount of judgment, it is one that I take very seriously as a Commissioner.

The NRC generally defines risk as the product of the probability and consequences of a given event. In the NRC's regulatory arena, the probabilities are almost always low, the consequences are often high, and there are inherent uncertainties in risk estimates. Thus, as a regulator, one must also take a hard look at whether concerns are based on realistic assumptions, as well as real world safety, security, and legal practices. The Commission should never consider these issues in a vacuum, outside the realm of real life and actual operating experience. For instance, when I visit nuclear power plants, I always seek to understand, and if possible view the actual impacts of proposed or existing regulatory requirements. To maintain situational awareness of regulatory challenges, I often ask: how will this be implemented; what will be the impact of the new regulation; how will this affect other processes; and are there any unintended negative safety (or security) consequences? Similarly, I often reach out to members of the public for their input on regulatory changes and any potential impacts those regulatory actions may have on the subject facility as well as the surrounding community. By including all perspectives, the Commission can guard against insulated or isolated regulatory decision making, which is both ineffective and inefficient.

Once the NRC has determined that there is a problem, the exact nature of the problem, and the risks associated with the problem, there is still a great deal of difficult work to be done. It is imperative that the NRC evaluate these regulatory issues in a structured manner within the boundaries of our framework. That framework has a built-in check and balance – the regulatory combination of adequate protection determinations and cost-benefit analyses – that ensures our regulations are neither too lax nor excessively burdensome. I firmly believe that if the NRC has determined that adequate protection has already been achieved, we have a duty as a reliable and consistent regulator to ensure that we make this perfectly clear to our licensees and stakeholders. Thus, we must ensure that we have effectively evaluated questions of adequate protection at the outset. By adhering to our adequate protection standard, the NRC is able to maintain its position as a predictable and stable regulator. It serves no interest – not ours, not the regulated industry's, and not the public's – to have regulatory uncertainty.

Of course, to be clear, this approach does not mean that we should not consider new information or new insights. To the contrary, the NRC must always remain vigilant in ensuring that adequate protection is being achieved. A stable regulatory structure does not mean a static regulatory structure. Operating experiences and new information can and should lead to appropriate changes. I consider our ability to be self-critical and learn lessons to be significant strengths of our regulatory framework. The NRC must, however, ensure that additional requirements are

imposed only after clearing the appropriate regulatory bar, and are not simply a result of "we can do better."

NRC response to the Fukushima Daiichi accident

Fukushima Daiichi and the NRC's Near-Term Task Force

On Friday, 11 March 2011, a 9.0-magnitude earthquake struck Japan and was soon followed by a tsunami, estimated to have exceeded fourteen meters (45 feet) in height. The Great Tohoku Earthquake caused the immediate automatic safe shutdown of eleven nuclear power plants at four sites along the northeast coast of Japan. The resultant giant tsunami waves caused extensive damage to several nuclear power reactors operated by the Tokyo Electric Power Company at the Fukushima Daiichi nuclear power plant. The estimated height of the tsunami exceeded the site design protection from tsunamis by approximately eight meters (27 feet).

Less than two weeks after the accident at Fukushima Daiichi, the NRC staff was directed to establish a senior-level agency task force to conduct a systematic and methodical review of NRC processes and regulations to determine whether the agency should make additional improvements to its regulatory system and to make recommendations to the Commission for its policy direction.[19] The NRC's Near-Term Task Force released their report on 12 July 2011, making a number of conclusions and recommendations for enhancements.[20] One of their conclusions helped anchor my views on how to responsibly move forward in assessing the NTTF recommendations:

> The current regulatory approach, and more importantly, the resultant plant capabilities allow the Task Force to conclude that a *sequence of events like the Fukushima accident is unlikely to occur in the United States* and some appropriate mitigation measures have been implemented, reducing the likelihood of core damage and radiological releases. *Therefore, continued operation and continued licensing activities do not pose an imminent risk to public health and safety*.[21]

One month after the Fukushima Daiichi accident, members of the public, as well as the State of Massachusetts, petitioned the Commission to essentially suspend all licensing and adjudications until the completion of the Fukushima Daiichi lessons learnt process. In a September 2011 adjudicatory order addressing the petition, the Commission determined that there was no need to suspend licensing and adjudications because nothing learnt to date put the continued safety of the currently operating regulated facilities, including reactors and spent fuel pools, into question.[22] Thus, it was determined that adjudications and licensing reviews could continue while the Fukushima Daiichi lessons learnt process moved along in parallel.[23]

19. NRC (2011), "Tasking Memorandum – COMGBJ-11-0002 – NRC Actions Following the Events in Japan", 23 March, available at: www.nrc.gov/reading-rm/doc-collections/commission/comm-secy/2011/2011-0002comgbj-srm.pdf.
20. NRC (2011), "Recommendations for Enhancing Reactor Safety in the 21st Century: The Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident" (hereafter NTTF Report), 12 July, available at: http://pbadupws.nrc.gov/docs/ML1118/ML111861807.pdf.
21. Ibid., p. vii (emphasis added).
22. Union Electric Co. d/b/a/ Ameren Missouri (Callaway Plant, Unit 2), CLI-11-5, 74 NRC (9 Sept. 2011) (slip op. at 22).
23. Ibid. (slip op. at 25).

