POLICY ISSUE
(Notation Vote)

August 14, 2012 SECY-12-0110

FOR: The Commissioners

FROM: R. W. Borchardt
Executive Director for Operations

SUBJECT: CONSIDERATION OF ECONOMIC CONSEQUENCES WITHIN THE U.S. NUCLEAR REGULATORY COMMISSION'S REGULATORY FRAMEWORK

PURPOSE:

The purpose of this Commission paper (SECY) is to provide the Commission with information and options to address to what extent, if any, the U.S. Nuclear Regulatory Commission's (NRC's) regulatory framework should be modified regarding its consideration of the economic consequences of an unintended release of licensed nuclear materials to the environment.

SUMMARY:

The accident at the Fukushima Dai-ichi nuclear power plant in Japan initiated discussion of how the NRC's regulatory framework considers offsite property damage and other economic consequences caused by a significant radiological release from an NRC-licensed facility and licensed material. In response to this discussion, on April 6, 2012, the Office of the Executive Director for Operations (OEDO) directed the staff (see Enclosure 1, "Tasking for RES") to provide a notation vote paper to the Commission on how the NRC's regulatory framework currently considers the economic consequences associated with the unintended[1] release of licensed nuclear material to the environment and alternatives for Commission consideration.

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[1] For the purposes of this paper, the terms "unintended" and "unplanned" are used synonymously, and are meant to include discussion of accidental releases but exclude deliberate sabotage events. The staff notes that the term "unplanned" is used in several regulations (e.g., 10 CFR 30.50, 10 CFR 40.60, 10 CFR 70.50) in reference to radiological contamination events.

This paper focuses on the NRC's current processes for considering economic consequences arising from offsite property damage caused by radiological contamination events.[2] Based on an analysis of these processes, the staff concluded that the NRC's regulatory framework for considering offsite property damage is sound and affords sufficient flexibility to account for the offsite economic consequences associated with unintended radionuclide releases and subsequent land contamination. Nonetheless, this paper provides options for updating staff guidance and methods in this area, as well as an option for exploring the merits of potential changes to the regulatory framework.

BACKGROUND:

NRC requirements relating to the adequate protection of public health and safety do not consider costs. Although health and safety requirements are not intended to minimize economic consequences, they have that effect by preventing or mitigating events that could lead to a radiological release. Additionally, the NRC considers the economic consequences of property damage from radiological contamination in establishing its regulatory requirements. Enclosure 2 includes further background material, including a discussion of the NRC's safety goal policy statement and a summary of specific regulatory requirements and guidance addressing offsite property damage. The NRC's legal authority in this area is discussed in Enclosure 3, "NRC Legal Authorities Concerning Offsite Property Damage." The NRC conducts cost-benefit determinations within regulatory, backfitting, and environmental analyses, which may include property damage and other economic consequences.

In performing cost-benefit determinations, the NRC has traditionally considered two categories of property, onsite and offsite. Generally, onsite property is owned or controlled by the license- or certificate-holder and located within the boundaries of the licensed facility, whereas offsite property is located outside of the site boundaries, and is not owned or controlled by the license- or certificate-holder.[3] However, in a cost-benefit analysis, the distinction between offsite and onsite property goes beyond the location or ownership of the property. Onsite property costs include replacement power, decontamination costs, and costs associated with refurbishment or decommissioning. Offsite property costs include both the direct costs associated with property damage (e.g., diminution of property values) and indirect costs (e.g., tourism, manufacturing, and agriculture disruption). The NRC has periodically reevaluated the consideration of offsite property damage within its regulatory framework.[4]

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[2] A number of terms have been used to describe offsite economic impacts and property loss following a radiological accident, including land contamination, offsite economic consequences, offsite contamination effects, and offsite property damage. In this paper, the term "offsite property damage" encompasses a broad range of offsite economic impacts associated with the unintended release of radionuclides: loss of use and damage to property, relocation costs, and business disruption. The intent is to be consistent with the NRC's regulatory authority, regulations, and guidance.

[3] As stated in NUREG/BR-0058, Revision 4, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," issued September 2004, "offsite property" refers to property that is not owned or leased by a licensee.

[4] See, for example, SECY-97-208, "Elevation of the Core Damage Frequency Objective to a Fundamental Commission Safety Goal," dated September 12, 1997; SECY-98-101, "Modifications to the Safety Goal Policy Statement," dated May 4, 1998; SECY-99-191, "Modifications to the Safety Goal Policy Statement," dated July 22, 1999; SECY-00-0077, "Modifications to the Reactor Safety Goal Policy Statement," dated March 30, 2000; and SECY-01-0009, "Modified Reactor Safety Goal Policy Statement," dated January 22, 2001.

DISCUSSION:

Significant offsite property damage and associated economic consequences would generally only occur if substantial amounts of radioactive material were released. This paper focuses on those regulations associated with nuclear power plants licensed under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," and 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants"; materials licensed under Part 30, "Rules of General Applicability to Domestic Licensing of Byproduct Material," 10 CFR Part 40, "Domestic Licensing of Source Material," and 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material"; independent spent fuel storage installations licensed under 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste"; and gaseous diffusion plants certified under 10 CFR Part 76, "Certification of Gaseous Diffusion Plants." This does not imply that the above regulations encompass all regulated activities that may result in economic consequences, but these are the most significant requirements associated with offsite property damage from unintended releases.

Certain intentional releases could result in substantial offsite effects. This paper does not consider property damage from a radiological dispersal device (RDD) or radiological exposure device (RED), or any deliberate sabotage event.[5] In 2010, the Radiation Source Protection and Security Task Force[6] recommended that Federal agencies reevaluate their protection and mitigation strategies to protect against a significant RED or RDD attack using both potential severe immediate or short-term exposure and contamination consequences (i.e., economic consequences arising from property damage). Enclosure 4, "Radiation Source Protection and Security Task Force, Recommendation 2," describes past Commission direction and staff efforts to address the recommendation of the Radiation Source Protection and Security Task Force.

Within the context of unintended releases of nuclear materials to the environment, the NRC traditionally has relied on a defense-in-depth approach to prevent or minimize the consequences of accidents. Although the defense-in-depth philosophy has been applied to provide adequate protection of public health and safety, it also provides ancillary protection to offsite property, and thus minimizes offsite economic consequences.[7] For example, NRC regulations that address the prevention of core damage and containment of radionuclides for nuclear power plants also serve to minimize the potential for land contamination. In this way,

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[5] SECY-09-0051, "Evaluation of Radiological Consequence Models and Codes," dated March 31, 2009, and SRMs, which affect radiation source security activities, have directed the staff not to independently develop criteria for economic consequences as a result of an RED or RDD. Rather, the staff continues to support the risk assessment activities of the U.S. Department of Homeland Security (DHS) regarding its Radiological and Nuclear Terrorism Risk Assessment (RNTRA).

[6] The Interagency Radiation Source Protection and Security Task Force, led by the NRC, evaluates the security of radiation sources in the United States from potential terrorist threats, including acts of sabotage, theft, or use of a radiation source in a RDD, and provides recommendations to the President and Congress.

[7] SECY-08-0038 states that it is "the longstanding Commission policy that protection of humans is also protective of non-human species" (SECY-08-0038, p. 3). Further, the enclosure to SECY-03-0038 states that "the NRC has a well-established system for considering environmental impacts to non-human species associated with its regulatory and licensing decisions." The staff reaffirmed this position in SECY-12-0064, "Recommendations for Policy and Technical Direction to Revise Radiation Protection Regulations and Guidance."

the NRC's regulatory philosophy has been based on the premise that protection public health and safety also affords protection for the environment.

This regulatory approach was affirmed by the NRC's Near Term Task Force (NTTF) following the accident at the Fukushima Dai-ichi nuclear power station. The NTTF examined the NRC's current approach to land contamination and concluded that:

> The current NRC approach to land contamination relies on preventing the release of radioactive material through the first two levels of defense-in-depth, namely protection and mitigation. Without the release of radioactive material associated with core damage accident, there would be no significant land contamination. The task force also concludes that the NRC's current approach to the issue of land contamination from reactor accidents is sound.[8]

Nonetheless, the accident at Fukushima-Dai-ichi resulted in a large area of radioactively contaminated land in Japan. This land contamination has disrupted the lives of a large number of Japanese citizens and raised stakeholder concern about such economic consequences. In light of the continued discussions regarding land contamination following the Fukushima Dai-ichi nuclear power plant accident, the staff reexamined areas of the regulatory framework, specifically, regulatory, backfit, and environmental analyses and the associated guidance and tools as areas of key consideration. Each of these is discussed below:

- Regulatory Analysis: The staff conducts regulatory analyses to support proposed and final rules and to evaluate requirements, guidance, or staff positions that would result in a change in licensee resources. If there is a change in licensee resources, the regulatory analysis will evaluate societal costs and benefits of the proposed action, and the staff considers offsite property damage is such cost-benefit analyses. The staff uses regulatory analyses to inform decision makers about (1) the basis supporting the need for regulatory change, and (2) alternatives considered. Enclosure 5, "Regulatory and Backfit Analysis," contains a detailed description.

- Backfit Analysis: The backfit rules contained in 10 CFR Parts 50, 70, 72, and 76 help ensure that requirements that go beyond adequate protection[9] provide a substantial[10] increase in the overall protection of public health and safety, and that the direct and indirect costs of implementation are justified in view of this substantial increase in protection. Analogous backfitting provisions applicable to early site permits and standard design certifications, differing in some regards from those in 10 CFR 50.109 are set forth in 10 CFR 52. Enclosure 5 describes a three-step process and factors considered during backfit analysis.

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8 Recommendations for Enhancing Reactor Safety in the 21st Century: The Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident. p. 21. See ADAMS Accession No. ML111861807.

9 In general, the backfitting provisions do not require a backfit analysis for proposed changes necessary to ensure adequate protection to the health and safety of the public, necessary to bring a facility into compliance with the licensed rules or orders, or involving a redefinition of adequate protection. Some variation exists in the exemptions of the backfitting provisions contained in 10 CFR 50.109(a)(4), 10 CFR 70.76(a)(4), 10 CFR 72.62(b), and 10 CFR 76.76(a)(4).

10 The Commission has stated that "substantial" means important or significant in a large amount, extent, or degree. (See the SRM to James M. Taylor and William C. Parler from Samuel J. Chilk, "SECY-93-086—Backfit Considerations," dated June 30, 1993.)

- Environmental Analysis: As part of the implementation of the National Environmental Policy Act (NEPA) requirements, NRC evaluates the costs and benefits of Severe Accident Mitigation Alternative and Severe Accident Mitigation Design Alternative analyses, including offsite property damage for certain nuclear reactor licensing and application reviews. For materials, waste, and fuel cycle facility licensing, there are no comparable analyses for treating accidents and offsite consequences. However, the staff considers economic consequences as part of its evaluation of potential environmental impacts. Enclosure 6, "Environmental and NUREG-0800 Standard Review Plan Chapter 19 Analysis," describes the NEPA process in more detail, primarily for nuclear power plants. It is important to emphasize that NEPA is a procedural statute which does not mandate a specific outcome. In other words, the NRC may not impose any safety requirements solely based on a finding that it would be cost-beneficial under NEPA.

Cost-Benefit Analysis Guidance, Tools, and Current Staff Initiatives: The staff uses similar guidance documents to perform the cost-benefit analysis portion of the above analyses as described in Enclosures 5 and 6. Together these documents provide the analysis methodology and specific values and parameters used in cost-benefit determinations. Among these parameters is the offsite impacts attribute, which is typically the product of the change in accident frequency and the property consequences resulting from an accident.

Prior to the most recent revision of the dollar per person-rem conversion factor, the offsite impacts attribute was subsumed within this conversion factor, and this value was $1000 per person-rem. In 1995, the NRC updated this value to $2000 per person-rem, which no longer subsumed offsite impacts, and it was incumbent upon staff to consider these costs elsewhere in the cost-benefit analysis.[11] Enclosure 7, "Relationship Between the Value of a Person-Rem Averted and Offsite Property Damage," provides a more detailed discussion of the historical relationship between the dollar per person-rem conversion factor and property damage.

The staff is updating specific aspects of the guidance (e.g., dollar per person-rem conversion factor, replacement power costs) as described in Enclosure 8, "Current Staff Initiatives to Update the Dollar per Person-Rem Conversion Factor Policy and Replacement Power Costs." However, several guidance documents have not had a comprehensive revision in many years. Furthermore, earlier guidance focused on the regulatory actions of operating reactors. Subsequently, the NRC has developed and implemented additional regulations (e.g., backfit rules specific to materials facilities and backfitting provisions applicable to early site permits and standard design certifications under 10 CFR Part 52). Future guidance updates may be necessary to ensure consistency across business lines.

In addition to the guidance, the staff uses the MELCOR Accident Consequence Code System version 2 (MACCS2) computer code to evaluate potential land contamination scenarios and the resultant offsite property damage. Enclosure 9, "MELCOR Accident Consequence Code System, Version 2 (MACCS2)," contains an overview of the MACCS2 code.

Based on the staff's evaluation, the NRC's regulatory framework for considering offsite property damage is sound, and affords sufficient flexibility to account for the offsite economic consequences associated with unintended releases of radionuclides with subsequent land

[11] See COMSECY-95-003.

contamination. To protect public health and safety, NRC regulations are focused on reducing the likelihood of a radiological release, which also provides protection to the environment. Within this framework, the staff has identified needed improvements to the implementation guidance for cost-benefit analysis to address updates and to enhance the consistency and efficiency of regulatory analysis, backfitting analysis, and environmental analyses.

The staff recognizes that the current Commission safety goal policy statement and backfit rule provisions of the reactor and materials regulations do not expressly require the minimization of land contamination and offsite property damage. The accident at the Fukushima Dai-ichi nuclear power plant has prompted various external organizations and stakeholders to question whether the existing NRC regulatory framework sufficiently considers economic consequences from radiological contamination.[12] Therefore, should the Commission desire to expand consideration of offsite property damage, the staff has identified potential ways to revise the regulatory framework.

Based on the staff's analysis, the staff identified three primary options for Commission consideration: (1) status quo, (2) updates to regulatory analysis guidance to enhance consistency, and (3) exploring the merits of potential changes to the regulatory framework. Options 1 and 2 are consistent with the assertion that the NRC's current approach to considering offsite property damage is sound, and they are focused on updating and enhancing guidance used within the current regulatory framework.

- Option 1—Status Quo: This option would maintain the status quo with regard to the agency's current practice of considering economic consequences in regulatory, backfit, and environmental analyses. The staff would update the existing guidance for these analyses on the current schedule and frequency. To ensure that the various program offices proceed in a coherent and consistent manner, the staff plans to improve the coordination and prioritization of these activities. These updates are associated with the values and parameters used in cost-benefit analysis, and do not result in a fundamental change in the regulatory framework (there would be no new or revised policy statements, changes in regulatory requirements, or revision to the cost-benefit analysis methodology).

  Pros and Cons

  The primary advantages to this option are that it would maintain regulatory stability and would require minimal additional resources. It is consistent with the NTTF report's conclusion that the NRC's current approach to land contamination from reactor accidents is sound.

  The primary disadvantage is that the current approach may not accomplish consistency across programs and is not responsive to stakeholder concerns that NRC should provide more consideration of economic consequences. Although the staff currently has sufficient flexibility to address offsite property damage within the current regulatory framework,

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[12] There has been initial discussion on analyzing how economic consequences are currently calculated in the Organization for Economic Cooperation and Development (OECD) Nuclear Energy Agency (NEA) member countries. Enclosure 10, "Consideration of Property Damage by External Organizations," summarizes staff's review of how select external organizations address economic consequences arising from property damage (e.g., land contamination).

analysts may need to derive their own economic consequence estimates for each new analysis, which could result in inefficiency and inconsistency.