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Although not necessarily a part of the NTTF Report, other observations helped inform my decision making on the Commission's many post-Fukushima Daiichi actions. For example, the International Atomic Energy Agency (IAEA) released its final report on the Integrated Regulatory Review Service (IRRS) Mission to the US in October 2010, which assessed the NRC's regulatory programme. The IRRS review found that "the NRC has a comprehensive and consistent regulatory system that has been developed in a determined manner"[24] and that "the NRC has a strong drive for continuous improvement in its own performance and has well achieved its goals."[25] Another factor is an observation Commissioner Apostolakis has repeated, and one that I fully endorse: "The accident [at Fukushima] was not of extremely low probability, i.e. it was not 'unthinkable' or 'unforeseen.'"[26]

A final factor that I believe has always been important to keep in mind is that the Fukushima Daiichi tragedy occurred in another country whose regulatory structure is quite different from that established in the US. While I have long maintained this as an element of my decision making,[27] this fact was underscored by the July 2012 Official Report of the Fukushima Nuclear Accident Independent Investigation Commission (NAIIC), an independent investigative commission empowered by the Japanese legislature. Kiyoshi Kurokawa, Chairman of the NAIIC, candidly stated that the Fukushima Daiichi disaster was "made in Japan." That is, the fundamental causes of the accident flowed from "the ingrained conventions of Japanese culture."[28]

The NTTF, however, did not focus on these differences, and instead concentrated on the technical lessons that they believed should be learnt for US reactors. Their stated focus was on "key areas most relevant to the safety of US reactors, such as external events that could damage large areas of the plant, protection against and mitigation of a prolonged station blackout, and management of severe accidents."[29] Thus, the NTTF Report began the discussion of whether reliable, hardened vents were needed on the boiling water reactors (BWRs) using the Mark I and Mark II containment designs in the United States, whether the assumption of single-unit events (as opposed to multi-unit events at sites with more than one reactor) should be reconsidered, and what, if any, instrumentation should be placed in spent fuel storage pools. They also provided insights into a number of areas, such as the need to make sure that risks from events such as earthquakes and tsunamis were appropriately understood.

After reading the NTTF Report, I formed my own opinion about which NTTF recommendations should be given high priority status for short-term regulatory

24. IAEA (2010) "Integrated Regulatory Review Service Mission to the United States of America, 17 to 29 October 2010", p. 7, available at: www.nrc.gov/public-involve/conference-symposia/irrs-mission-review/irrs-mission-report.pdf.
25. Ibid., p. 8.
26. See e.g. Apostolakis, G. (2011),"Statement of George Apostolakis, Commissioner, United States Nuclear Regulatory Commission before the Committee on Environment and Public Works and the Clean Air and Nuclear Safety Subcommittee United States Senate", 2 August, p. 1, available at: www.nrc.gov/about-nrc/organization/commission/comm-george-aposto lakis/apostolakis-08-02-2011-senate-epw.pdf.
27. See Ostendorff, W. (2011), Vote on SECY-11-0093, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," 27 July, p. 2, available at: www.nrc.gov/reading-rm/doc-collections/commission/cvr/2011/2011-0093vtr-wco.pdf. ("The Fukushima tragedy occurred in another country whose regulatory structure is quite different from that found in the U.S.")
28. The National Diet of Japan (2012), "The Official Report of the Fukushima Nuclear Accident Independent Investigation Commission", Executive Summary, p. 9, available at: www.nirs.org/fukushima/naiic_report.pdf
29. NTTF Report, supra note 20, p. 1.

action.[30] But, I firmly believed it was essential for the NRC to have an integrated, prioritised approach – based on recommendations from the NRC staff as a whole – to the many NTTF recommendations.[31] The failure to have such an approach was a key lesson learnt from the NRC's response to the events at Three Mile Island in 1979[32] and was stated as a key concern by the Executive Director for Operations (EDO) at our first meeting on the Fukushima Daiichi events in March 2011.[33] Because of concerns such as these, the Commission directed the NRC staff to recommend a prioritisation of the NTTF recommendations.[34]

In October 2011, the NRC staff provided the Commission with their proposed prioritisation of the NTTF recommendations.[35] The NRC staff first agreed with the NTTF that none of the findings represented an immediate hazard to public health and safety. The NRC staff then recommended breaking up the rest of the recommendations into three tiers, with tier 1 consisting of those NTTF recommendations that should be started without unnecessary delay. The tier 1 recommendations had the greatest potential for safety improvement in the near term and had sufficient resource flexibility for implementation. The rest of the recommendations were divided into tiers 2 and 3. Tier 2 actions were those that could not be instituted in the near term, but did not require long-term study and

30. See Ostendorff, W. (2011), Vote on SECY-11-0093, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan", 27 July, p. 4, available at: www.nrc.gov/reading-rm/doc-collections/commission/cvr/2011/2011-0093vtr-wco.pdf (listing six discrete actions that should be given high priority for short-term regulatory action: the re-evaluation of seismic and flooding hazards, performance of seismic and flood protection physical verification walkdowns, strengthening station blackout capability, additional equipment needs for multi-unit events, review of venting capability for Mark I and Mark II containments, and maintenance of severe accident management guidelines). These largely fit with the NRC staff's later recommendations for tier 1 actions.
31. Ibid., p. 5(calling for the EDO to provide the Commission with its recommendations for a draft charter for the NRC staff's longer-term review of the NTTF Report that incorporates senior-level NRC managers on a steering committee, with an internal advisory committee, and provides an "integrated, prioritized assessment of the Task Force recommendations along with its recommendations and bases for further regulatory actions").
32. Following the accident at Three Mile Island, the NRC created what was called the "TMI Action Plan". See NRC (1980), "NRC Action Plan Developed as a Result of the TMI-2 Accident", vols. 1 & 2, May, available at: http://pbadupws.nrc.gov/docs/ML0724/ML072470526.pdf andhttp://pbadupws.nrc.gov/docs/ML0724/ML072470524.pdf; NRC (1980), "Clarification of TMI Action Plan Requirements", NUREG-0737, November, available at: www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0737/final/sr0737.pdf; NRC (1983), "Clarification of TMI Action Plan Requirements: Requirements for Emergency Response Capability", NUREG-0737, Supp. 1, January, available at: www.nrc.gov/reading-rm/doc-collections/nuregs/staff/ sr0737/sup1/sr0737sup1.pdf. The TMI Action Plan included approximately 371 individual requirements, which resulted in 13863 applicable action plan items.
33. The NRC's EDO stated in the March 2011 meeting that some of the TMI Action Plan items "were absolutely instrumental in improving the safety in this country", while others "might have actually been counterproductive in a way." NRC (2011), "Briefing on NRC Response to Recent Nuclear Events in Japan", Transcript, 21 March, p. 40 (remarks of R.W. Borchardt), available at: www.nrc.gov/reading-rm/doc-collections/commission/tr/2011/20110321.pdf.
34. NRC (2011), "Staff Requirements – SECY-11-0093 – Near-Term Report and Recommendations for Agency Actions Following the Events in Japan", 19 August, p. 1, available at: www.nrc.gov/reading-rm/doc-collections/commission/srm/2011/2011-0093srm.pdf.
35. NRC (2011), "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned", SECY-11-0137, 3 October, available at: www.nrc.gov/reading-rm/doc-collections/commission/secys/ 2011/2011-0137scy.pdf.