- Option 2—Enhanced Consistency of Regulatory Analysis Guidance: Under this option, the staff would systematically update and enhance regulatory analysis guidance in a more comprehensive, integrated, and coordinated fashion compared to Option 1. The pace for these update activities would be moderated by coordination with other ongoing activities (e.g., NTTF Recommendation 1).

  In addition to ongoing updates, the staff would improve guidance for estimating offsite economic costs based on up-to-date data and advancements in accident consequence assessment knowledge (e.g., SOARCA insights, the current Level 3 probabilistic risk assessment project, and Fukushima follow-up activities), as applicable. In addition, staff would identify potential areas to develop new guidance, as needed, for other regulatory applications (e.g., materials, fuel cycle facilities, security, and emergency preparedness) and conforming changes to associated documents across business lines. Similar to Option 1, this option maintains the current regulatory framework.

  Pros and Cons

  Advantages of this option are that it would be a more systematic approach to updating guidance and addressing agency-level needs across programs while providing a stable and predictable regulatory process, and would also provide more comprehensive guidance for methods and parameters than is currently available. This option would help harmonize regulatory analysis guidance across the agency. As with Option 1, this option is consistent with the NTTF report's conclusion that the NRC's current approach to the issue of land contamination from reactor accidents is sound.

  The primary disadvantage of this option is that it would not be responsive to stakeholder concerns about the need to expand considerations of economic consequences. In addition, this option would require more resources than Option 1. These resources would be associated with coordinating and developing additional new guidance in a more comprehensive, integrated and coordinated fashion.

- Option 3—Exploring the Merits of Potential Changes to the Regulatory Framework: This option could be combined with either Option 1 or Option 2. Under this option, the staff would explore the merits of potential changes to the regulatory framework to more expressly consider adverse offsite economic consequences. The staff would evaluate the following potential changes to the regulatory framework:

  - Risk-informed policy statement for offsite property damage: This alternative would involve developing a policy statement for offsite property damage that parallels the design and structure of the Policy Statement on Safety Goals for the Operation of Nuclear Power Plants. If implemented, such a policy statement could be used to support guidance development and future regulatory enhancements for consideration for offsite property damage.

- Rulemaking: This alternative would consider regulatory changes explicitly. For instance, these changes could include adding licensing requirements addressing offsite property damage to 10 CFR Parts 50 and 52, similar to those found in 10 CFR Parts 30, 40, 70, 72, and 76 (e.g., 10 CFR 30.11, 10 CFR 30.32, and 10 CFR 30.34). This alternative could also explore changes to the backfit regulations in 10 CFR Part 50, 10 CFR Part 70, 10 CFR Part 72, and 10 CFR Part 76 and the finality provisions in 10 CFR Part 52 to expressly consider offsite property damage. Such a change to the backfit regulations could be a new exception to the preparation of a backfit analysis, which would reflect a policy decision to treat economic consequences as equivalent in regulatory character to matters of adequate protection or compliance. Another alternative could be modifying the backfit analysis standard to allow a showing of either a substantial increase in protection to public health and safety (or common defense and security) or a substantial reduction in adverse offsite economic consequences, which would reflect a policy decision to treat offsite economic consequences as equivalent in regulatory character to "safety enhancements."

- Analysis Methodology: This alternative would explore revisions to the methodology described in regulatory analysis guidance documents to change the overall regulatory framework when considering offsite property damage. For example, current staff practice is to assess potential offsite economic impacts using site-specific values for facility-specific backfits and generic values that are representative of the affected class of facilities for generic backfits. A change in policy to conduct generic backfitting analyses on a site-by-site basis using facility-specific offsite economic values could result in backfitting only a subset of the facilities within the generic class.

Any actions taken under Option 3 would be coordinated with ongoing initiatives, such as NTTF Recommendation 1 and activities conducted in response to NUREG-2150, "A Proposed Risk Management Regulatory Framework (RMRF)," issued in April 2012. Some aspects of this coordination are discussed in Enclosure 11, "Coordination with Ongoing Initiatives."

Pros and Cons

Advantages to this approach are that it could provide a clear Commission statement on the importance of offsite property damage as a consequence of severe accidents, and demonstrate the NRC's willingness to explore alternatives to revise the existing regulatory framework. Furthermore, this option would allow for stakeholder input to proposed revisions or policy changes and would promote the transparency of agency decision-making.

One disadvantage to this option is that it could signal the Commission's intent to change the regulatory framework, which could increase regulatory uncertainty. Another disadvantage is that staff would be exploring revisions to the regulatory framework in parallel with other potential regulatory changes that may arise from NTTF or RMRF follow-up activities. As discussed above, this would require close coordination with other activities, increase the complexity of the task, require substantial resources, and may not be feasible in the near future given current and competing priority assignments.

RESOURCES:

The resources required for Option 1 have already been included in proposed budgets for fiscal years (FYs) 2013 and 2014. Implementation of Option 1 would require no additional resources.

The resource estimate for Option 2 is approximately two additional staff full-time equivalents (FTEs) in FY 2013, which would be spread across multiple business lines. Approximately three to four additional FTEs may be required per fiscal year in FY 2014 and beyond.

Option 3 is estimated to require two additional FTEs in FY 2013 and additional resources in future years to identify and assess potential changes to the regulatory framework. The staff estimates that approximately five to seven FTEs may be required per fiscal year in FY 2014 and beyond.

For all options, resources in future years would be either reallocated or addressed through the Planning, Budgeting, and Performance Management process.

RECOMMENDATION:

The staff recommends that the Commission approve Option 2. The staff has determined that this option would 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.

COORDINATION:

The Office of the General Counsel has reviewed this paper and has no legal objection. The Office of the Chief Financial Officer has reviewed this paper for resource implications and has no objection.

/RA MWeber for/

R. W. Borchardt
Executive Director
for Operations

Enclosures:
As stated

Tasking for RES

Provide a notation vote Commission paper, with options, to address the following policy question:

(RES) (EDO Due Date: 07/24/12[1]) 201200065/EDATS: SECY-2012-0161

To what extent, if any, should NRC's regulatory framework modify consideration of economic consequences of the unintended release of licensed nuclear materials to the environment?

The Commission paper should summarize the following background information sufficiently to inform the Commission's decision on this policy question:

1. How economic consequences are currently considered in current regulatory analysis guidelines (NUREG/BR-0058 and NUREG/BR-0184), the bases for this treatment, the extent to which these guidelines have been applied historically across the full range of all NRC licensees, and any changes to the bases that have occurred over time that indicate reconsideration may be warranted (e.g. changing federal views on the monetary value of a statistical human life, updated nuclear reactor accident consequence analysis insights).

2. How economic consequences are currently considered in Severe Accident Mitigation Alternatives and Severe Accident Mitigation Design Alternatives analyses.

3. Summary of all NRC's ongoing initiatives related to economic consequences with an assessment of any differences in approach.

4. How other federal regulatory agencies consider economic consequences within their areas of regulatory purview and whether any federal guidelines exist (e.g. OMB).

5. Any relevant guidance from IAEA or NEA on consideration of economic consequences in regulatory decision-making.

6. How NRC has historically considered economic consequences as part of the regulatory framework for meeting our security mission.

7. An analysis by OGC of any statutory limitations regarding economic consequences that NRC must currently adhere to, any legal considerations of prior NRC decisions or policy statements regarding economic consequences, and any case law pertaining to previous NRC decisions regarding consideration of economic consequences.

8. Any U.S. nuclear industry initiatives in this area (e.g. ASME standards).

9. A description of current NRC analytical tools to assess economic consequences and their capabilities and limitations.

10. The extent to which the activities leading to the NRC Safety Goal Policy statement considered economic consequences.

[1] This due date was later extended to August 7, 2012 by the Office of the Executive Director of Operations on June 12, 2012

Provide policy options for the Commission's consideration, including maintaining the status quo. Each option should be accompanied by a pro/con analysis and estimated resources to implement changes, as appropriate.

Background Information on the NRC's Consideration of Offsite Property Damage Within the Current Regulatory Framework

Property damage and cost-benefit determinations are conducted within regulatory analyses, backfitting, and environmental analyses and generally include property damage. In performing cost-benefit determinations, the NRC has traditionally considered two categories of property: onsite and offsite. Generally, onsite property is owned or controlled by the license or certificate holder and located within the boundaries of the licensed facility, while offsite property is located external to the site boundary and not owned or controlled by the license or certificate holder.[1] However, in cost benefit analysis, the distinction between offsite and onsite property is more significant than simply the location or ownership of the property. Onsite property costs include replacement power, decontamination costs, and costs associated with refurbishment or decommissioning. Offsite property costs include both the direct costs associated with property damage (e.g., property values) and indirect costs (e.g., tourism, manufacturing, and agriculture disruption). The NRC has periodically reevaluated the role of offsite property damage within its regulatory framework.[2]

Current staff guidelines are based in part on radiological release estimates as reported in NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," issued December 1990, and experience from the 1979 accident at Three Mile Island Unit 2. These guidelines (i.e., NUREG/BR-0184) indicate that onsite costs may be significantly greater than offsite costs and that estimated values for onsite property costs may significantly outweigh other values and impacts considered in cost benefit analysis. However, offsite property damage associated with the accident at the Fukushima Dai-ichi nuclear power plant in Japan in 2011 has initiated discussion on how the NRC considers offsite property damage following a significant release of radionuclides with subsequent contamination of the environment. In response to this discussion, the staff formed a working group with members from across the regulatory program offices and the Office of the General Counsel to review current approaches for considering offsite property damage within the regulatory framework and to identify options for modifying these approaches.[3] Additionally, the staff held a public meeting on May 24, 2012, to inform the public of this effort and to solicit feedback.[4]

This enclosure describes the development of NRC's safety goal policy statement and summarizes specific regulatory requirements addressing offsite property damage. However, it

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1 As stated in NUREG/BR-0058, Revision 4, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," issued September 2004, "offsite property" refers to property that is not owned or leased by a licensee.

2 See, for example, SECY-97-208, "Elevation of the Core Damage Frequency Objective to a Fundamental Commission Safety Goal," dated September 12, 1997; SECY-98-101, "Modifications to the Safety Goal Policy Statement," dated May 4, 1998; SECY-99-191, "Modifications to the Safety Goal Policy Statement," dated July 22, 1999; SECY-00-0077, "Modifications to the Reactor Safety Goal Policy Statement," dated March 30, 2000; and SECY-01-0009, "Modified Reactor Safety Goal Policy Statement," dated January 22, 2001.

3 Staff from the Office of Nuclear Regulatory Research (RES), the Office of Nuclear Reactor Regulation (NRR), the Office of New Reactors (NRO), the Office of Federal and State Materials and Environmental Management Programs (FSME), the Office of Nuclear Materials Safety and Safeguards (NMSS), the Office of Nuclear Security and Incident Response (NSIR), and the Office of the General Counsel (OGC) formed the working group.

4 See Agencywide Documents Access and Management System (ADAMS) Accession No. ML 121320176.

is important to note that this background information does not represent an exhaustive description of the NRC policy, precedence, and practice related to economic consequences, but rather is a collection of information, which the working group found most pertinent during the development of this paper. The NRC's legal authority concerning protection of public health and safety and offsite property damage is discussed in Enclosure 3.

Policy Statement on Safety Goals for the Operation of Nuclear Power Plants

When the NRC considers actions beyond adequate protection, the staff determines if the incremental safety benefits of the action would substantially improve the existing level of safety. The NRC has used the Commission's Policy Statement on Safety Goals for the Operation of Nuclear Power Plants[5] to support decisionmaking on actions beyond adequate protection where cost may be considered.[6]

Discussion of offsite property damage manifested itself in the early stages of developing this policy statement. In response to the recommendations of the President's Commission on the Accident at Three Mile Island Unit 2,[7] the NRC undertook a large-scale effort to develop safety goals, which were intended to broadly define an acceptable level of risk to the public from nuclear power plant operation, in other words, determining how safe is safe enough. During the development and implementation of the safety goals, which spanned two decades, the Commission engaged in considerable debate regarding whether and how offsite property damage risks, as well as averted onsite costs, should be taken into account. In 1983, the Commission approved the preliminary policy statement for a two-year evaluation period. This statement expressed the Commission's views on the acceptable level of risks to public health and safety and on the safety-cost tradeoffs in regulatory decisionmaking. However, the Commission decided that the aversion of economic losses should not be considered a benefit in the implementation of the preliminary safety goal policy. Instead, the Commission's cost-benefit guidance focused on protection of the public health and safety. Therefore, in the preliminary policy statement, the Commission did not address nonhealth-related economic consequences, but did adopt for trial use of a health benefit-cost guideline of $1,000 per person-rem averted as one consideration in decisions on safety improvements.[8] The NRC incorporated this cost-benefit guideline into NUREG/CR-3568, "A Handbook for Value-Impact Assessment," which

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5 See Volume 51, page 28044, of the *Federal* Register dated August 4, 1986, as revised, "Safety Goals for the Operation of Nuclear Power Plants, Policy Statement."

6 Although reactor safety goals have been established through the August 4, 1986 policy statement, the Commission's approach for safety goals for the materials and waste regulated areas is less formal. The Commission approved in the Staff Requirements Memorandum (SRM) for SECY-04-0182, "Status of Risk-Informed Regulation in the Office of Nuclear Material Safety and Safeguards," dated October 7, 2004, the staff's plan to continue applying risk-informed methods on materials and waste repository issues. Furthermore, the Commission stated that the staff should consider applying the risk-informed decision-making guidance, which contained the six proposed safety goals for materials and waste activities, to planned and emergent activities. The safety goals are contained in "Risk-Informed Decision Making for Nuclear Material and Waste Applications" (ADAMS Accession No. ML080720238).

7 See "Report of the President's Commission on the Accident at Three Mile Island, The Need for Change: The Legacy of TMI," dated October 30, 1979.

8 See NUREG-0880, Revision 1, "Safety Goals for Nuclear Power Plant Operation," issued May 1983. The benefit-cost guideline in the policy statement states: "The benefit of an incremental reduction of societal mortality risks should be compared with the associated costs on the basis of $1,000 per person-rem averted. During the evaluation period, the application of the benefit-cost guideline should be focused principally on situations where one of the quantified safety goals is not met. No further benefit-cost analysis should be made when it is judged that all of the design objectives have been met."

was endorsed in Revision 1 of NUREG/CR-0058, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," as an acceptable method for conducting cost-benefit analyses.

In its report[9] following the two-year evaluation period, the Safety Goal Evaluation Steering Group concluded that, for core-melt accidents averted, the economic costs of onsite consequences, as well as offsite costs borne by the public, should be considered as a benefit in the cost-benefit guideline. In addition, the report concluded that the $1,000 per person-rem conversion factor adequately bounded the offsite nonhealth-related economic costs. As such, the $1,000 per person-rem factor was determined to include both health and nonhealth-related offsite impacts. However, the Steering Group recommended that the safety goals exclude the loss of societal resources (e.g., water bodies, arable land, endangered species, burial grounds, national monuments and parks[10]), beyond their economic value, because of the difficulty in quantifying the loss of such resources.