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could be initiated when sufficient information and resources became available. These actions consisted of activities to address: spent fuel pool makeup capability, emergency preparedness regulatory actions, and a recommendation that licensees perform another external-hazards evaluation (i.e. hazards other than seismic and flooding). Although implementation of tier 1 and tier 2 actions is underway, the tier 3 recommendations will require further staff study to support a regulatory action, have an associated shorter-term action that needs to be completed to inform the longer-term action, or are dependent on the availability of critical skill sets.[36]

I fully supported the NRC staff's three-tiered prioritisation.[37] In my personal opinion, not all of the twelve NTTF recommendations (with 35 subparts) are equal from either a safety enhancement or urgency perspective. Every post-Fukushima Daiichi action cannot be considered high priority. Thus, the NRC had to focus on the most safety-significant actions first. And that is exactly what the NRC has done.

First post-Fukushima Daiichi orders

Focus on safety significance in the evaluation of post-Fukushima Daiichi actions resulted in an NRC staff proposal to issue three sets of orders on tier 1 items: (1) installation of reliable, hardened containment vents for BWRs with Mark I and Mark II containments; (2) development of strategies to mitigate beyond-design-basis natural phenomena, which addresses both multi-unit events and reasonable protection of equipment identified under such strategies; and (3) installation of enhanced spent fuel pool instrumentation.[38] According to the NRC staff, the events at Fukushima Daiichi highlighted the possibility that extreme natural phenomena could challenge the prevention, mitigation, and emergency preparedness layers of defence-in-depth.[39] Thus, the staff proposed issuing the orders based upon a redefinition of the level of protection regarded as adequate pursuant to our backfit rule. This would have, in essence, "raised the bar" for adequate protection, which is quite a weighty decision for the Commission to make. Decisions on adequate protection are among the most significant policy decisions entrusted to the Commission and are not impulsive "go or no-go" choices. The decision-making

36. Some examples of tier 3 actions are: a ten-year confirmation of seismic and flooding hazards, potential enhancements to the capability to prevent or mitigate seismically-induced fires and floods, and hydrogen control and mitigation inside containment or other buildings. See ibid. at 4. Additional items with a nexus to the Fukushima Daiichi accident were later added to tier 3, beyond what was initially recommended in the NTTF Report.
37. Ostendorff, W. (2011), Vote on SECY-11-0137, "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned", 31 October, p. 17, available at: www.nrc.gov/reading-rm/doc-collections/commission/cvr/2011/2011-0137vtr.pdf.
38. In accordance with the procedures in 10 CFR § 2.202, the NRC may issue orders to modify, suspend, or revoke a licence on the basis of violations of NRC requirements or on "potentially hazardous conditions or other facts deemed to be sufficient ground for the proposed action." The NRC staff presented the commission its proposal to issue the three orders discussed in this section in NRC (2012), "Proposed Orders and Requests for Information in Response to Lessons Learned from Japan's March 11, 2011, Great Tohoku Earthquake and Tsunami", SECY-12-0025, 17 February, available at: www.nrc.gov/reading-rm/doc-collections/ commission/secys/2012/2012-0025scy.pdf.
39. At a high level, the NRC defines "defense-in-depth" as: "An approach to designing and operating nuclear facilities that prevents and mitigates accidents that release radiation or hazardous materials. The key is creating multiple independent and redundant layers of defense to compensate for potential human and mechanical failures so that no single layer, no matter how robust, is exclusively relied upon. Defence-in-depth includes the use of access controls, physical barriers, redundant and diverse key safety functions, and emergency response measures." NRC (n.d.) "NRC: Glossary – Defense-in-Depth", www.nrc.gov/reading-rm/basic-ref/glossary/defense-in-depth.html (accessed 9 July 2013).

process for these orders demonstrated just how seriously the Commission took its responsibility in evaluating the orders.

While I agreed that the requirements in the hardened vents and mitigation strategies orders should be grounded in adequate protection, I could not conclude that the NRC was "defining or redefining" the level of protection regarded as adequate. The NRC has generally "defined or redefined" adequate protection by implementing generic requirements that establish a new minimum level of protection through the rulemaking process. In these two orders, however, the NRC was not raising the bar on the level of adequate protection; instead, the orders supplemented existing requirements and codified current regulatory expectations. Thus, the NRC was responding to operating experience from the Fukushima Daiichi accident and ensuring, rather than redefining, adequate protection.

To help illustrate, after 11 September 2001, the NRC required all US plants to have mitigation strategies and extra equipment such as portable generators, water pumps, hoses, and batteries to provide reactor safety capability under the extreme circumstances associated with loss of large areas of the plant due to fires or explosions.[40] This work stemmed from concerns over the effects of a potential aircraft attack on nuclear power plants. The mitigation strategies order called for upgrades to this portable equipment to handle extreme natural phenomena, including events at multiple nuclear reactors at a single site. The mitigation strategies order, therefore, expanded upon the post-9/11 framework by incorporating operating experience and lessons learnt from the Fukushima Daiichi accident. It did not, however, redefine the level of protection the NRC regards as adequate.

Similarly, the hardened vents order clarified current regulatory expectations by incorporating lessons learnt from the Fukushima Daiichi accident. The accident vividly illustrated the consequences of both unreliable vents and overly restrictive operational limits,[41] which prevented earlier venting during an accident, contrary to US practices. Further, the hardened vent order codified current regulatory expectations by incorporating the extensive operating experience and risk insights with BWR Mark I and Mark II containment integrity over the past three decades. Again, this is an example of the NRC ensuring adequate protection through normal regulatory measures rather than raising the bar on the adequate protection standard.