In response to other recommendations identified by the Steering Group, the staff proposed an integrated safety goal matrix to be used as a template for implementing the Commission's safety goals and for cost-benefit analyses for safety improvements.[11] The matrix provided for a sliding scale of benefits (averted onsite and offsite costs) to weigh against costs of the plant safety improvements. However, the final policy statement did not include the proposed matrix and the original cost-benefit guideline. In the final policy statement issued in 1986, the Commission established two qualitative health safety goals which were supported by two quantitative health objectives (QHOs). The goals and QHOs are described in terms of health risks; no goal or objective was established to address potential land contamination, offsite property damage, and interdiction in a direct manner. Although the safety goal policy statement does not address economic consequences, the Commission noted that the specific guidance required to implement the safety goal policy statement would address matters such as the conduct of cost-benefit analyses.

During 1997–2001,[12] the staff considered modifying the safety goal policy to include land contamination. In SECY-97-208, "Elevation of the Core Damage Frequency Objective to a Fundamental Commission Safety Goal," dated September 12, 1997, the staff noted that no goal had been established with respect to potential land contamination and interdiction and, as evidenced by the Chernobyl accident, accidents involving core damage and containment failure could result in a societal impact. Additionally, in SECY-00-0077, "Modifications to the Reactor Safety Goal Policy Statement," dated March 30, 2000, the staff noted that development of a safety goal for land contamination and overall societal impacts would provide a clear message of the importance of considering contamination of the environment following a severe accident.

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[9] See memorandum to W. Dircks, Executive Director for Operations, from T. Murley, Chairman, Safety Goal Evaluation Steering Group, "Safety Goal Evaluation Report," dated April 18, 1985.

[10] Even today, the NRC does not have formal guidance for valuing these special categories of societal resources, including tribal lands, beyond their economic value.

[11] See memorandum to the Commissioners from V. Stello, Acting Executive Director for Operations, "Safety Goal Policy," dated February 14, 1986.

[12] See SECY-97-208; SECY-98-101, "Modifications to the Safety Goal Policy Statement," dated May 4, 1998; SECY-99-191, "Modifications to the Safety Goal Policy Statement," dated July 22, 1999; SECY-00-0077; and SECY-01-0009, "Modified Reactor Safety Goal Policy Statement," dated January 22, 2001.

However, the staff recommended that no additional safety goal be developed for land contamination because of the uncertainties in predicting severe accident consequences and weaknesses in the analytical tools for evaluating land contamination and collective dose at significant distances from the plant. Ultimately, the Commission disapproved issuance of any revised Reactor Safety Goal Policy Statement, citing the need for the staff to focus on the agency's new risk-informed regulatory initiatives.[13]

Regulatory Requirements

Beyond the context of formal Commission policy statements, the NRC's regulatory framework addresses offsite property damage both through regulations and as a component of required analyses. Consideration of offsite property damage can arise during cost-justified substantial safety enhancements, as well as regulatory and environmental analyses. In addition, various nuclear materials requirements provide for the consideration of property damage. Specific examples include the following:

- Materials Licensing: For 30 years, from January 1, 1961 (25 FR 8595, September 7, 1960), through October 15, 1991(56 FR 40757, August 16, 1991), 10 CFR Part 20 included the requirement for licensees to immediately notify Federal authorities "by telephone and telegraph" of any incident involving byproduct, source, or special nuclear material which caused or threatened to cause property damage in excess of $100,000; a 24-hour notification was required for property damage in excess of $1,000. The NRC removed this requirement in a 1991 rulemaking because "a dollar figure for property damage, regardless of amount, is not necessarily indicative of the hazard of the public health and safety."[14] Despite removing this criterion, the NRC, in the same rulemaking, added new criteria for the reporting of significant events at materials licensee facilities in 10 CFR Parts 30, 40, and 70 which were related more closely to health and safety issues.

  Currently, the NRC expressly requires consideration of property damage within its regulatory framework for nuclear materials licensing and certification of gaseous diffusion plants. Within 10 CFR Parts 30, 40, 70, 72, and 76, several regulations,[15] including general requirements for the approval of certain license applications, require that the applicant's proposed equipment, facilities and procedures are adequate to protect health and minimize danger to life or property. The reactor licensing regulations in 10 CFR Part 50 and 10 CFR Part 52 do not address property in a manner similar to these materials licensing requirements.[16]

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[13] See SRM-SECY-01-0009, "Modified Reactor Safety Goal Policy Statement," dated April 16, 2001.

[14] See 56 FR 40757.

[15] For example, 10 CFR 30.11, "Specific Exemptions," 10 CFR 30.32, "Application for Specific Licenses," and 10 CFR 30.34, "Terms and Conditions of Licenses," include requirements to minimize danger to life or property. 10 CFR 40.32, "General requirements for issuance of specific licenses," 10 CFR 70.23, "Requirements for the approval of applications," 10 CFR 72.40, "Issuance of license," and 10 CFR 76.35, "Contents of application," include similar provisions.

[16] Such verbiage is absent from 10 CFR Part 52 and from the general criteria in 10 CFR Part 50 except in reference to granting relief or imposing alternate requirements for inservice inspection and inservice testing under 10 CFR 50.55a(f) and 10 CFR 50.55a(g).

- Backfitting: A backfit analysis is an analytical tool used by the NRC to assist in determining whether a proposed regulatory action applicable to nuclear facilities, already licensed when the new requirement is being considered, should be adopted. The requirements set forth in 10 CFR 50.109, "Backfitting," govern backfitting for nuclear power reactors. In addition, 10 CFR Part 70, 10 CFR Part 72, and 10 CFR Part 76 include backfit regulatory provisions for other facilities.[17] A backfit analysis may be performed for a single facility (termed a facility-specific backfit) or for multiple facilities (termed a generic backfit).

  In general, the backfitting requirements for reactor and materials facilities consider the following three main steps (see Enclosure 5 for a more detailed discussion of backfitting):

  (1) Evaluate whether a backfit analysis exemption for adequate protection or compliance applies.

  (2) Determine whether a substantial increase in the overall protection of the public health and safety or common defense and security would be achieved by the proposed change.

  (3) Complete a cost-benefit evaluation.

  When evaluating whether a substantial increase in the overall protection of the public health and safety results from a proposed backfit, the NRC considers health effects related to the release of radiological contamination to the environment but does not consider the socioeconomic impact associated with property damage. The cost-benefit determination of these backfitting provisions requires the NRC to consider both the direct and indirect costs of implementing the proposed changes. Although the backfitting provisions do not directly address offsite property damage, staff guidance[18] for implementing these requirements includes consideration of offsite property damage and the associated economic impacts. Current staff practice is to assess potential offsite economic impacts using site-specific values for facility-specific backfits and generic values that are representative of the affected class of facilities for generic backfits.

- Regulatory Analysis: A regulatory analysis is an analytical tool agencies use to anticipate and evaluate the likely consequences of rules.[19] The NRC's decisionmakers use regulatory analyses to assist in determining whether a proposed regulatory action is cost beneficial, and offsite property damage is an express consideration in such

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[17] Analogous backfitting provisions applicable to early site permits and standard design certifications, differing in some regards from those in 10 CFR 50.109, are set forth in 10 CFR Part 52. Specifically, 10 CFR 52.39 and 10 CFR 52.63 address changes in requirements under finality provisions, and 10 CFR 52.59 address standard design certification requirement changes during license renewal. The backfit requirements for materials facilities are similar to the reactor backfit requirements, though there are some differences. The backfit provisions in 10 CFR Part 70 have limited applicability (i.e., backfit provisions apply only to Subpart H, "Additional Requirements for Certain Licensees Authorized to Possess a Critical Mass of Special Nuclear Material") and have not yet been applied. Further, to date, no backfit analyses have been required for rules amending 10 CFR Parts 72, and 76.

[18] See NUREG/BR-0058, Revision 4 and NUREG-1409.

[19] See OMB Circular A-4, issued September 2003.

determinations.[20] No legislation or regulation requires a regulatory analysis for NRC-initiated actions. However, multiple Executive Orders have been issued on this topic over the past several years,[21] and the NRC has been voluntarily performing such analyses since 1976 and voluntarily complying with OMB Circular A-4, "Regulatory Analysis," since 1981.[22] Nonetheless, the regulatory analysis process may be modified or eliminated at the discretion of an NRC office director or higher authority. Although regulatory analyses and backfit analyses are distinct types of evaluations, a regulatory analysis may be sufficient to satisfy the cost-evaluation requirements for a backfit analysis. Enclosure 5 also includes more discussion on regulatory analysis.

- Environmental Reviews: There are two principal actions for which the environmental impacts from nuclear power plant accidents are evaluated—license renewal for operational reactors and new reactor applications (e.g., design certifications, combined licenses, or early site permits under 10 CFR Part 52 or construction permits and operating licenses under 10 CFR Part 50). For license renewal, the provisions of 10 CFR 51.53(c)(3)(ii)(L) require that license renewal applicants consider alternatives to mitigate severe accidents if the staff has not previously evaluated severe accident mitigation alternatives (SAMAs) or severe accident mitigation design alternatives (SAMDAs)[23] for the applicant's plant in an environmental impact statement (EIS) or related supplement or in an environmental assessment.[24] The staff addresses offsite property damage within cost-benefit determinations related to SAMAs and SAMDAs. Enclosure 6 includes a more detailed discussion of environmental analyses and SAMAs and SAMDAs.

- Siting: An October 17, 1994, proposed rule and proposed denial of petition for 10 CFR Parts 50, 52, and 100, "Reactor Site Criteria Including Seismic and Earthquake Engineering Criteria for Nuclear Power Plants and Proposed Denial of Petition from Free Environment, Inc. et al.," (59 FR 52255) addressed the Commission's explicit consideration of societal risk and land contamination as it pertains to requirements for a low population zone outside the exclusion area. The Commission noted that, "Whereas the exclusion area size is based upon limitation of individual risk, population density requirements serve to set societal risk limitations and reflect consideration of accidents

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20 See NUREG/BR-0058, Revsion 4, Section 4.3.3.

21 For example, see Executive Order 12291 (1981) and Executive Order 12866 (1993).

22 OMB Circular A-4 provides guidance to Federal agencies on the development of regulatory analysis as required under Section 6(a)(3)(c) of Executive Order 12866, "Regulatory Planning and Review," (referred to as the Regulatory Right-to-Know Act), and a variety of related authorities. OMB Circular A-4 provides high level guidance for the conduct of regulatory analysis and does not specifically address property damage due to radiological contamination. However, OMB Circular A-4 notes the importance of accounting for land use changes when accounting for costs. The circular further notes that when demonstrating the need for regulatory action, significant market failures caused when one party's actions impose uncompensated benefits or costs on another party can be considered.

23 The purpose of a SAMA/SAMDA is to ensure that plant design changes with the potential for improving severe accident performance (i.e., reducing the risk or probability-weighted consequences) are identified and evaluated. SAMAs include SAMDAs, which are particularly important for design certifications, but SAMAs also include changes in operating procedures and training.

24 Section 5.4 of NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," provides background information on the genesis of the SAMA regulatory requirement. The severe accident analysis for license renewal is prepared as a site-specific environmental impact statement supplement to NUREG-1437.

beyond the design basis, or severe accidents" (59 FR 52259). The Commission also described the specific benefits of limiting population density:

> Limitation of population density beyond the exclusion area has the following benefits:
>
> (a) It facilitates emergency preparedness and planning.
> (b) It reduces potential doses to large numbers of people and *reduces property damage* in the event of severe accidents" (59 FR 52259).

The Commission also stated that:

> In addition to the risks of latent cancer fatalities, the Commission has also investigated the likelihood and extent of land contamination arising from the release of long lived radioactive species, such as cesium-137, in the event of a severe reactor accident…From analysis done in support of this proposed change in regulation, the likelihood of permanent relocation of people located more than about 20 miles (50 km) from the reactor as a result of land contamination from a severe accident is very low.
>
> Therefore, the Commission concludes that the current NRC staff guidance in Regulatory Guide 4.7 provide a means of locating reactors away from population centers, including "major" population centers, depending on their size, that would limit societal consequences significantly, in the event of a severe accident…
>
> The Commission also notes that future population growth around a nuclear power plant site, as in other areas of the region, is expected but cannot be predicted with great accuracy, particularly in the long-term. Since higher population density sites are not unacceptable, per se, the Commission does not intend to consider license conditions or restrictions upon an operating reactor solely upon the basis that the population density around it may reach or exceed levels that were not expected at the time of site approval. Finally, the Commission wishes to emphasize that population considerations as well as other siting requirements apply only for the initial siting for new plants and will not be used in evaluating applications for the renewal of existing nuclear power plants.

NRC Legal Authorities Concerning Offsite Property Damage

Summary

The Atomic Energy Act of 1954, as amended (AEA), provides the NRC with authority to regulate its licensees or applicants for the purpose of avoiding or mitigating offsite property damage (i.e., damages to offsite property resulting from a release of radionuclides from an NRC-licensed facility during or following a severe accident or other event at the facility). In addition, the National Environmental Policy Act of 1969, as amended (NEPA), requires Federal agencies to consider the potential environmental impacts of proposed actions and reasonable alternatives to such actions.

As a general matter, there are considerations that *must* be included in Commission deliberations on regulatory matters, and considerations that *may* be considered since they are within the Commission's discretion. Under section 182 of the AEA, the Commission must take those actions it deems necessary to achieve "adequate protection" of public health and safety. Courts have interpreted the AEA to mean that costs must not be considered by the NRC when it determines that a given regulatory action is necessary for adequate protection.

The AEA provides the NRC additional authority (primarily under AEA sections 103 and 161) to take measures, beyond those needed to achieve adequate protection, to protect health and to *minimize* danger to life or property as the Commission deems necessary or desirable.[1] Thus, courts have held that once adequate protection of public health and safety has been achieved, the NRC has broad discretionary authority to determine what additional actions are necessary or desirable to minimize danger to life or property. Courts have further held that when exercising this discretionary authority, the Commission may consider other factors, such as costs, when deciding whether to take an action. While NRC discretion is not totally unfettered (i.e., there must be some reasonable nexus between the statutory mission of protecting against radiological dangers and the impacts being addressed), the NRC has broad discretion to determine the impacts to be considered in its determinations.

For its part, NEPA requires an analysis of the reasonably foreseeable environmental impacts of major federal actions. In this regard, NRC's environmental analyses may include evaluations of impacts that are not limited to human health effects. NRC's NEPA guidance includes discussions of the impacts from construction, as well as from both normal operations and accident scenarios.[2]

AEA—Adequate Protection Standard

The AEA is the NRC's organic statute, providing virtually all of the NRC's rulemaking, licensing, and enforcement authority. The AEA's minimum safety standard for production and utilization facilities, which is mandatory for the NRC to ensure, is the "adequate protection" standard, as set forth in subsection a. of section 182, "License Applications." Section 182a. states, in pertinent part:

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[1] Note that while the "Price-Anderson" provisions of section 170 of the AEA provide for indemnification for certain losses from regulated activities, those provisions do not expand or alter the authority of the NRC in developing its underlying regulatory requirements.

[2] *E.g.*, NUREG-1555, "Standard Review Plans for Environmental Review for Nuclear Power Plants" (October 1999); NUREG-1748, "Environmental Review Guidance for Licensing Actions Associated with NMSS Programs" (August 2003).