The spent fuel pool instrumentation order was a different story. The staff also proposed using the "defining or redefining" adequate protection exception to the backfit rule to implement this new requirement. In my opinion, however, this action did not rise to the level of an adequate protection measure. While the operating experience at Fukushima Daiichi demonstrated that reliable and available instrumentation is important for plant personnel to effectively prioritise emergency actions, it did not show that the absence of spent fuel pool instrumentation resulted in radiological consequences. But, based upon my many years of nuclear propulsion plant operations, I know that a lack of reliable instrumentation can cause operator confusion and can be a significant distraction that may adversely impact safe

40. These requirements, called "interim compensatory measures," were originally issued as immediately effective orders. All Operating Power Reactor Licensees: Order Modifying Licenses (Effective Immediately), 67 Fed. Reg. 9792 (4 March 2002). These requirements were later largely codified as 10 CFR § 50.54 (hh).
41. See e.g. Institute of Nuclear Power Operations (2011), "Special Report on the Nuclear Accident at the Fukushima Daiichi Nuclear Power Station," INPO 11-005, November, p. 10, available at: www.nei.org/corporatesite/media/filefolder/11_005_Special_Report_on_Fukushima_Daiichi_MASTER_11_08_11_1.pdf.

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operations. Given the significant radiological inventory in a typical spent fuel pool, I believed that spent fuel pools should have reliable instrumentation.

Without an adequate protection basis to impose the spent fuel pool instrumentation requirement, and in the absence of a cost-benefit analysis, the Commission needed some way to impose this important safety measure. In this instance, the Commission turned to the administrative exemption. Commission action exempting itself from its own binding regulations should be a rare occurrence that takes place only in special circumstances or when the underlying NRC action to be exempted is necessary. In the only previous use of the administrative exemption, the Commission stated that it "will continue to be an extremely rare action to be taken only if regulatory considerations strongly favor taking such administrative exemption."[42] Personally, I was able to determine that the order for enhanced spent fuel instrumentation was necessary and the events at Fukushima Daiichi demonstrated the type of rare underlying occurrence where an administrative exemption is acceptable. Therefore, I approved the use of an administrative exemption to the backfit rule.

Ultimately, the Commission approved issuing hardened vents and mitigation strategies orders as necessary for continuing adequate protection and approved the spent fuel pool instrumentation order as an administrative exception to the backfit rule.[43] From this experience, one point should be evident: our regulatory standard has *not* changed since Fukushima Daiichi. The NRC *still* regulates based upon reasonable assurance of adequate protection of public health and safety. And the Commission's existing framework was robust and flexible enough to disposition the most safety-significant post-Fukushima Daiichi actions.

NTTF Recommendation 1

The NTTF found that "[a]lthough complex, the current regulatory approach has served the Commission and the public well."[44] But, the NTTF nevertheless began its recommendations with this proposal:

> The Task Force recommends establishing a logical, systematic, and coherent regulatory framework for adequate protection that appropriately balances defense-in-depth and risk considerations.[45]

This recommendation, which is referred to at the NRC as "Recommendation 1," also had sub-recommendations that called for "enhanc[ing] the NRC regulatory framework to encompass beyond-design-basis events and their oversight through,"

42. Consideration of Aircraft Impacts for New Nuclear Power Reactors, Final Rule, 74 Fed. Reg. 28112, 28144 (12 June 2009).
43. NRC (2012), "Staff Requirements – SECY-12-0025 – Proposed Orders and Requests For Information in Response to Lessons Learned from Japan's March 11, 2011, Great Tohoku Earthquake and Tsunami", 9 March, available at: www.nrc.gov/reading-rm/doc-collections/commission/srm/2012/2012-0025srm.pdf. The orders were thereafter issued by the NRC staff. See All Power Reactor Licensees and Holders of Construction Permits in Active or Deferred Status: Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Effective Immediately), 77 Fed. Reg. 16082 (19 March 2012); Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Effective Immediately), 77 Fed. Reg. 16091 (19 March 2012); All Operating Boiling Water Reactor Licensees with Mark I and Mark II Containments: Order Modifying Licenses with Regard to Reliable Hardened Containment Vents (Effective Immediately), 77 Fed. Reg. 16098 (19 March 2012).
44. NTTF Report, supra note 20, p. 18.
45. Ibid., p. 22.

among other actions, "inclu[sion of] extended design-basis requirements in the NRC's regulations as essential elements for ensuring adequate protection."[46]

One word used only three times throughout the almost 100 page NTTF Report seems to have shaped much of the debate on Recommendation 1: patchwork. The NTTF first referenced a supposed regulatory "patchwork" by saying:

> [The NRC's] regulatory approach, established and supplemented piece-by-piece over the decades, has addressed many safety concerns and issues, using the best information and techniques available at the time. *The result is a patchwork of regulatory requirements and other safety initiatives*, all important, but not all given equivalent consideration and treatment by licensees or during NRC technical review and inspection. Consistent with the NRC's organizational value of excellence, the Task Force believes that improving the NRC's regulatory framework is an appropriate, realistic, and achievable goal.[47]

My personal opinion is that the NRC's regulatory framework is not broken, however, and calling it a "patchwork" unfairly paints it in a negative light. As I stated in my first vote on the NTTF Report, the "use of the word 'patchwork' diminishes the dynamic, evolving nature of the NRC's regulatory framework."[48] The NRC is a continuously learning organisation, which should be viewed as a strength. With the benefit of hindsight, one can usually suggest better ways to approach past issues. But, I am not a critic of actions this agency took in response to major events like Three Mile Island or September 11th. Rather, previous NRC staff and Commissioners used their best judgment to appropriately address the problems they faced. Those judgments have generally stood the test of time. As I said then, and continue to believe now, "[w]hile the NRC's regulatory approach…may not have the coherence of a framework that might be developed with the luxury of being done in a closed room at one static point in time, it does not mean that the framework is not effective."[49]

While there is no AEA mandate to formally reconsider or reconfirm original findings of adequate protection, the NRC must always ensure that NRC-regulated activity is conducted in a manner that provides for adequate protection. Learning from operating experience has been a cornerstone of the NRC's regulatory process since its inception and is central to this continuous assurance of adequate protection. The NRC has a formal Reactor Operating Experience (OpE) Programme that "provides means for assessing the significance of OpE Information, providing timely and effective communication to stakeholders, and applying the lessons learned to regulatory decisions and programs affecting nuclear reactors."[50] The Fukushima Daiichi Lessons Learnt initiative fits within this OpE Programme, as have a number of other initiatives undertaken by the NRC over the years.[51] Hundreds, if not thousands, of Information Notices[52] have been issued over the years sharing OpE

46. Ibid.
47. Ibid., p. vii. (emphasis added).
48. Ostendorff, W (2011), Vote on SECY-11-0093, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan", 27 July, p. 2, available at: www.nrc.gov/reading-rm/doc-collections/commission/cvr/2011/2011-0093vtr-wco.pdf.
49. Ibid., p. 3.
50. NRC (2012), "Management Directive 8.7, Reactor Operating Experience Program", 27 September, p. 2, available at: http://pbadupws.nrc.gov/docs/ML1227/ML122750292.pdf.
51. Other examples of longer-term reactor safety focus areas arising from OpE are groundwater contamination (tritium), concrete degradation, and corrosion and leaking issues found in some buried pipes.
52. Information Notices are the NRC's vehicle for communicating generic operating or analytical experience to the nuclear industry. Information Notices may also communicate the results of newly completed research. The NRC expects the industry to review the information for applicability and consider appropriate actions to avoid similar problems.

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on issues such as failed components, degradation mechanisms, and design errors. More significant events such as the Browns Ferry fire, Salem anticipated transient without scram, and Three Mile Island accident all resulted in more substantive regulatory changes. Thus, the NRC is not "patching" its regulations; rather, it is continuously strengthening its regulations as appropriate.

The Commission has yet to receive the NRC staff's analysis and options for addressing NTTF Recommendation 1, but the Commissioners have been periodically briefed on the working group's progress. Because the NRC staff's final paper is not yet finished, I cannot say with certainty how I will vote on this issue. In the briefings I have had, I have consistently asked the same question: what is the problem we are trying to solve? And, I have yet to hear what safety issues exist, but cannot be remedied, through our current regulatory process. Everything that I have seen during my time as a Commissioner has suggested that our current regulatory process has served us well. In fact, one very apt example stands out: just as the Commission has already dispositioned the most safety-significant post-Fukushima Daiichi actions under our current regulatory framework, so too does it appear that the Commission will likewise be able to disposition *all* Fukushima Daiichi tier 1, 2, and 3 actions under that same regulatory framework.

This opinion should not be taken, however, as any indication that I do not believe this approach to be a worthwhile effort. As a continuously learning organisation, it is helpful to stop sometimes and take a retrospective, historical look at where we came from and how we got here. This exercise is certainly helpful to me as a Commissioner since it continues to give me great confidence that our regulatory structure is fundamentally strong.

Moving forward in the wake of the Fukushima Daiichi accident

New reactor licensing

The Commission's handling of new reactor licensing demonstrates the agency's ability to successfully perform its licensing functions while also effectively moving forward in its post-Fukushima Daiichi actions. In September and October of 2011, six months after the Fukushima Daiichi accident, the Commission held mandatory hearings[53] for the Vogtle (Georgia) and Summer (South Carolina) combined licence (COL) applications, which would eventually become the first new nuclear power plant construction authorisations by the US government in over thirty years. After

Information Notices, do not, however, impose new requirements. NRC Information Notices from 1979 to the present may be found at: www.nrc.gov/reading-rm/doc-collections/gen-comm/info-notices/.

53. The United States Congress, through the AEA, requires that a hearing be held for those proceedings that involve the granting of a construction permit for a nuclear power plant, even if the proceeding is uncontested, AEA § 189a.(1)(A), 42 USC § 2239(a)(1)(A). This requirement dates back to 1957, in part to address a perceived lack of transparency in the AEC's handling of early plant applications, when construction permits were issued largely without prior notice or hearing and without public dissemination of the AEC's safety evaluation. See Pub. L. 85-256 § 7, 71 Stat. 576 (1957). Therefore, before every construction permit is granted for new reactors, the commission itself holds a public hearing prior to making a decision to grant or deny the application. The "mandatory" hearing generally refers to the uncontested portion of the proceeding and the commission itself has decided it will hold those hearings for combined licences. In these uncontested hearings, which are generally held in public session, the commission typically receives presentations from the NRC staff and the license applicant and may hear from interested state or local governments or Indian tribes. See NRC (2012), "Internal Commission Procedures", 12 June, chap. IV, pp. IV-12-21, available at: www.nrc.gov/about-nrc/policy-making/icp-chapter-4-2012.pdf#page=12.

the hearings, and while the Commission was weighing its ultimate decision on the COL applications, the agency was also considering the three Fukushima Daiichi orders previously discussed. The Commission had to make certain determinations regarding the proper sequencing of those actions and whether those post-Fukushima Daiichi orders had to be issued prior to licensing the new reactors.

A majority of the Commissioners strongly believed that the agency need not depart from its rigorous, well-established licensing process to deal with post-Fukushima Daiichi actions in new reactor licensing. For the majority, the Commission could assure timely implementation of any new requirements and ensure adequate protection of public health and safety without departing from the existing regulatory process. I was in absolute agreement. To me, four main considerations informed this determination: (1) that the Task Force concluded "continued operation and continued licensing activities do not pose an imminent risk to public health and safety"; (2) that the NRC has "in place well-established regulatory processes by which to impose any new requirements or other enhancements that may be needed"; (3) that the "applicability of any new requirement will be determined when the justification is fully developed and we evaluate the Staff's bases [for their recommendations]"; and (4) that "all affected nuclear plants will be required to comply with NRC direction resulting from lessons learned from the Fukushima accident, regardless of the timing of issuance of the affected licenses."[54] Thus, our regulatory structure was already flexible and robust enough to deal with these issues.