> In connection with applications for licenses to operate production or utilization facilities, the applicant shall state such technical specifications . . . and such other information as the Commission may, by rule or regulation, deem necessary in order ***to enable it 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*.[3]

The term "adequate protection" is not defined in the AEA; it is a subjective, yet mandatory standard. Under applicable case law, the NRC must have "reasonable assurance" that there is "adequate protection" of public health and safety before approving a licensing action.[4] In addition, case law has further clarified that the NRC does not have to regulate to zero risk[5] and that there is no requirement for unanimity among technical experts as to what constitutes "adequate protection."[6] It has been held that "adequate protection" must be defined without regard for the economic costs that must be borne by the licensee[7], however, there is a layer of protection beyond "adequate protection" in which the Commission can consider costs (as well as societal benefits) under section 161 of the AEA.[8]

AEA—Minimizing Offsite Property Damage

The NRC's authority to minimize danger to offsite property arises primarily out of sections 103b., 161b., and 161i.[9] The Commission may consider measures the sole purpose of which is to minimize danger to offsite property and may rely upon a cost-benefit analysis in determining whether to implement such a measure. It is, primarily, a Commission policy decision as to whether the NRC should act to protect offsite property, and if the Commission chooses to protect such property, what the appropriate measures should be. Likewise, the manner in which the Commission may protect offsite property or the methodology the Commission may employ in determining the adequacy of such measures is also a matter of Commission discretion and technical judgment.

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3 42 U.S.C. § 2232(a) (emphasis added).

4 *Power Reactor Development Co. v. Int'l Union, Electrical Workers*, 367 U.S. 396, 407 (1961); *Nader v. Ray*, 363 F. Supp. 946, 954 (D.D.C. 1973).

5 *Nader v. Ray*, 363 F. Supp. at 954.

6 *Nader v. Nuclear Regulatory Commission*, 513 F.2d 1045, 1054 (D.C. Cir. 1975).

7 If there is more than one method of achieving adequate protection, the NRC may take cost into account in selecting the method. Only in this event may the NRC take cost into account for adequate protection matters. 10 CFR 50.109(a)(7) ("[S]hould it be necessary or appropriate for the Commission to prescribe a specific way to comply with its requirements or to achieve adequate protection, then cost may be a factor in selecting the way, provided that the objective of compliance or adequate protection is met.")

8 *Union of Concerned Scientists v. NRC*, 824 F.2d 108 (D.C. Cir. 1987) (*UCS I*); *Union of Concerned Scientists v. NRC,* 880 F.2d 552 (D.C. Cir. 1989) (*UCS II*).

9 The authority to minimize danger to property is also set forth in AEA sections 31d.(2), 53e.(7), 83b.(1)(A), and 84b.(1).

Section 161 of the AEA, entitled "General Provisions," provides the general authorities of the NRC and includes two subsections of note. Under AEA section 161b., the Commission is authorized to:

> Establish by rule, regulation, or order, such standards and instructions to govern the possession and use of special nuclear material, source material, and byproduct material as the Commission *may* deem necessary or desirable to promote the common defense and security or to protect health *or to minimize danger to* life *or property*.[10]

Under AEA section 161i.(3), the Commission is authorized to prescribe such regulations or order as it may deem necessary to:

> *Govern* any activity authorized pursuant to this chapter, including standards and restrictions *governing* the design, location, and operation of facilities used in the conduct of such activity, in order to protect health and to *minimize danger to* life or *property*.[11]

The key phrase used in these two subsections is "minimize danger to life or property." For the purposes of this memorandum, the phrase "minimize danger to . . . property" refers to the authority granted by these sections. Notably, the phrase "minimize danger to . . . property" also appears in section 103, "Commercial Licenses," which is the AEA provision governing the licensing of nuclear power reactors and production facilities. Specifically, section 103b.(2) states that the Commission shall:

> Issue such licenses on a nonexclusive basis to persons applying therefor . . . (2) who are equipped to observe and who agree to observe such safety standards to protect health and *to minimize danger to* life or *property* as the Commission may by rule establish.[12]

The phrase is also used in various NRC regulations.[13] The terms "minimize," "eliminate," "danger" or "property" are not defined in AEA section 11, "Definitions."[14] As AEA section 11 does not define the terms constituting the phrase "minimize danger to . . . property" and given that the legislative history of neither the AEA nor the predecessor 1946 AEA provides any particular discussion as to the meanings of these terms, then, under the rules of statutory construction, the terms are given their "plain meaning" if the terms are clear and unambiguous.[15] As the various sections of the AEA all address the regulation of the use of

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[10] 42 U.S.C. § 2201(b) (emphasis added).

[11] 42 U.S.C. § 2201(i)(3) (emphasis added).

[12] 42 U.S.C. § 2133(b) (emphasis added).

[13] *E.g.*, 10 CFR §§ 20.2302, 30.33(a)(2); 40.32(b) and (c), 70.22(a)(7)-(8), and 72.40(a)(5).

[14] The terms "govern" and "governing," as used in subsection 161i.(3) are also not defined in the section 11.

[15] Sutherland Statutory Construction, § 46.01(6th ed. 2000).

radiological materials, it is reasonable to interpret the ordinary meaning of the phrase "minimize danger to . . . property" when used within the context of these statutory provisions as meaning reducing the risk of radiological harm or damage to property.[16]

Further, it is also reasonable to interpret the word "property" broadly. In the sections of the AEA identified above, the word "property" is used without an adjective. In other AEA sections, however, the word "property" is preceded by an adjective such as "real" [17] or "personal."[18] Given that Congress chose to specify certain types of property in some sections of the AEA (i.e., real property and personal property), then it is reasonable to interpret the word "property" in those AEA sections using the phrase "minimize danger to . . . property," as including both real and personal property. Thus, "property" would include land, buildings, equipment, vehicles, livestock and crops.[19] Additionally, the term "property" may fairly be viewed as including intangible aspects of property, such as incorporeal real estate interests (e.g., easements, water rights or mining rights), and other related property interests, such as income or profits from property.[20] It logically follows that any radiological harm or damage to property, such as land contamination, would have economic consequences, namely, the permanent or temporary loss to the owner of all or part of his or her property.

Courts Have Interpreted the AEA to Give Commission Broad Authority

Given the broad language of the provisions of AEA sections 103 and 161, and the plain meaning of the phrase "minimize danger to . . . property," the Commission has the legal authority to consider offsite property damage resulting from radiological events, and if it chooses, may regulate its licensees for the purpose of avoiding or mitigating such offsite property damage. If the Commission were to decide to regulate for this purpose, within the limitations discussed in the next section, the Commission's actions would be within the bounds of the AEA. Federal case law has consistently held that the Commission has broad authority in interpreting the provisions of the AEA, such as sections 103 and 161. The Commission's broad discretion is enshrined in the *Siegel* decision, in which the D.C. Circuit described the AEA as "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."[21] Similarly, the First Circuit stated that the AEA "is hallmarked by the amount of discretion granted the Commission in working to achieve the statute's ends."[22]

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16 *See Kerr-McGee Chemical Corp.*, LBP-86-18, 23 NRC at 805-06 (AEA section 161b. provides the NRC jurisdiction to regulate offsite radiation hazards caused by a licensee).

17 *E.g.*, AEA §§ 43 (42 U.S.C. § 2063), 66b (42 U.S.C § 2096).

18 *E.g.*, AEA §§ 161g (42 U.S.C. § 2201), 167 (42 U.S.C. § 2207).

19 *See* Black's Law Dictionary 1095 (5th ed. 1979).

20 *Id.*

21 *Siegel v. AEC*, 400 F.2d 778, 783 (D.C. Cir. 1968).

22 *Public Service Company of New Hampshire v. NRC*, 582 F.2d 77, 82 (1st Cir. 1978).

AEA—Case Law Suggesting Limits to the Commission's Discretion

1. Intervenor Standing Cases

We have identified no cases in which agency regulatory action in the form of rulemaking or orders has been challenged as having been based on considerations of health, safety or property damage that is too far attenuated from NRC authority under the AEA. However, two Commission intervenor standing cases, *Quivira Mining Company* and *Gulf States Utilities Company* are illustrative of the potential limits in Commission regulation of offsite property damage. In both these cases, the petitioner alleged a purely economic injury (no potential physical harm was offered as the basis for standing). The Commission found no standing (i.e., no basis to bring a claim before the Commission) in one case because the economic injury had no link to a radiological harm, but found standing in the other because the economic injury (i.e., damage to the petitioner's property) had a potential link to a prospective radiological harm.

The Commission, in the *Quivira Mining Company* proceeding, held that an economic injury, "unlinked to a claim of radiological injury, is not among those interests arguably protected or regulated under the Atomic Energy Act."[23] In *Quivira Mining Company*, the matter before the licensing board and ultimately the Commission concerned a challenge to Quivira's license amendment request brought by a competing operator of a commercial disposal facility, Envirocare of Utah, Inc. Envirocare asserted that the license amendment request would allow Quivira to become a general commercial disposal facility like Envirocare, but that the NRC did not require Quivira to meet the same regulatory standards the NRC imposed upon Envirocare.[24]

The Commission, in upholding the Licensing Board decision[25] to deny Envirocare's request for a hearing, determined that Envirocare would indeed suffer an economic injury,[26] but that the injury failed to be within the "zone of interests"[27] protected by the AEA.[28] The Commission determined that the AEA "zone of interests" did not cover economic injury resulting from a mere competitive disadvantage.[29] Rather, the AEA "concentrates on the licensing and regulation of nuclear materials for the purpose of protecting public health and safety and the common defense and security."[30]

The requisite element missing in Envirocare's request for a hearing and leave to intervene, a nexus between its economic injury and a radiological harm, was present in an earlier case, *Gulf States Utilities Company*.[31] In *Gulf States*, the licensee of the River Bend Station, Gulf States

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23 *Quivira Mining Company*, CLI-98-11, 48 NRC 1, 10 (1998).

24 *Quivira Mining Company*, CLI-98-11, 48 NRC at 4.

25 *Quivira Mining Company,* LBP-97-20, 46 NRC 257 (1997).

26 *Quivira Mining Company*, CLI-98-11, 48 NRC at 6.

27 *Id.* at 8.

28 *Id.* at 10.

29 *Id.* at 14.

30 *Id.*

31 *Gulf States Utilities Company*, *et al*, LBP-94-3, 39 NRC 31 (1994) *aff'd* CLI-94-10, 40 NRC 43 (1994).

Utilities Company (Gulf States), sought to amend its operating license to allow Gulf States to become a wholly owned subsidiary of Entergy Corporation and to allow Entergy to operate, manage and maintain the River Bend plant.[32] Gulf States owned a 70% share of River Bend; another entity, Cajun Electric Power Cooperative, Inc. (Cajun), held a 30% interest in the River Bend facility. Cajun filed a petition to intervene seeking to have additional conditions imposed on the licensee to protect its financial interest in the plant. Cajun claimed that the license amendments sought by Gulf States could cause unsafe operation of the plant and "that unsafe operations can jeopardize Cajun's ownership property interest in the plant and increase the potential for third-party liability resulting from accidents."[33]

The Board, in granting standing to Cajun, stated that "property interests can confer standing," if the interest is to protect property "from radiological hazards arising from unsafe plant operation."[34] The Board, however, indicated that those interests involving "economic interests of ratepayers and taxpayers or general concerns about a facility's impact on local utility rates and the local economy"[35] are beyond the AEA's coverage. The Board, in contrasting Cajun's interest with those of other petitioners in prior cases whose economic interests were not in the AEA's zone of interests, held that:

> Cajun's stated interest in this proceeding, on the other hand, is to protect its property, River Bend, from radiological hazards arising from unsafe plant operation. Cajun's asserted interest *in avoiding damage to property* from nuclear-related accidents coincides with the Atomic Energy Act's stated purpose of affording protection from radiological hazards. As Staff correctly points out, radiological protection under the Act is afforded for both human life and property. *In fact, the protection of property is specifically mentioned in the Atomic Energy Act in several places, including sections 103b and 161b which speak of minimizing "danger to life or property."* 42 U.S.C.A. §§ 2133(b) and 2201(b) (West Supp. 1974-1993). *Cajun's property interest in River Bend thus clearly meets the zone of interests requirement for standing.*[36]

In upholding the Board's determination that Cajun had standing to file its petition, the Commission stated that the AEA "expressly authorizes the Commission to accord protection from radiological injury to both health and property interests."[37]

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32 *Id.* at 33.

33 *Id.*

34 *Id.* at 37-38.

35 *Id.* at 37 ("There are a limited number of NRC cases involving standing that involve property interests. Most have held that the property interests involved were insufficient to confer standing since they were outside the zone of interests designed to be protected by the AEA—namely, interests related to health, safety, and radiological matters.") (citations omitted).

36 *Id.* at 38 (emphasis added).

37 *Gulf States Utilities Company, et al*, CLI-94-10, 40 NRC at 48.

Both *Quivira* and *Gulf States* provide some insight into the potential limits of the NRC's statutory authority to regulate a licensee for the purpose of avoiding or mitigating a prospective harm to an offsite property interest. The same consideration may also arise in considering the cost-benefit methodology to be used in making such determinations. The NRC is well within its AEA authority in taking a regulatory action if the potential harm to the offsite property (e.g., land contamination; contaminated crops; loss of income because a workplace is contaminated; damage to property as a result of a mass evacuation) has a nexus to a potential radiological release. The further attenuated the link between radiological release and the harm to offsite property becomes, however, the more vulnerable the NRC position with respect to a challenge that the NRC has exceeded its statutory authority becomes. As discussed further below, within these broad boundaries, it is ultimately a Commission policy decision on how far the Commission should go in taking regulatory actions to protect offsite property.

2. *Metropolitan Edison*, the Three Mile Island (TMI) Restart Case

In *Metropolitan Edison Co. v. People Against Nuclear Energy*, the United States Court of Appeals for the D.C. Circuit evaluated the reach of the AEA in providing protection against radiological harm.[38] People Against Nuclear Energy (PANE), an intervenor in the TMI restart proceeding, raised two contentions that would ultimately be considered by the D.C. Circuit:

> First, that restart of TMI-1 would cause severe psychological distress to persons living in the vicinity of the reactor, and second, that renewed operations would seriously damage the stability, cohesiveness, and well-being of the neighboring communities because it would perpetuate loss of citizen confidence in community institutions and *would discourage economic growth*.[39]

The Commission denied the requests to admit the contentions. PANE then filed a petition for review with the D.C. Circuit, asserting that the Commission's denial violated the AEA and NEPA.[40] The D.C. Circuit on January 7, 1982, ordered the Commission to study the "alleged psychological health impacts arising from the proposed restart" under NEPA and, with respect to the AEA, "to submit to the court a statement of [the Commission's] reasons for concluding that the [AEA] did not require consideration of psychological health in the restart proceeding."[41] On March 30, 1982, the Commission complied with the January 7, 1982 court order, by filing a "Memorandum and Order" with the D.C. Circuit.[42]

In its March 30, 1982 Memorandum and Order, the Commission determined that consideration of psychological impacts was not intended under the AEA as there was no precedent in establishing a requirement that "health and safety" in sections 2 and 103 of the AEA be interpreted to include psychological health.[43] Moreover, even if consideration of psychological

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38 *Metropolitan Edison Co. v. People Against Nuclear Energy*, 678 F.2d 222 (D.C. Cir. 1982).

39 *Id.* at 224.

40 *Id.* at 226.

41 *Id.* (alterations added).

42 *Metropolitan Edison Co.*, CLI-82-6, 15 NRC 407 (1982).

43 *Id.* at 408-415.

impacts were permitted, the Commission asserted that there were "strong policy reasons" against the consideration of psychological health effects in NRC licensing and enforcement proceedings, such as limitations on agency expertise and availability of resources.[44]

While ultimately reversing the Commission on NEPA grounds, the D.C. Circuit upheld the Commission's March 30, 1982 Memorandum and Order regarding the AEA, stating that it agreed with the Commission's decision "not to consider psychological stress issues under the AEA."[45] The D.C. Circuit also found "reasonable and in accord with the AEA"[46] the Commission's interpretation that its AEA mandate to "protect the health and safety of the public"[47] did not include "the responsibility to consider psychological reactions to nuclear power"[48] and that:

> [AEA] itself does not discuss psychological health, and the statute, its legislative history, and applicable caselaw all suggest strongly that Congress intended the Commission to exercise its regulatory authority to protect only against the physical risks associated with radioactivity.[49]

The latter part of this statement is in accord with the principle that there should be a nexus to radiological harm for the NRC to exercise its discretionary authority to consider non-health and safety effects in deciding on regulatory action.