Holding the mandatory hearings for new reactor licensing was a major signal that although the NRC was seriously studying and considering lessons learnt from the Fukushima Daiichi accident, the normal licensing processes were going to be followed, and there was no need to suspend regulatory decision-making. Further, from the Commission's decisions to issue the licences for the Vogtle and Summer new reactors, it should be clear that while Fukushima Daiichi made us take a harder look at many things at the NRC, our regulatory structure remains sound. Although our framework is stable and predictable, it is also flexible enough to incorporate enhanced requirements when appropriate.

Offsite consequences

While there was no health risk associated with the radiation from the Fukushima Daiichi accident to those in the United States,[55] the large amount of

54. See Southern Nuclear Operating Co. (Vogtle Electric Generating Plant, Units 3 and 4), CLI-12-02, 75 NRC __ (slip op.)(9 February 2012); South Carolina Electric Gas Co. and South Carolina Public Service Authority (also referred to as Santee Cooper) (Virgil C. Summer Nuclear Station, Units 2 and 3), CLI-12-09, 75 NRC __ (slip op.) (30 March 2012). In the end, due to issues related to timing, the commission did not include any licence conditions related to the Fukushima Daiichi lessons learnt in the Vogtle COL, and instead issued the post-Fukushima Daiichi requirements through orders. Regarding the Summer COL, however, the mitigation strategies requirement was included as a licence condition, but the spent fuel pool instrumentation requirement was imposed through an order.
55. Only extremely low levels (barely above background radiation) of short-lived radioactive iodine and longer-lived cesium were detected by US nuclear power plant monitors and the US EPA's RadNet system. See e.g. EPA, "Monitoring Radiological Incidents," www.epa.gov/radnet/radiation-monitoring/ (accessed 21 February 2013). The EPA describes RadNet as a system that "monitors the nation's air, precipitation, drinking water, and pasteurized milk to track radiation in the environment." RadNet comprises more than 100 fixed radiation air monitors in 48 states as well as another 40 portable air monitors that can be sent anywhere in the United States if needed. RadNet runs continuously while computers also continuously review the data. EPA states that "If there is a meaningful

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radioactive material released to the environment in Japan[56] has initiated a discussion within the NRC about how our framework considers the offsite consequences of accidental radiological releases. I was able to observe some of those offsite consequences when I visited Fukushima Daiichi on 19 January 2012. The impact of the tsunami on structures and equipment at the site was overwhelming. I was similarly overcome by the barren landscape in the drive to the facility through the Fukushima prefecture. But, as affected as one might be by such sites, as regulators in the United States, we must not lose sight of the fact that no power generating technology comes without risks. We should be vigilant in mitigating those risks, though it will never be feasible to completely eliminate them.

Consideration of offsite economic consequences

The AEA does not require that the NRC protect against the offsite economic consequences associated with the unintended release of licensed nuclear material to the environment (or simply, "economic consequences") in its determinations of adequate protection standards. The NRC's long-standing regulatory philosophy, however, does provide that regulatory actions that are protective of public health and safety also afford protection of the environment.[57] As it specifically relates here, the NRC's reliance on prevention and mitigation of severe accidents provides ancillary protection to offsite property, thus minimizing potential economic consequences. Accordingly, the NTTF concluded that the NRC's "current approach to the issue of land contamination from reactor accidents is sound."[58] But, due to the continued interest in land contamination following the Fukushima Daiichi accident, the NRC staff re-examined whether any changes were necessary or desirable to the way the Commission considers economic consequences.[59]

The NRC currently considers economic consequences through our regulatory analysis process. That means that for all the regulatory actions where we perform regulatory analyses (for most rules, orders, bulletins, regulatory guides, and for all actions involving a backfit or the imposition of generic requirements), we evaluate the costs and benefits of the issue at hand. The benefit of some regulatory actions can include a reduction in the costs associated with land contamination. The possibility of offsite property damage, however, must be weighed against other costs and benefits, like severe accident prevention or mitigation.

The NRC staff concluded that our regulatory framework for considering offsite property damage is sound and affords sufficient flexibility to account for economic consequences. Regardless, the NRC staff presented the Commission an option, although not the recommended one, to add licensing requirements addressing offsite property damage and potentially adding a new exception to the backfit rule that would treat economic consequences as equivalent in regulatory character to

increase in radiation levels, laboratory staff immediately investigate." EPA, "About RadNet", www.epa.gov/radnet/about-radnet/index.html (accessed 9 July 2013).

56. Although there was a large release of radiation in Japan, multiple governmental and nongovernmental reports suggest that radiation risks to people living in Japan are very low due to evacuation measures and control of food and that health effects to the Japanese public will be minimal. See e.g. IAEA (2011), "Final Report of the International Mission on Remediation of Large Contaminated Areas Off-site the Fukushima Daiichi NPP", 15 November, pp. 4, 14, available at: www.iaea.org/newscenter/focus/fukushima/final_report151111.pdf; American Nuclear Society Special Committee on Fukushima (2012), "Fukushima Daiichi: ANS Committee Report", June, pp. 15-18, available at: http://fukushima.ans.org/report/Fukushima_report.pdf.
57. See e.g. NRC (2012), "Consideration of Economic Consequences within the U.S. Nuclear Regulatory Commission's Regulatory Framework", SECY-12-0110, 14 August (hereafter SECY-12-0110), p. 4, available at: www.nrc.gov/reading-rm/doc-collections/commission/secys/2012/2012-0110scy.pdf.
58. NTTF Report, supra note 20, pp. 21-22.
59. NRC, SECY-12-0110, supra note 57, p. 4.

matters of adequate protection or compliance. Another alternative mentioned was modifying the backfit analysis threshold to require a showing of either a substantial increase in protection to public health and safety, which is the current approach, or a substantial reduction in adverse offsite economic consequences, which as the staff explained, would treat "economic consequences as equivalent in regulatory character to 'safety enhancements.'"[60] The NRC staff stated that pursuing this approach "could signal the Commission's intent to change the regulatory framework, which could increase regulatory uncertainty."[61]

Not only is that statement true, but it is an understatement of the outcome of adopting that path. By affording equal regulatory treatment to an issue that has no nexus to radiological public health and safety with one that does, the NRC would be opening the door to a potentially never-ending stream of new regulatory requirements. I do not want to diminish the serious nature of possible radiation contamination following a severe accident. The possibility of severe accidents has been acknowledged since the initial development of nuclear power. But, our job as regulators is to manage the risks of severe accidents, not to prevent the possibility of an accident ever occurring.