AEA—Conclusion

As discussed above, the Commission has the discretion to regulate for the purpose of avoiding or mitigating radiological harm to offsite property. The Commission's authority under section 161 to "minimize danger . . . to property" provides discretionary authority to regulate above section 182's safety "floor" of reasonable assurance of adequate protection of the public health and safety, however, such regulatory activity must be linked to avoiding or mitigating the impacts of an actual radiological harm or injury that could potentially result from licensed activities. If the Commission wishes to consider offsite property damage in its licensing or other regulatory activities differently from its current practice, there is wide discretion to do so under the AEA, so long as the prospective offsite property damage under consideration results from a radiological harm and that the NRC provides a "reasoned analysis" for any change from current practice. [50]

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[44] *Id.* at 416-17.

[45] *Metropolitan Edison Co.*, 678 F.2d at 250.

[46] *Id.*

[47] *Id. quoting* 42 U.S.C. § 2012(d) (1976).

[48] *Id. citing Metropolitan Edison Co.*, CLI-82-6, 15 NRC 407.

[49] *Id. quoting Metropolitan Edison Co.,* CLI-82-6, 15 NRC at 408.

[50] *See Motor Vehicle Manufacturers Association of the United States, Inc., et al v. State Farm*, 463 U.S. 29, 42, 103 S. Ct. 2856 (1983) ("an agency changing its course by rescinding a rule is obligated to supply a reasoned analysis for the change").

NEPA

NEPA[51] is a procedural statute which requires a federal agency to consider the environmental consequences of a proposed action prior to making a decision to approve or disapprove of that action.[52] NEPA requires federal agencies to take a "hard look" at the environmental impacts of the proposed action as well as the impacts from any reasonable alternatives to that proposed action.[53] But, this "hard look" is tempered by a "rule of reason" that requires agencies to address only impacts that are reasonably foreseeable — not those that are remote and speculative.[54] Essentially, an agency is only *required* to analyze potential impacts to the physical environment that have a reasonably close causal connection to those effects arising from the proposed agency action.[55]

Under NEPA, the NRC, in considering a proposed regulatory or licensing action, must consider the impacts of prospective damage to offsite property as a result of a potential radiological event at a NRC licensed facility. As a procedural statute, however, NEPA does not mandate any particular result nor can it serve as a basis for the NRC to require its licensees to take any measures that may avoid or mitigate radiological damage to offsite property; while the NRC has this authority, it derives from the AEA, not NEPA.[56]

The NRC regulations in 10 CFR Part 51 require that an environmental impact statement (EIS), if prepared, shall include the environmental impacts of the proposal and reasonable alternatives, and where important to the comparative evaluation of alternatives, discussion of the appropriate mitigating measures of the alternatives.[57] The NRC's 10 CFR Part 51 regulations are based upon, and voluntarily take account of, the government-wide NEPA regulations of the Council on Environmental Quality (CEQ).[58] As the NRC is an independent regulatory agency within the Executive branch of the Federal government, the NRC has long taken the position that CEQ's regulations are not binding, unless expressly adopted by the NRC.[59] The NRC has specifically adopted certain CEQ definitions, including the definition of the terms "effects" and "human environment."[60] The CEQ definition of "effects" includes direct effects which are caused by the

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51 42 USC § 4321 *et seq*.

52 *Limerick Ecology Action, Inc. v. NRC*, 869 F.2d 719.

53 *See Louisiana Energy Servs., L.P.*, CLI-98-3, 47 NRC 77, 87-88 (1998).

54 *See, e.g., Long Island Lighting Co.*, ALAB-156, 6 AEC 831, 836 (1973).

55 *Metropolitan Edison Co.*, 460 U.S. at 772.

56 *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 350 (1989).

57 10 CFR 51.71.

58 10 CFR 51.10(a).

59 NRC Proposed Rule, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions and Related Conforming Amendments," 45 FR 13739 (March 3, 1980) (proposed rule's statements of consideration describe NRC's position that, as an independent regulatory agency, the NRC will "voluntarily" take account of CEQ regulations, subject to certain conditions, including "[t]he Commission reserves the right to examine future interpretations or changes to the regulations on a case-by-case basis;" and the "NRC reserves the right to make a final decision on all matters within its regulatory authority").

60 10 CFR 51.14(b). The CEQ definitions section is at 40 CFR Part 1508.

action and occur at the same time and place, and indirect effects, which are caused by the action, but occur at a later time or are farther removed in distance, but are still reasonably foreseeable.[61] The CEQ definition of "human environment"[62] is defined, in pertinent part, as including "the natural and physical environment and relationship of people with that environment."[63] When preparing an EIS, the NRC evaluates the effects of the proposed action, and any reasonable alternatives, on the human environment. The CEQ "human environment" definition expressly states that "economic or social effects are not intended *by themselves* to require preparation of an [EIS]."[64] According to the CEQ definition of "human environment," economic or social effects are only analyzed in an EIS when "economic or social and natural or physical environmental effects are interrelated."[65] The EIS will then "discuss all of these effects on the human environment."[66] Essentially, there must be some physical impact upon the environment, directly or indirectly related to the agency's proposed action, and a nexus between that impact and an economic or social effect,[67] before that economic or social effect is required to be considered in a NEPA document.[68]

NEPA provides the NRC with authority to analyze potential offsite environmental consequences related to activities within its jurisdiction. The Commission has broad discretion to expand its current practice to encompass a broader range of economic impacts in its NEPA reviews. Most NEPA case law concerns what an agency must do; there are comparably few limitations on what an agency may consider if it so desires, so long as it is reasonably related to the action under consideration.

Conclusion

Under the AEA, the NRC has authority under sections 103, 161, and other sections to minimize damage to property from radiological harm as the Commission deems appropriate or desirable. This authority provides broad discretion to impose requirements that are based on the Commission's consideration of potential radiological impacts to offsite property. Because this authority stems from the AEA authority to "minimize danger to . . . property" and not from the statutory directive to ensure "adequate protection to the health and safety of the public," the Commission may include the consideration of cost or other factors in reaching a decision on whether to impose such requirements. There is very little case law that establishes the limits of Commission authority to take regulatory actions to minimize damage to property. Such a requirement faces an increased risk of successful legal challenge as the connection to radiological health and safety and common defense and security becomes more attenuated.

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61 40 CFR 1508.8.

62 10 CFR 51.14(b).

63 40 CFR 1508.14.

64 *Id.* (emphasis added).

65 *Id.*

66 *Id.*

67 Typically referred to as a "socio-economic effect" in NEPA parlance.

68 Mandelker, NEPA Law and Litigation, § 8:42.

However, the broad discretion provided by the AEA likely makes such decisions more a question of policy, rather than a question of limits on NRC authority.

Radiation Source Protection and Security Task Force, Recommendation 2

Background

The Energy Policy Act of 2005 (EPAct) created an interagency task force on radiation source protection and security under the lead of the U.S. Nuclear Regulatory Commission (NRC). The Interagency Radiation Source Protection and Security Task Force evaluates and makes recommendations to the President and Congress relating to the security of radiation sources in the United States from potential terrorist threats, including acts of sabotage, theft, or use of a radiation source in a radiological dispersal device (RDD).

The NRC Office of Federal and State Materials and Environmental Management Programs (FSME) on the behalf of the Chairman coordinates the efforts of this interagency task force. Additional NRC offices including Nuclear Material Safety and Safeguards (NMSS), Nuclear Security and Incident Response (NSIR), International Programs (IP), Office of the General Counsel (OGC), and Office of Public Affairs (OPA) are involved in the development and implementation of the recommendations and actions. Other agencies involved in development and implementation are the Department of Homeland Security (DHS), Federal Emergency Management Agency (FEMA), Transportation Security Administration (TSA), Department of State (DOS), Department of Transportation (DOT), Department of Defense (DOD), Federal Bureau of Investigations (FBI), Central Intelligence Agency (CIA), Environmental Protection Agency (EPA), Department of Commerce (DOC), Department of Energy (DOE), Department of Justice, Food and Drug Administration, Department of Health and Human Services (HHS), and Office of the Director of National Intelligence (ODNI).

This Task Force evaluates and makes recommendations, which can include possible regulatory and legislative changes, on several specific topics related to the protection and security of radiation sources. For the purposes of the Task Force, the EPAct defines a radiation source as a "Category 1 Source or a Category 2 Source as defined in the Code of Conduct and any other material that poses a threat such that the material is subject to this section, as determined by the Commission, by regulation, other than spent nuclear fuel and special nuclear material."[1] The Task Force submits its reports to Congress and the President; it submitted its first report on August 15, 2006. The Task Force will submit subsequent reports not less than once every four years. The Task Force submitted its second report on August 11, 2010. The first report contained 10 recommendations and 18 actions and the second report contained 11 new recommendations that address the security and control of radioactive sources.

As part of the efforts to prepare the 2006 report, the Task Force reviewed available information on lists of radioactive sources that Government agencies have established for security or safety-related purposes. The Task Force concluded that agencies were protecting the appropriate radioactive sources (i.e., those sources requiring security based on the potential attractiveness of the source to terrorists and the extent of the threat to public health and safety). At the time, the Task Force did not recommend that additional radionuclides be added to the list of risk-significant sources, but encouraged the U.S. Government to continue the efforts underway internationally to better align transportation guidance with the Code of Conduct. Overall the programs appropriately address the sources consistent with the Code of Conduct.

[1] See 42 U.S.C. § 2210h.

The Code of Conduct serves as an appropriate framework for considering which sources may warrant additional protection. The Code of Conduct considers that a country should "define its domestic threat, and assess its vulnerability with respect to this threat for the variety of sources used within its territory, based on the potential for loss of control and malicious acts involving one or more radioactive source." Since the threat environment is not static, but is continually changing, the Task Force recommended that the U.S. Government periodically reevaluate the list of radioactive sources that may warrant additional security and protection. This reevaluation should be coordinated within the Federal family and can be performed as part of the Task Force activities every four years. Therefore the report included 2006 Recommendation 3-1, which recommends that the U.S. Government periodically reevaluate the list of radioactive sources that warrant enhanced security and protection.

In preparation for the 2010 report, a subgroup of this Radiation Source Protection and Security Task Force reevaluated the list of radioactive sources and the Task Force endorsed its conclusion that the Code of Conduct Category 1 and 2 radionuclides and threshold values could result in a significant radiation exposure device (RED) or RDD event and therefore warrant enhanced security and protection. The Task Force also endorsed the identification of seven additional radionuclides that may be of concern when aggregated; however, because they are infrequently shipped or possessed in quantities likely to cause a significant RDD event, at the time, the Task Force proposed no recommendation about these radionuclides. Since the reevaluation was based on economic consequences and the Task Force did not evaluate whether additional security and protection were needed to protect against contamination and resultant economic consequences, the Task Force and subsequently the Commission approved Recommendation 2 of the 2010 Task Force report. That recommendation states that "U.S. Government agencies should re-evaluate their protection and mitigation strategies to protect against significant RED or RDD attack using both potential severe immediate or short-term exposure and contamination consequences to public health, safety, and the environment …." Specifically, the report, proposed that U.S. Government agencies should reevaluate their current strategies using Task Forces assumptions and parameters that included economic consequences (or economic loss). The evaluation of economic consequences is consistent with the National Infrastructure Protection Plan (NIPP) framework that assesses risk as a function of consequences, vulnerability, and threat.

Past Commission Papers and Decisions

The economic consequences of an RDD are primarily driven by the costs to clean up the contaminated area. With regard to physical protection of radioactive sources (i.e. Category 1 and 2 sources), NRC uses a Security Assessment (SA) decision-making framework methodology as a tool for determining the need for additional security measures and currently it is based on deterministic effects (prompt fatalities). The SA framework methodology is discussed in SECY-04-0222, "Decision-making Framework for Materials and Research and Test Reactor Vulnerability Assessments." Economic consequences from an RDD or RED were not considered in the decision making framework.

A summary of the recent Commission papers and decisions with respect to the use of existing economic consequence modeling processes for an RDD is briefly described below.

- SRM-SECY-04-0222, the Commission directed the staff to "…make a recommendation to the Commission if the existing NRC consequence criteria or methodologies for future vulnerability assessments should be modified."

- SECY-06-0045, "Results of Implementation of the Decisionmaking Framework for Materials and Research and Test Reactor Security Assessments," the staff's commits to "…provide feedback and appropriate recommendations to the Commission regarding the use of alternative consequence criteria" in SECY-06-0045.

- SRM-SECY-09-0051, "Evaluation of Radiological Consequence Models and Codes," the Commission directed NSIR staff to provide a policy paper on how guidance from the EPA Protective Action Guide (PAG) Manual could be incorporated into an economic consequence model. The staff explained how this could be done and in fact, was completed initially by DOE/NNSA and then DHS/DNDO as part of HSPD-18, a required bi-annual DHS risk assessment.

- SECY-10-0080, "Economic Consequence Modeling for Postulated Radiological Events," NSIR staff informed the Commission of the process by which PAGs had been incorporated into an interagency DHS' Radiological/Nuclear Terrorism Risk Assessment (RNTRA) economic consequence assessment model for potential radiological events. As explained in SECY-10-0080, DHS' RNTRA applied a modeling structure that provides consistent estimates of terrorism economic risk across CBRN threats. This approach also ensured that the assessment could be used as a comprehensive planning tool (if needed) by other Federal agencies, without duplicative federal efforts. The SECY also sought the Commission's agreement with the staff's recommendation to support the use of DHS processes and models, rather than developing its own economic consequence modeling processes.

- SRM-SECY-10-0080 the Commission approved the staff's recommendation to support the use of DHS processes and models, rather than developing its own economic consequence modeling processes. The Commission directed that the staff continue to support the Federal interagency (DHS) process regarding risk assessment and to limit its expenditure of resources (regarding economic consequence research and assessments) to those that support participation in the interagency working groups by the agency Senior Level Service staff already supporting those activities. The SRM also requested a TA briefing to be conducted upon completion of the DHS RNTRA which was conducted in May 2012.

Staff Efforts Regarding Recommendation 2 of the Radiation Source Protection and Security Task Force

The 2010 Task Force Recommendation 2 recommends that if agencies choose to implement the recommendation, then they should consider contamination consequences when reevaluating their protection and mitigation strategies currently in place. As stated previously, NRC uses an SA decision-making framework methodology (SECY-04-0222) as a tool for determining the need for additional security measures and currently it is based on deterministic effects. Considering contamination/economic consequences would constitute a significant change in the underpinning assumptions used by the NRC in its current SA framework.

Additional direction to the staff would be needed in order to consider relooking at the SA framework based on alternative (economic consequences or property damage) consequences.

FSME and NSIR have initiated an informal working group to conduct a high level assessment of whether consideration of economic consequences has an impact on the current security measures in place (via the Security Orders). The regulatory basis for 10 CFR Part 37 is to protect against prompt fatalities. If economic consequences are to be considered, then other scenarios beyond the original prompt fatality scenarios would also need to be evaluated. Consideration of these other consequences could prompt the need for additional requirements beyond those approved in 10 CFR Part 37.

This group's efforts commenced February 2012. Conclusions drawn from this group may be presented in the next Radiation Source Protection and Security Task Force report, as required by the Energy Policy Act of 2005, which is due to the President and Congress in August 2014.

Regulatory and Backfit Analysis

Regulatory Analysis

A regulatory analysis is an analytical tool used by NRC decisionmakers to assist in determining whether the NRC should implement a proposed regulatory action. A regulatory analysis contains estimates of benefits and costs, which are quantified when possible, together with a conclusion as to whether the proposed regulatory action is cost-beneficial. "Cost-beneficial" means that the benefits of the proposed action are equal to, or exceed, the costs of the proposed action.[1]

The regulatory analysis process should begin when it becomes apparent that some type of NRC regulatory action to address an identified problem may be needed. A regulatory analysis is intended to be an integral part of the NRC's decisionmaking, and should not be used to produce after-the-fact rationalizations to justify decisions already made, nor should it unnecessarily delay regulatory actions.[2] A regulatory analysis is prepared for, and normally accompanies, any proposed NRC action that establishes or communicates requirements, guidance, requests, or staff positions that results in a change in licensee resources.[3]

There is no statute or NRC regulation that requires the performance of a regulatory analysis for NRC-initiated actions. However, the NRC has been voluntarily performing them since 1976. The regulatory analyses prepared by the NRC before 1983 were termed value-impact analyses.

In February 1981, President Reagan issued Executive Order (E.O.) 12291 that directed executive agencies to prepare a regulatory impact analysis for all major rules and stated that regulatory actions should be based on adequate information concerning the need for and consequences of any proposed actions. Moreover, E.O. 12291 directed that actions were not to be undertaken unless they resulted in a positive net value to society. As an independent agency, the NRC was not required to comply with E.O. 12291. However, the Commission noted that its established regulatory review procedures included an evaluation of proposed and existing rules in a manner consistent with the regulatory impact analysis provisions of E.O. 12291. The Commission determined that clarifying and formalizing the existing NRC value-impact procedures for the analysis of regulatory actions would enhance the effectiveness of NRC regulatory actions and further meet the spirit of E.O. 12291. Thus, the NRC issued NUREG/BR-0058, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," in January 1983 (Guidelines). The NRC has updated the Guidelines several times, and the current version is Revision 4, issued in 2004.

The Office of Management and Budget (OMB) has published regulatory analysis guidance in its Circular A-4, last issued on September 17, 2003. Although the NRC, as an independent agency, is not required to follow Circular A-4, the Guidelines have consistently followed it.

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[1] The decision criterion for a regulatory analysis, viz., that the benefits of the proposed action are equal to, or exceed, the costs of the proposed action, are different from the decision criterion in a backfit analysis under 10 CFR 50.109. Under 10 CFR 50.109(a)(3), the backfit analysis must address whether the proposed backfit represents a "substantial increase in the overall protection of the public health and safety or the common defense and security to be derived from the backfit and that the direct and indirect costs of implementation for that facility are justified in view of this increased protection." The differences between these decision criteria are addressed in this Enclosure in the discussion of backfit analysis.

[2] See NUREG/BR-0058, Revision 4, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," dated September 2004.

[3] If there is a change in licensee resources, the regulatory analysis will analyze societal costs and benefits of the proposed NRC action. *Id.*

Circular A-4 establishes a discount rate of 3 percent as the expected return on a government investment, and a discount rate of 7 percent as the expected return on a private investment. The discount rate provides a means for a fair presentation, expressed in present day dollars, of future costs and benefits.

The Guidelines identifies "averted offsite property damage" as one of the values to be assessed in a regulatory analysis. Additional detailed guidance on how to perform a regulatory analysis is described in "Regulatory Analysis Technical Evaluation Handbook," NUREG/BR-0184, January 1997 (Handbook). The Handbook states on page 5.11 that the averted offsite property damage (which it describes as the offsite impacts attribute):

> …measures the expected total monetary effects on offsite property resulting from the proposed action. Changes to offsite property can take various forms, both direct (e.g., land, food, and water) and indirect (e.g., tourism). This attribute is typically the product of the change in accident frequency and the property consequences resulting from the occurrence of an accident (e.g., costs of interdiction measures, such as decontamination, cleanup, and evacuation). A reduction in offsite property damage is taken as positive; an increase in offsite property damage is considered negative.

Further, the Handbook indicates that in the case of nuclear power plants, changes in public health and safety from radiation exposure and offsite property impacts should be examined over a 50-mile distance from the plant site which go well beyond the NRC emergency planning zone.

As noted in the following Backfit Analysis Section, a regulatory analysis is required for all actions that involve "backfits" and impose generic requirements. The "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," NUREG/BR-0058, Revision 2, November 1995, was the first edition to state that,

> Certain regulatory actions are subject to the backfit rule at 10 CFR 50.109 . . . NRC intends that, for these actions, the analysis performed in accordance with the Guidelines will satisfy the documentation requirements of the backfit rule. . .

In other words, a complete regulatory analysis will provide all the information necessary to address the nine factors of the backfit analysis.[4] However, as noted in footnote 1, the decision criterion for a regulatory analysis differs from a backfit analysis.

Backfit Analysis

A backfit analysis is a regulatory requirement that is an analytical tool used by NRC decisionmakers to assist in determining whether a proposed regulatory action applicable to nuclear power plants or materials facilities, identified as a backfit, is a cost-justified substantial safety enhancement and should be adopted. The decision criterion in a backfit analysis is whether the proposed backfit is a "substantial increase" in protection to public health and safety or common defense and security and that the costs are justified by the benefit. Thus, the

[4] Although 10 CFR 50.109(c) specifically cites nine (9) factors that must be considered in a backfit analysis, the introductory sentence of that paragraph also states that the NRC should consider any other information relevant and material to the proposed backfit.

backfitting decision criterion differs from the regulatory analysis decision criterion in that a "substantial increase" is needed to justify backfitting. The Commission has indicated that "substantial" effectively means "large,"[5] but the Commission has not indicated whether this is an absolute or relative measure, nor has the Commission set thresholds for a substantial increase if it is an absolute measure.

The requirements governing backfitting for nuclear power reactors are set forth in 10 CFR 50.109[6]. Backfit regulatory provisions for other facilities are included in 10 CFR Part 70, 10 CFR Part 72, and 10 CFR Part 76.

The NRC's backfitting and issue finality requirements were adopted by the Commission as self-imposed restrictions on agency action – that is, there is no statutory requirement for these backfitting and issue finality requirements. In 1970, the Backfit Rule was first adopted in response to complaints of nuclear power plant applicants and licensees over the evolution of AEC safety requirements as the agency processed the first generation of nuclear power plant construction permits and operating licenses. In 1985, the Commission adopted major revisions to the rule in response to complaints of nuclear power applicants and licensees about the numerous post-Three Mile Island orders and regulations. The 1985 rule was subsequently modified in 1988 to add the "exceptions" to preparing backfit analysis for those backfits which involve adequate protection.[7] Thereafter, the Commission has extended backfitting protection to new nuclear power plants by adopting "issue finality" provisions in 10 CFR Part 52, and extended backfitting protection to certain non-power reactor entities, as identified above. The NRC issued guidance on the Backfit Rule in 1990,[8] but, as with other guidance discussed in this SECY, it would be appropriate to update this guidance, possibly on an expedited basis to reflect the Commission's decision on this SECY.

The relationship between backfit analyses and regulatory analyses was first reflected in Revision 2 of NUREG/BR-0058, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," in November 1995. Footnote 3 of NUREG/BR-0058 stated that traditional cost/benefit analysis as performed in the NRC's Regulatory Analyses will satisfy the backfitting requirement that actions be shown to be cost-beneficial. The guidance in footnote 3 of the Guidelines continues to be provided in footnote 2 of Revision 4 of the Guidelines.

NUREG-1409, "Backfitting Guidelines", dated July 1990, states that, averted offsite costs that result from an estimated decrease in accident frequency or severity that are tied directly to the public health and safety are considered benefits (safety enhancement), citing to NUREG/BR-0058, the NRC's Regulatory Analysis Guidelines. The NRC's intent was that only averted offsite deaths and adverse health effects, resulting from an estimated decrease in accident frequency or severity attributable to the proposed backfitting, be considered as a benefit.

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5 SRM to James M. Taylor and William C. Parler from Samuel J. Chilk, "SECY-93-086 – Backfit Considerations," June 30, 1993. This position is also reflected in footnote 3 of the Guidelines, Revision 4.

6 Analogous backfitting provisions applicable to nuclear power licenses and regulatory approvals, differing in some regards from those in 10 CFR 50.109, are set forth in 10 CFR Part 52 ("issue finality" provisions). Backfit provisions in 10 CFR 70 have limited applicability (backfit provisions apply only to Subpart H) and have not yet been applied by the NRC.

7 The 1988 rulemaking was the result of the D.C. Circuit Court of Appeal's decision in *UCS v. NRC*, in which the D.C. Circuit held that the 1985 Backfit Rule was defective because it allowed the NRC to consider costs in determining adequate protection.

8 NUREG-1409, "Backfitting Guidelines," dated July 1990.

However, at that time, the Regulatory Analysis Guidelines used a dollar per person-rem amount of $1,000 as a surrogate for *all* averted offsite losses, health as well as property. Thus, a simple reading of NUREG-1409 could lead to the erroneous conclusion that averted offsite costs not directly resulting from the estimated decrease in accident frequency or severity attributable to the proposed backfitting should be regarded as a public health and safety benefit (the correct conclusion is that such averted offsite costs should be regarded as a cost offset).

Prior to preparing a backfit analysis, the staff determines whether the proposed NRC action is a "backfit," as defined in 50.109(a)(1)[9]. If the proposal constitutes a backfit, the staff must determine whether one or more exceptions to preparation of a backfit analysis apply. Section 50.109(a)(4) allows exemptions to the analysis requirement if the action is necessary for compliance, adequate protection, or involved with defining or redefining what is needed for adequate protection. Unless one of these exemptions in 50.109(a)(4) applies, the staff proceeds with determining whether the backfit represents a cost-justified substantial safety enhancement. To make this determination, the staff must develop a backfit analysis of the type discussed in 10 CFR 50.109(a)(3) and 10 CFR 50.109(c) and a finding is made that there is (1) a substantial increase in the overall protection of the public health and safety or the common defense and security and (2) the direct and indirect costs of implementation are justified by the benefit.

The staff can consider several factors (among which are those identified in 50.109(c)(1) through (9)) to determine whether the backfit would provide a substantial increase in protection to public health and safety or common defense. For backfits associated with nuclear reactors, the staff typically uses, if applicable, a safety goal screening evaluation as a surrogate for this question. NUREG/BR-0058 states that "[i]f the proposed safety goal screening criteria are satisfied, the NRC considers that the substantial additional protection standard is met for the proposed new requirement." Once the staff determines that the potential backfit would result in a substantial increase in protection, they determine whether it is cost-justified in light of this increased protection.

As stated in the previous section, a regulatory analysis is used to help determine (1) whether a proposed action is subject to the backfit rule (e.g., 10 CFR 50.109), (2) whether that action is within the rule's exceptions (e.g., 10 CFR 50.109(a)(4)), (3) whether it provides a substantial increase in the overall protection of the public health and safety or the common defense and security, and (4) whether the direct and indirect costs of implementation are justified in view of this substantial increase in protection. Therefore, the offsite property damage can be taken into account at this stage in the cost-benefit analysis of the backfit analysis.

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[9] Backfitting is defined as: (1) a modification of or addition to: systems, structures, components, or design of a facility; or the design approval or manufacturing license for a facility; or the procedures or organization required to design, construct, or operate a facility; and (2) may result from: a new or amended provision in Commission rules; or the imposition of a regulatory staff position that is either new or different, from a previously applicable staff position.

Environmental and NUREG-0800 Standard Review Plan Chapter 19 Analyses

Purpose and Regulatory Requirements

Safety Review

In a new nuclear power reactor design certification (DC) application, the applicant provides an evaluation of potential design improvements to show compliance with Title 10 of the *Code of Federal Regulations* (10 CFR) 52.47(a)(8), which refers to the Three Mile Island (TMI)-related requirements in 10 CFR 50.34(f) with exceptions. The applicant performs a cost-benefit analysis of potential design improvements based on the probabilistic risk assessment (PRA) of the facility and considers severe accident consequences, including estimates of the economic consequences of offsite property damage. As required by 10 CFR 52.47(a)(23), a light-water reactor DC application must include a description and analysis of design features for prevention and mitigation of severe accidents. Furthermore, 10 CFR 52.47(a)(27) requires that the DC application include a description of the design-specific PRA and its results.

Similarly, a combined license (COL) application must include a description of the plant-specific PRA and its results, in accordance with 10 CFR 52.79(a)(46); a light-water reactor design-related severe accident features analysis, in accordance with 10 CFR 52.79(a)(38); and an evaluation of potential design improvements, in accordance with 10 CFR 52.79(a)(17). The COL application that refers to the standard DC must use the PRA information for the DC, updated to account for site-specific design information and any design changes or departures.

Environmental Review

The National Environmental Policy Act of 1969, as amended (NEPA), requires that a Federal agency complete an assessment of the impact to the environment resulting from any major Federal action which significantly affects the quality of the human environment. In this case, the Federal agency is the U.S. Nuclear Regulatory Commission (NRC), and the pertinent Federal actions are issuances of permits, certifications, or licenses, or changes thereof. The NRC's NEPA implementing regulations are contained in 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." The provisions of 10 CFR 51.20(b) requires the NRC staff to issue an environmental impact statement (EIS) for the following actions:

- issuance of a limited work authorization or construction permit for a nuclear power reactor, testing facility, or fuel reprocessing plant under 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," or an early site permit (ESP) under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants"

- issuance or renewal of a full-power or design capacity operating license for a nuclear power reactor, testing facility, or fuel reprocessing plant under 10 CFR Part 50 or a COL under 10 CFR Part 52 (renewal requirements fall under 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants)

- issuance of permit to construct or a design capacity license to operate an isotopic enrichment plant under 10 CFR Part 50

- conversion of a provisional operating license to a full-term or design capacity license for a nuclear power reactor, testing facility, or fuel reprocessing plant under 10 CFR Part 50, if a final EIS covering full-term or design capacity operation was not previously prepared

- issuance of a license to possess and use special nuclear material for processing and fuel fabrication, scrap recovery, or conversion of uranium hexafluoride under 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material"

- issuance of a license to possess and use source material for uranium milling or production of uranium hexafluoride under 10 CFR Part 40, "Domestic Licensing of Source Material"

- issuance of a license for an independent spent fuel storage installation at a site not occupied by a nuclear power reactor or for a monitored retrievable storage installation under 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste"

- issuance of a license for a uranium enrichment facility

- issuance of renewal of a license authorizing receipt and disposal of radioactive waste under 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste"

- issuance of a license amendment under 10 CFR Part 61 authorizing closure of land disposal facility, transfer, or termination of the license

- issuance of a construction authorization and license under 10 CFR Part 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories," or 10 CFR Part 63, "Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada"

- any other action which the Commission determines is a major Commission action significantly affecting the quality of the human environment

In addition, 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," also requires applicants for the above actions to submit an environmental report with pertinent information to support the NRC staff's development of its EIS for the major Federal action. The review of environmental impacts of postulated accidents involving radioactive material and related to the nuclear power plant is based on the relevant requirements of the following:

- 10 CFR 51.45, "Environmental Report," with respect to the requirement to address alternatives to the proposed action

- 10 CFR 51.50(b), with respect to applications for ESPs

- 10 CFR 51.50(c), with respect to applications for COLs

- 10 CFR 51.53(c)(3)(ii)(L) with respect to license renewals

Issuance of a certification for a standard design does not require an EIS, but instead receives an environmental assessment, in accordance with 10 CFR 51.21, "Criteria for and Identification of Licensing and Regulatory Actions Requiring Environmental Assessments."