In its final determination on this issue, the Commission approved the NRC staff's recommendation to "enhance the currency and consistency of the existing framework through updates to guidance documents integral to performing cost-benefit analyses in support of regulatory, backfit, and environmental analysis."[62] I firmly agree with this approach.[63] Our Principles of Good Regulation[64] state that once established, regulations should be perceived as reliable and not unjustifiably in a state of transition. This approach does not mean that our processes and policies should be static and immune from self-assessment. Rather, the NRC should pursue justifiable improvements based on domestic and international operating experience. Therefore, although the NRC's defence-in-depth philosophy and risk considerations for adequate protection of public health and safety have provided substantial ancillary protection of offsite property, we should take action to refine our regulatory analysis tools to account for new information.[65] Such action is appropriate for any organisation that values operating experience. That approach, however, does not mean that broader changes need to be made. Our existing regulatory structure is flexible and robust enough to appropriately appreciate economic considerations. And our current treatment of economic consequences is fundamentally sound.

Reducing offsite releases: filtered containment venting

While the NRC staff was prioritising the NTTF recommendations, they determined that an issue that has been considered by the Commission in the past,

60. Ibid., p. 8.
61. Ibid.
62. NRC (2013), "Staff Requirements – Consideration of Economic Consequences within the U.S. Nuclear Regulatory Commission's Regulatory Framework", SECY-12-0110, 20 March, p. 1, available at: www.nrc.gov/reading-rm/doc-collections/commission/srm/2012/2012-0110 srm.pdf.
63. Ostendorff, W. (2013), Vote on SECY-12-0110, "Consideration of Economic Consequences within the U.S. Nuclear Regulatory Commission's Regulatory Framework", 10 January, p. 17, available at: www.nrc.gov/reading-rm/doc-collections/commission/cvr/2012/2012-0110vtr.pdf.
64. NRC (n.d.), "Principles of Good Regulation" available at: www.nrc.gov/about-nrc/values.html#principles (accessed 9 July 2013).
65. An example of that refinement is the inclusion of the State-of-the-Art Reactor Consequence Analysis study insights (which estimated consequences in terms of early fatality risk and latent cancer fatality risk) into agency guidance for estimating offsite economic costs.

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but that was not included in the NTTF recommendations – whether the NRC should require installation of engineered filtered containment venting systems for BWRs with Mark I and Mark II containments – warranted further consideration and potential prioritisation.[66] Engineered filtered containment venting systems would prevent the release of significant amounts of radioactive material following most severe accident scenarios at BWRs with Mark I and Mark II containments. They would not, however, prevent a Fukushima Daiichi-type hydrogen explosion.

When the NRC staff evaluated the issue this time around, they presented the Commission with four potential options: (1) continue with the reliable hardened vents order, but pursue no further requirements; (2) upgrade or replace the reliable hardened vents with a severe accident capable containment venting system; (3) require installation of an engineered filtered containment venting system; or (4) pursue a performance-based approach to filtering whereby several site-specific strategies, including potentially a filter, could be used to reduce contamination in the event of a severe accident.[67] Some of these options could be pursued independently or in conjunction with each other. For example, requiring that vents be strengthened so that they will remain functional during severe accident conditions (Option 2) could be implemented in parallel with either Option 3 (engineered filtered vents) or Option 4 (performance-based approach).

Our Deputy Executive Director for Operations and Chairman of the Japan Lessons-Learned Steering Committee observed at the Commission's 9 January 2013 briefing on this issue, "There were *no* stakeholders who argued for the status quo."[68] Public interest groups, individual members of the public, the Nuclear Energy Institute (NEI),[69] utilities, Congress, and the Advisory Committee on Reactor Safeguards (ACRS)[70] all believed that there needed to be *some* type of filtering strategy to enhance defence-in-depth for these types of containments. There was a vigorous public debate about which of the other options should be the preferred path forward. While the NRC staff recommended Option 3,[71] many, including NEI,[72]

66. NRC (2011), "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned", SECY-11-0137, 3 October, available at: www.nrc.gov/reading-rm/doc-collections/commission/secys/2011/2011-0137scy.pdf. Subsequently, the Commission determined that the filtered containment vents issue should be moved from an "additional issues" category into tier 1. NRC (2011), "Staff Requirements – SECY-11-0137 – Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned", 15 December, available at: www.nrc.gov/reading-rm/doc-collections/commission/srm/2011/2011-0137srm.pdf. This was not, however, due to safety or urgency reasons. Rather, concurrent consideration of this issue with the hardened vents for Mark I and Mark II containments, a tier 1 action was the most practical path forward.
67. NRC (2012), "Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containments", SECY-12-0157, 26 November, p. 7, available at: www.nrc.gov/reading-rm/doc-collections/commission/secys/2012/2012-0157scy.pdf.
68. NRC (2013), "Briefing on Venting Systems for Mark I and II Containments", transcript, p. 65, (remarks of M. Johnson) (emphasis added), 9 January, available at: www.nrc.gov/reading-rm /doc-collections/commission/tr/2013/20130109b.pdf.
69. NEI is the US policy organisation for the nuclear energy and technologies industry. See NEI (n.d.), "About NEI", available at: www.nei.org/aboutnei (accessed 9 July 2013).
70. The ACRS is a body of technical experts that provides independent advice on a range of issues, such as the safety of reactor facility licence applications and licence renewals, specific generic matters or nuclear facility safety-related items, and health physics and radiation protection. The ACRS is statutorily mandated by the AEA and reports directly to the Commission (AEA § 29, 42 USC § 2039).
71. NRC, SECY-12-0157, supra note 67, p. 10, available at: www.nrc.gov/reading-rm/doc-collections/commission/secys/2012/2012-0157scy.pdf.
72. Pietrangelo, A. R. (2013), "Filtering Strategies and Filtered Vents", 25 January, available at: http://pbadupws.nrc.gov/docs/ML1303/ML13030A145.pdf.

utilities,[73] and the ACRS,[74] the NRC's legislatively-mandated independent, expert safety body, supported Option 4. And the discussion did not end there. Because the NRC staff did not recommend that the addition of engineered filters to the hardened vents be considered a matter of adequate protection, implementation would require either a satisfactory backfit analysis or some alternative regulatory method.