Historical Perspective

Prior to the time of the Three Mile Island accident, the Commission had relied on the draft accident classification scale, set forth in a December 1, 1971 proposed rulemaking, to determine that severe accidents were essentially remote and speculative (36 FR 22848, 22851).[1] In 1980, the Commission issued a policy statement on the consideration of severe accidents in EISs for new reactor applications submitted after July 1, 1980 (volume 45, page 40101, of the *Federal Register* (45 FR 40101) dated June 13, 1980). This policy statement states that it is "the intent of the Commission that the staff take steps to identify additional cases that might warrant early consideration of either additional features or other actions which could prevent or mitigate the consequences of severe accidents." These features became known as severe accident mitigation alternatives (SAMAs), which include severe accident mitigation design alternatives (SAMDAs) (particularly important for DC), as well as changes in operating procedures and training. In 1985, the Commission issued in the *Federal Register* a notice titled, "Policy Statement on Severe Reactor Accidents Regarding Future Designs and Existing Plants" (50 FR 32138; August 8, 1985), concluding "that existing plants pose no undue risk to public health and safety and that there was no present basis for immediate action on generic rulemaking or other regulatory changes for those plants because of severe accident risk." This policy statement also called for each licensee to perform an analysis to discover instances of particular vulnerability to core melt or poor containment performance given a core melt accident. The NRC believed that this policy statement was a sufficient basis for not requiring SAMDAs to be considered at the operating license review stage for previously constructed plants. However, a 1989 court decision ruled that such a policy statement was not sufficient under NEPA to preclude consideration of SAMDAs and that such a consideration is required for plant operation (*Limerick Ecology Action v. NRC*, 869 F.2d 719 (3rd Cir. 1989)). This is known as the "Limerick decision."[2]

For new nuclear power reactor licensing, SECY-90-016, "Evolutionary Light Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory Requirements," dated January 12, 1990, and SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs," dated April 2, 1993, which the Commission approved in related staff requirements memoranda (SRMs) dated June 26, 1990, and July 21, 1993, respectively, laid out expectations for evolutionary and advanced light-water reactor design with respect to severe accident prevention and mitigation capabilities.

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[1] Although never published as a final rule, the agency relied on the proposed rule containing the accident classification scale to address severe accidents under NEPA, and appellate courts have upheld this practice. *Limerick Ecology Action v. NRC*, 869 F.2d 719, 725-26 (3d Cir. 1989) (citing *Carolina Environmental Study Group v. United States*, 510 F.2d 796, 798-800 (D.C. Cir. 1975)).

[2] This paragraph quotes extensively from NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," issued in 1996 (referred to as the GEIS).

For materials, waste, and fuel cycle facility licensing, there are no comparable analyses for treating accidents and offsite consequences. NUREG-1748, "Environmental Review Guidance for Licensing Actions Associated with NMSS Programs," which provides general procedures for the environmental review of licensing actions regulated by NMSS and FSME, contains no guidance that specifically addresses the impact of accidents and offsite consequences.

Process

Severe nuclear accidents are those in which substantial damage is done to the reactor core whether or not there are serious offsite consequences (50 FR 32138). Severe accidents are expected to involve multiple failures of equipment or function. Therefore, the likelihood of occurrence is much lower for severe accidents than for design-basis accidents, but the consequences of such accidents may be higher. The environmental consequences of severe accidents are estimated using acceptable methodology (PRA analysis and NRC regulatory techniques). The MELCOR Accident Consequence Code System, Version 2, (MACCS2) software package is used to estimate the consequences of severe accidents for NEPA reviews. The risks for specific accident types are defined as the product of the probability of that type of accident occurring multiplied by the estimated consequences for that type of accident.

Consideration of the environmental impacts of operating a nuclear power plant in the EIS includes an evaluation of the environmental risk (or probability weighted consequences) of accidents involving radioactive material. The scope of the NRC staff's evaluation of the environmental risks of accidents includes severe accident consequence analysis, which includes health impacts from radiological dose and the socioeconomic impacts, including offsite property damage. As discussed above, there are two principal actions for which the environmental risks of accidents from nuclear power plants are evaluated—license renewal for operational reactors and new reactor applications (e.g., DCs, COLs, and ESPs under 10 CFR Part 52 or construction permits and operating licenses under 10 CFR Part 50).

The NRC staff's evaluation of severe accidents for new reactor licensing is coordinated between the safety review of the PRA and severe accident evaluation and the development of the EIS section concerning the postulated accidents presented in the applicant's environmental report. Chapter 19.0 of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Plants: LWR Edition," provides guidance for the PRA and severe accident review. Sections 7.2 and 7.3 of the latest revision of NUREG-1555, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan (with Supplement 1 for Operating Reactor License Renewal), provides guidance on severe accident consequence assessment and SAMAs. Regulatory Guide (RG) 4.2, "Preparation of Environmental Reports for Nuclear Power Stations," gives guidance to applicants on preparing their environmental report.

The NRC considers the evaluation of SAMAs/SAMDAs in the environmental review of applications for construction permits or operating licenses under 10 CFR Part 50, and of DC, ESP, or COL applications under 10 CFR Part 52. For license renewals, 10 CFR 51.53(c)(3)(ii)(L) requires that license renewal applicants consider alternatives to mitigate severe accidents if the staff has not previously evaluated SAMAs or SAMDAs for the

applicant's plant in an EIS or related supplement or in an environmental assessment.[3] The purpose of a SAMA/SAMDA is to ensure that plant design changes with the potential for improving severe accident performance (i.e., reducing the risk, or probability-weighted consequences) are identified and evaluated. These reactor licensing actions include offsite property damage as an averted cost component of the SAMDA/SAMA evaluation. While new reactor ESPs consider severe accident consequences, thus disclosing offsite property damage impacts as necessitated by NEPA, SAMDAs/SAMAs are not addressed under ESPs; thus, the expected subsequent COL application should include a complete averted offsite property damage cost assessment.

Section 7.2, "Severe Accidents," of NUREG-1555 instructs that environmental reviewers should evaluate the environmental impacts of severe accidents using an accepted methodology. Section 7.3, "Severe Accident Mitigation Alternatives," of the Environmental Standard Review Plan instructs that environmental reviewers should evaluate the applicant's SAMA analysis in the environmental report to identify cases that might warrant either additional features or other actions that would prevent or mitigate the consequences of severe accidents. The NRC staff and industry uses the NRC-sponsored MACCS2 code package[4] as the accepted methodology to estimate the radiological and economic consequences of the airborne releases from severe accidents.

Under the SRP Chapter 19.0 safety review, there are two aspects of the NRC staff's review. The first aspect is the use of the PRA and severe accident evaluation to identify and assess preventive and mitigative features, including consideration of operator actions, such that the plant's operation will reflect a reduction in risk compared to existing operating plants. The second aspect is the use and application of the PRA results and insights to support other programs. The NRC staff reviews the applicant's description and analysis of the design features to prevent and mitigate severe accidents, in accordance with the requirements in 10 CFR 52.47(a)(23) or 10 CFR 52.79(a)(38), for a DC or a COL application, respectively. This review specifically addresses the issues identified in SECY-90-016 and SECY-93-087, and their related SRMs, for severe accident prevention (e.g., anticipated transients without scram, midloop operation, station blackout, fire protection, and intersystem loss-of-coolant accident) and mitigation (e.g., hydrogen generation and control, core debris coolability, high-pressure core melt ejection, containment performance, dedicated containment vent penetration, equipment survivability). In addition, the SRP Chapter 19.0 safety review addresses the information provided by the applicant to satisfy the technically relevant TMI-related requirements. In particular, the invoked requirement in 10 CFR 50.34(f)(1)(i) to specify that a design-specific or plant-specific PRA should be performed to seek improvements in core heat removal system reliability and containment heat removal system reliability that are significant and practical and do not excessively impact the plant.

Excluding ESPs, which are not required to include the SAMDA/SAMA evaluation, the applicant's analysis should identify potential SAMDAs/SAMAs and provide an estimate of the cost of implementing them. This requires that the potential benefits (monetized) of the SAMDA/SAMA are estimated. Potential benefits of a SAMDA/SAMA include averted public exposure; averted

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[3] Table B-1 of Appendix B, Subpart A, 10 CFR Part 51, provides a generic finding that the probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts from severe accidents are small for all plants.

[4] The NRC staff uses a version of MACCS2 known as WinMACCS, which has a graphical user interface for input deck development, running the code, and output reviews for PC-based computers.

offsite property damage; averted onsite occupational exposure; and averted onsite costs, such as decontamination and replacement power. Finally, the costs and benefits of the SAMDA/SAMAs are compared to see whether any SAMDA/SAMA is cost beneficial. The NRC staff evaluates the applicant's benefit-cost comparison to determine whether it is consistent with the benefit-cost balance criteria and methodology given in NUREG/BR-0184 and NUREG/BR-0058. The staff further analyzes any SAMAs that are within a factor of 10 of the benefit-cost criteria given in NUREG/BR-0058 or NUREG/CR-6349, "Cost-Benefit Considerations in Regulatory Analysis," issued October 1995, to ensure that a sufficient margin is present to account for uncertainties in assumptions used to determine the cost and benefit estimates. For new reactor COL applications, the DC SAMDA evaluation for the reactor design being proposed by the application forms the basis for the site-specific SAMA included as part of the COL application's environmental report. Thus, the Office of New Reactor's environmental review staff confirms that the COL applicant reexamined the SAMDA analyses from the selected reactor DC and includes site-specific population, land use, and meteorology data in the severe accident consequence calculations performed using the MACCS2 computer code.

The process for the review of SAMAs as part of the NEPA review for license renewal is similar to that used in the new reactor licensing reviews. Section 5.4 of the GEIS provides background information on the genesis of the SAMA regulatory requirement. The severe accident review for license renewal uses guidance in NUREG-1555, Supplement 1, to prepare site-specific EIS supplements to the GEIS. RG 4.2, Supplement 1, gives guidance to applicants on preparing the environmental report for nuclear power plant operating license renewal. Additionally, the NRC staff has recommended that applicants for license renewal follow the guidance provided in the Nuclear Energy Institute's report, NEI-05-01, Revision A (NEI-05-01A), in the staff's license renewal interim staff guidance, LR-ISG-2006-03. NEI-05-01A provides a template for completing the SAMA analysis in support of license renewal. The method described relies upon NUREG/BR-0184 regulatory analysis techniques. As described above, NUREG/BR-0184 includes estimates of the economic consequences of offsite property damage. Relative to the evaluation of potential improvements for existing reactors in the United States, the NRC gained considerable experience during the 1980s and 1990s by means of (1) staff assessments of SAMDAs for the Limerick, Comanche Peak, and Watts Bar plants performed as a result of the aforementioned Limerick decision, (2) the containment performance improvement program, (3) the individual plant examination and individual plant examination of external events programs, and (4) the implementation of severe accident management programs at all nuclear power plants as part of an industry initiative. These regulatory programs and initiatives provide assurance that any major vulnerabilities to severe accidents have been identified and addressed and that the residual level of risk is low. As a result, major plant modifications would not be expected as a result of a SAMA analysis. As stated in the GEIS, "the NRC expects that a site-specific consideration of severe accident mitigation for license renewal will only identify procedural and programmatic improvements (and perhaps minor hardware changes) as being cost-beneficial in reducing severe accident risk or consequence." This expectation has generally been met.

Reference/Guidance Material

36 FR 22851, December 1, 1971, "Consideration of Accidents in Implementation of the National Environmental Policy Act of 1969," Federal Register, Atomic Energy Commission.

45 FR 40101, June 13, 1980. “Nuclear Power Plant Accident Considerations Under the National Environmental Policy Act of 1969.” Federal Register. U.S. Nuclear Regulatory Commission.

50 FR 32138, August 8, 1985. “Policy Statement on Severe Reactor Accidents Regarding Future Designs and Existing Plants.” Federal Register. U.S. Nuclear Regulatory Commission

51 FR 30028. August 21, 1986. “Safety Goals for the Operation of Nuclear Power Plants; Policy Statement; Correction and Republication.” Federal Register. U.S. Nuclear Regulatory Commission.

SECY-90-016, "Evolutionary Light-Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory Requirements," ADAMS Accession No. ML003707849, January 12, 1990, and the related staff requirements memorandum (SRM), ADAMS Accession No. ML003707885, June 26, 1990.

SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor Designs," ADAMS Accession No. ML003708021, April 2, 1993, and the related SRM, ADAMS Accession No. ML003708056, July 21, 1993.

U.S. Nuclear Regulatory Commission (NRC). 1976. *Preparation of Environmental Reports for Nuclear Power Stations.* Regulatory Guide 4.2, Rev. 2, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*. NUREG-1437, Vols. 1 and 2. Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1997. *Regulatory Analysis Technical Evaluation Handbook*. NUREG/BR-0184, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999. *Environmental Standard Review Plan — Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal*. NUREG-1555, Supplement 1. Washington, D.C

U.S. Nuclear Regulatory Commission (NRC). 2000. *Environmental Standard Review Plan — Standard Review Plans for Environmental Reviews for Nuclear Power Plants*. NUREG-1555, Vol. 1. Washington, D.C. Includes 2007 revisions.

U.S. Nuclear Regulatory Commission (NRC). 2000. *Supplement 1 to Regulatory Guide 4.2, Preparation of Environmental Reports for Applications to Renew Nuclear Power Plant Operating Licenses.* Regulatory Guide 4.2S1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2004. *Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission.* NUREG/BR-0058, Rev. 4, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2007. *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, LWR Edition*. NUREG-0800, Washington, D.C.

Relationship between the Value of a Person-Rem Averted and Offsite Property Damage

The dollar per person-rem averted is the monetized value of a person-rem used in regulatory and backfit analysis. When proposed regulatory actions are analyzed, the value of a person-rem averted is used as an economic measure of the amount of radiation that could potentially be reduced by the proposed action.

The NRC and its predecessor agency, the Atomic Energy Commission, used a conversion factor originally developed in the 1970's of $1000 per person-rem as the monetary valuation of the consequences associated with radiological exposure. Subsequently, in the 1980s the NRC undertook an evaluation of the use of $1000 per person-rem value and subsequently defined it as a surrogate for all averted offsite losses, health as well as property. Further, at that time the value was not discounted over time such that a person-rem averted was worth the same dollar amount whether it was averted next year, in 10 years, or in 100 years.

In the 1980s, the NRC issued and then amended 10 CFR 50.109, its reactor backfitting regulation, and in 1990, issued NUREG-1409, "Backfitting Guidelines." At that time, the $1000 per person-rem value incorporated all offsite property costs and neither the backfit rule nor the implementing guidelines provide any detail about considering offsite property in relation to a backfit analysis for a cost-justified substantial safety enhancement.

In 1995, the NRC revisited the $1000 per person-rem value and issued NUREG-1530, "Reassessment of NRC's Dollar per Person-Rem Conversion Factor Policy."[1] The document revised the value to $2000 per person-rem and limited it to health effects. Therefore, offsite property damage costs were no longer included within the $2000 per person-rem value. Separate estimates of the offsite costs are now necessary in order to account for impacts beyond human health concerns.