In the late 1980s, when the NRC previously evaluated whether to require filtered vents, it found "that the low probability of such events resulted in the costs of design improvements exceeding the calculated benefits."[75] Thus, no new requirements were then imposed. Unlike the last time the NRC staff considered this matter, this time they were able to satisfy the cost-benefit analysis. The NRC staff found that although the quantitative costs did not justify the benefits, when qualitative factors are considered, the direct and indirect costs associated with filtered containment vents were cost justified.[76]

My colleagues and I unanimously supported modifying our earlier reliable hardened vents order to require that those vents also be severe accident capable.[77] This measure is important because these vents can help reduce pressure inside a reactor and safely release built-up hydrogen to prevent explosions. In my visit to Fukushima Daiichi last year, I saw all too clearly what the after effects of a hydrogen explosion look like. This new requirement for severe accident capable vents is a pragmatic and sensible defence-in-depth measure to address those issues promptly.[78]

The Commission also approved a filtering strategies rulemaking process that considers engineered filters, as well as other severe accident confinement strategies.[79] I firmly agree with this hybrid approach based on Options 3 and 4.[80] Use of a performance-based approach is consistent with 25 years of Commission policy and past treatment of severe accidents. It is being successfully employed by our Canadian colleagues and I was able to see first-hand one possible approach to US implementation in a visit to Nine Mile Point in New York. Further, the rulemaking process will facilitate valuable stakeholder engagement in the development of a performance-based approach. Finally, although there has been considerable debate

73. See e.g. Korsnick, M. G. (2013), "Severe Accident Management and Filtering Strategies", 9 January, available at: www.nrc.gov/reading-rm/doc-collections/commission/slides/2013/20130109/korsnick-ceng-20130109.pdf.
74. ACRS (2012), "ACRS Review of Staff's Draft SECY Paper on Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containment Designs", 8 November, available at: http://pbadupws.nrc.gov/docs/ML1231/ML12312A099.pdf.
75. NRC, SECY-12-0157, supra note 67, p. 5, available at: www.nrc.gov/reading-rm/doc-collections/commission/secys/2012/2012-0157scy.pdf.
76. Ibid., p. 9.
77. NRC (2013), "Staff Requirements – SECY-12-0157 – Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containments", 19 March, p. 1, available at: www.nrc.gov/reading-rm/doc-collections/commission/srm/2012/2012-0157srm.pdf.
78. Ostendorff, W. (2013), Vote on SECY-12-0157, "Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containments", 2 February, p. 26, available at: www.nrc.gov/reading-rm/doc-collections/commission/cvr/2012/2012-0157vtr.pdf.
79. NRC (2013), "Staff Requirements – SECY-12-0157 – Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containments", 19 March, p. 1, available at: www.nrc.gov/reading-rm/doc-collections/commission/srm/2012/2012-0157srm.pdf.
80. Ostendorff, W., Vote on SECY-12-0157, supra note 78, p. 26.

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about the use of qualitative factors in this cost-benefit analysis,[81] I believe the staff's consideration of defence-in-depth as one of the principal qualitative factors was both appropriate and consistent with agency guidance.[82] That being said, the final decision on this type of cost-benefit analysis is a matter of judgment best left to Commission determination.

When I was considering this issue, I was struck by the almost universal consensus that existed among our diverse stakeholders for taking some action in this area. This general agreement confirmed that the Commission's decision is a logical outcome of the operating experience the nuclear industry gained as a result of the Fukushima Daiichi accident. It also demonstrated just how robust and flexible our current regulatory structure is to enable the Commission to move forward in a logical manner on an issue that, while important, no one argued was a matter of adequate protection.

Conclusion: Maintaining our adequate protection framework

On even some of the least controversial post-Fukushima Daiichi actions, some critics in the nuclear industry were already asking whether "the agency's proposed course of action undermines the integrity of the regulatory process" and, if the backfit rule is inconsistently applied, whether "the rule retain[s] any practical value in the future."[83] Although the criticisms were wrongly targeted, the overarching concerns were valid. This agency must vigilantly ensure that the memory of Fukushima Daiichi does not result in loose interpretations of our adequate protection mandate. Fukushima Daiichi was a terrible accident, and that should never be forgotten. But what also should not be forgotten is that it was an accident that occurred in another country – a country with a different regulatory structure and a different regulatory culture. I have not seen any evidence that suggests our current regulatory structure in the United States is broken or that there is any need to divert from the stable, predictable way that the NRC evaluates issues. The NRC must adhere to its well-proven approach to regulation. If we do not, the regulations will be only as predictable as the five individuals carrying the title "Commissioner."

81. See e.g. Stenger, D. F. (2013), "Backfitting Analysis for Filtered Vents for Mark I and II BWRs", 6 February, available at: http://pbadupws.nrc.gov/docs/ML1303/ML13039A139.pdf.
82. Ostendorff, W., Vote on SECY-12-0157, supra note 78, p. 26.
83. Ginsberg, E. and J. Zorn (2012), "Application of the NRC's Regulatory Framework for Imposing New Requirements in a Post-Fukushima Era", *American Bar Association Energy Committees Newsletter*, June, Vol. 9, No. 3, p. 11, available at: www.americanbar.org/content/dam/aba/publications/nr_newsletters/energy/201206_energy.authcheckdam.pdf.

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