Two guidance documents discuss the treatment of offsite costs. The first, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," NUREG/BR-0058, Revision 4, 2004, describes attributes to be considered when performing a regulatory analysis including "averted offsite property damage." The second, "Regulatory Analysis Technical Evaluation Handbook," NUREG/BR-0184, 1997, provides additional detailed guidance for the analysis.[2] NUREG/BR-0184 indicates that, in the case of nuclear power plants, changes in public health and safety from radiation exposure and offsite property impacts should be examined over a 50-mile distance from the plant site, which is beyond the 10-mile Emergency Planning Zone.

Although these guidance documents have been created to determine the affects of offsite property damage outside the dollar per person-rem, NUREG-1409 has not been updated to take into account the separation of offsite property damage from the dollar per person-rem value.

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[1] The Office of Nuclear Reactor Regulation recently requested that the Office of Nuclear Regulatory Research reassess and update the dollar per-person rem conversion factor policy. Please see Enclosure 8 for more details.

[2] NUREG-0184 attempts to account for the total monetary effects on offsite property including direct effects and indirect effects like tourism. The total monetary effects are normally calculated as the product of the change in accident frequency and the property consequences resulting from the occurrence of an accident (e.g., costs of interdiction measures such as decontamination, cleanup, and evacuation).

Current Staff Initiatives to Update the Dollar per Person-Rem Conversion Factor Policy and Replacement Power Costs

Reassessment of NRC's Dollar per Person-Rem Conversion Factor Policy

As Enclosure 7 describes in greater detail, the NRC uses its current dollar per person-rem conversion factor to capture the dollar value of the health detriment resulting from radiation exposure. This value is used by all NRC program offices in the evaluations of their regulatory actions. The NRC last revised its value of a person-rem averted in 1995, and published it in "Reassessment of NRC's Dollar per Person-Rem Conversion Factor Policy," NUREG-1530 (ADAMS Accessions No. ML063470485).

In 2010, the Office of Nuclear Reactor Regulation (NRR) contracted the services of ICF International to begin to reassess the dollar per person-rem conversion factor. In 2011, NRR sent the Office of Nuclear Regulatory Research (RES) a user-need request to further this research and publish a revised conversion factor policy in the form of a NUREG.

RES began by reviewing the ICF report and the value of statistical life (VSL)[1] used by other federal agencies to determine whether the recommendations of ICF were up-to-date and comparable to that of other agencies. In order to facilitate information gathering and exchange with other federal agencies, RES sponsored an interagency regulatory analysis workshop focusing on the VSL, a major component of the dollar per person-rem conversion factor.[2] The workshop was held on March 19 and 20, 2012. It brought together approximately 50 participants from 10 different federal agencies and included representatives from the Department of Energy, the Department of Homeland Security, the Department of Transportation, the Environmental Protection Agency, the Food and Drug Administration, the National Oceanic and Atmospheric Administration, and the Department of Agriculture. The participants exchanged lessons learned regarding calculating, updating, applying, and communicating the VSL, and identified potential areas for future interagency collaboration in the area of regulatory analysis. The workshop highlighted similar and unique challenges regarding the VSL faced by each agency and provided useful insights for the NRC's updating efforts.

The staff is continuing work on determining an updated dollar per person-rem conversion factor and researching the feasibility of developing a well-defined process to periodically update this factor. Staff expects to complete research on an updated dollar per person-rem factor and publish a final NUREG documenting the revised value in 2014. The staff will engage external stakeholders and seek approval from the Commission prior to finalizing this NUREG.

Replacement Power Costs

In performing a regulatory analysis relating to power reactor regulatory actions, the NRC staff often identifies among the key impacted attributes those relating to replacement energy costs. Replacement energy costs may be required because a required regulatory activity needs to be performed while a plant is not operating. This is generally identified as an industry

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[1] As discussed in OMB Circular A-4, the value of statistical life (VSL) refers to the monetized value of small changes in fatality risk and provides a measurement of willingness to pay for reductions in only small risks of premature death. The VSL has no application to an identifiable individual or to very large reductions in individual risks.

[2] Per NUREG-1530, the dollar per person-rem conversion factor is determined by multiplying the value of statistical life (the dollar value of the health detriment) and a risk-cancer factor (a risk factor that establishes the nominal probability for stochastic health effects attributable to radiological exposure).

implementation cost and is specifically referred to as short-term replacement power. Also, replacement energy cost estimates could be the result of a decrease in the risk of an accident, the benefit of which can be estimated through the change in replacement energy costs for an operating reactor. This is generally addressed in the onsite property costs attribute and is referred to as long-term replacement power.

The NRC published estimates for plant-specific replacement energy costs for both the long and short term in NUREG/CR-6080, “Replacement Energy, Capacity, and Reliability Costs for Permanent Nuclear Reactor Shutdowns,” October 1993, and NUREG/CR-4012, “Replacement Energy Costs for Nuclear Electricity-Generating Units in the United States,” September 1997. However, many changes have occurred in the electrical generation and transmission industries since the publication of these documents. Most significantly was the deregulation of the electric generation industry in several states and in the electrical transmission market. Furthermore, the Federal Energy Regulatory Commission (FERC) has instituted rulemakings over the time period which would also impact the transmission costs and, as a result, replacement energy costs. Given the time since the replacement energy values were last derived and the changes in market conditions, the NRC has been revisiting this concept and is initiating guidance revisions that will provide updated estimates.

MELCOR Accident Consequence Code System, Version 2 (MACCS2)

The U.S. Nuclear Regulatory Commission (NRC) developed MELCOR Accident Consequence Code System, Version 2 (MACCS2) specifically to evaluate offsite consequences from a hypothetical release of radioactive material into the atmosphere [1], [2]. The code models atmospheric transport and dispersion (ATD), emergency response actions, exposure pathways, health effects, and economic costs. This enclosure provides an overview of the MACCS2 code.

History

MACCS2 evolved from predecessor codes MACCS, Calculation of Reactor Accident Consequences, Version 2 (CRAC2), and CRAC. MACCS was used to support NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," issued December 1990; CRAC2 was used to estimate consequences in the 1982 Siting Study, and CRAC was initially developed for WASH-1400, which was published in 1975. These codes were developed mainly as tools to assess the risk and consequences associated with accidental releases of radioactive material into the atmosphere in probabilistic risk assessment (PRA) studies.

The MACCS2 code has gone through additional improvements since its original release in 1997. Version 2.5 of the code has been released recently together with the graphical user interface (GUI), WinMACCS version 3.6 [3]. WinMACCS was developed to facilitate routine uses of MACCS2. The three most important modeling features implemented in WinMACCS are (1) the ability to easily evaluate the impact of parameter uncertainty, (2) the ability to manipulate input parameters for network evacuation modeling, and (3) the ability to model alternative dose-response relationships for latent cancer fatality evaluation (e.g., linear with threshold model). Uncertainty in the source term and in most of the other MACCS2 input parameters, including parameters related to emergency response, can be treated through WinMACCS. WinMACCS invokes the Latin Hypercube Sampling (LHS) code to prepare a user-specified number of MACCS2 input decks to reflect variations of the uncertain parameters specified [4]. The output from multiple runs of "equally likely" MACCS2 input sets is evaluated by the WinMACCS postprocessor to provide expectation values and statistical information.

Current NRC Uses

The MACCS2 code is currently used by U.S. nuclear power plant license renewal applicants to support the plant specific evaluation of severe accident mitigation alternatives (SAMAs) that may be required as part of the applicant's environmental report for license renewal (as discussed further in enclosure 6). Applicants follow guidance provided in NEI-05-01, Revision A, "Severe Accident Mitigation Alternatives (SAMA) Analysis Guidance Document," which is endorsed by NRC License Renewal Interim Staff Guidance LR-ISG-2006-03, "Staff Guidance for Preparing Severe Accident Mitigation Alternatives Analyses." NEI-05-01 refers to both NUREG/BR-0058, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," and NUREG/BR-0184, "Regulatory Analysis Technical Evaluation Handbook." The NRC's regulatory analysis guidelines in NUREG/BR-0058 and NUREG/BR-0184 specifically recommend the use of MACCS2 to estimate the averted "offsite property damage" cost (benefit) and the offsite averted dose cost elements. The information from MACCS2 code runs supports a cost-benefit assessment for various potential plant improvements as part of SAMAs. MACCS2 is also routinely used in severe accident mitigation design alternative

(SAMDA), or severe accident consequences analyses for environmental impact statements (EISs) supporting design certification, early site permit, and combined construction and operating license reviews for new reactors (as discussed in more detail in Enclosure 6). In another recent example, the MACCS2 code was used in the State-of-the-Art Reactor Consequence Analysis (SOARCA) study to estimate consequences in terms of early fatality risk and latent cancer fatality risk. Staff made numerous enhancements to the code for the SOARCA study including the capability for more plume segments (up to 200), a potassium iodide ingestion model, and the ability to model alternative dose-response relationships for latent cancer fatality. Staff continues to enhance the code as part of its update and maintenance program, for example, incorporating an alternative ATD model and economic consequence model as discussed below.

Previous Commission papers have indicated limitations associated with MACCS capability to evaluate land contamination and economic consequences. In SECY 00-0077, "Modifications to the Reactor Safety Goal Policy Statement," the staff considered whether a land contamination goal should be added to the safety goal policy but recommended against it. Part of the justification was that the current analytical tools have weaknesses in predicting land contamination and collective dose at significant distances. NRC staff continues to acknowledge that uncertainties increase for consequence projections at significant distances, but a 2004 benchmarking study provides increased confidence in the ATD model results from MACCS2 for distances out to 100 miles. The MACCS2 ATD model was compared against two Gaussian puff codes (Radiological Assessment System for Consequence AnaLysis (RASCAL) and Regional Atmospheric Transport Code for Hanford Emission Tracking (RATCHET)) and a Lagrangian particle tracking code (Lagrangian Operational Dispersion Integrator (LODI) from the National Atmospheric Release Advisory Center (NARAC)) [5]. The study showed that the MACCS2 mean results (over weather) were within a factor of 2 for arc-averages and a factor of 3 at a specific grid location out to 100 miles from the point of release.

In addition, as described in SECY-05-0233, "Plan for Developing State-of-the-Art Reactor Consequence Analyses," dated December 22, 2005, the State-of-the-Art Reactor Consequence Analysis (SOARCA) project's original scope included calculating offsite consequences of severe accidents in terms of (1) health effects and (2) land contamination. Subsequently in an April 3, 2007 memo to the Commission, the staff indicated that the MACCS2 code's capabilities with respect to land contamination and economic impacts of severe accidents should be updated before attempting a best-estimate, realistic calculation of those outcomes. The Commission directed the staff, in SRM-COMPBL-08-002/COMGBJ-08-0003, not to delay reporting the results of the SOARCA project in order to include an assessment of land contamination and the economic consequences of land contamination. In the April 3, 2007 memorandum, the staff noted to the Commission that "LC [land contamination] and EC [economic consequence] cost are interrelated and depend on models for rehabilitation and clean up. There is some evidence that the models may be excessively conservative." It is not obvious to current MACCS2 experts at both the NRC and Sandia National Laboratories (SNL) that rehabilitation and clean up, land contamination area, or economic models and results are excessively conservative. Economic results and some land contamination area results are controlled by user inputs and could be biased to be either conservative or nonconservative, depending on the input values selected by the user. A MACCS2 user's guide and code manual is available for reference when deciding various parameter inputs [1]. Other land contamination areas produced by MACCS2 are influenced chiefly by the Gaussian plume and deposition modeling. Based on the 2004 benchmarking study, these values do not appear to have either a

conservative or nonconservative bias. Current MACCS2 experts do note that a conservative result produced by the code is likely to be the peak centerline dose, due to the use of the Gaussian plume ATD model. This particular result is not used in current MACCS2 applications (such as cost-benefit analyses and SAMA analyses), which rely on the mean results out to 50 miles.

Most recently, the Pilgrim nuclear power plant license renewal proceeding included a contention related to the SAMA analyses and the use of the MACCS2 code. The issue was whether the ATD model was adequate for the Pilgrim site, and whether a potential existed for underestimating offsite property damage. After the hearing in March 2011, the Atomic Safety and Licensing Board (ASLB) ruled that SAMA analyses and use of MACCS2 were adequate (NRC testimony available at [6] and [7]; final ASLB ruling available at [8]).

MACCS2 Steps for Estimating Consequences

MACCS2 estimates consequences in four steps: (1) atmospheric transport and deposition onto land and water bodies, (2) the estimated exposures and health effects for up to seven days following the beginning of release (early phase), (3) the estimated exposures and health effects during an intermediate time period of up to one year (intermediate phase), and (4) the estimated long-term (e.g., 50 years) exposures and health effects (late-phase model). The assessment of offsite property damage in terms of contaminated land and economic consequences use all four parts of the modeling. An overview of the code is provided below to explain the assessment of offsite property damage in MACCS2.

Atmospheric Transport and Dispersion Model

MACCS2 models dispersion of radioactive materials released into the atmosphere using the straight-line Gaussian plume model with provisions for meander and surface roughness effects. The ATD model treats the following: plume rise resulting from the sensible heat content (i.e., buoyancy), initial plume size caused by building wake effects, release of up to 200 plume segments, dispersion under statistically representative meteorological conditions, deposition under dry and wet (precipitation) conditions, and decay and ingrowths of up to 150 radionuclides and a maximum of six generations. The model does not treat in detail irregular terrain, spatial variations in the wind-field, and temporal variations in wind direction.

The user has the option to select meteorological sampling, such as a single weather sequence or multiple weather sequences. The latter of these weather sampling options is used in PRA studies to evaluate the effect of weather conditions at the time of the hypothetical accident.

The results generated by the ATD model include contaminant concentrations in air, on land, and as a function of time and distance from the release source; these results are subsequently used in early, intermediate, and late-phase exposure modeling.

A new and alternative ATD model, with the capability to model three-dimensional, time-dependent wind-fields, is planned as part of the MACCS2 update and maintenance program. The updates for the model, including documentation, will be developed and tested during the fiscal year (FY) 2013 to FY 2014 timeframe subject to available funding.

Early Phase Model and Exposure Pathways

The early-phase model in MACCS2 assesses the time period immediately following a radioactive release. This period is commonly referred to as the emergency phase and it can extend up to seven days after the arrival of the first plume at any downwind spatial interval. Early exposures in this phase account for emergency planning (i.e., sheltering, evacuation, and relocation of the population). The early-phase modeling in MACCS2 is limited to seven days from the beginning of release. MACCS2 models sheltering and evacuation actions within the emergency planning zone (EPZ). Different shielding factors for exposure to cloudshine, groundshine, inhalation, and deposition on the skin are associated with three types of activities: normal activity, sheltering, and evacuation.

Outside the sheltering/evacuation zone, dose-dependent relocation actions may take place during the emergency phase. That is, if individuals at a specific location are projected to exceed either of two dose thresholds over the duration of the emergency phase, they are relocated at a specified time after plume arrival.

For a radioactive release containing radioiodine, some of the iodine is highly likely to be absorbed by the thyroid. As a consequence the chance of thyroid cancer to the individual may be increased. Potassium iodide (KI) can saturate the thyroid with iodine and thereby reduce the amount of radioiodine that can be absorbed. KI is distributed near some nuclear power plants. MACCS2/WinMACCS has implemented a KI model to account for the beneficial effect of taking KI. This model accounts for the fraction of the population taking KI and the efficacy, or dose reduction, provided by the KI.

Intermediate Phase and Exposure Pathways

MACCS2 can model an intermediate phase with duration of up to one year following the early phase. The only mitigative action modeled in this phase is relocation. That is, if the projected dose leads to doses in excess of a threshold, the population is assumed to be relocated to an uncontaminated area for the entire duration of this phase, with a corresponding per-capita economic cost defined by the user. The intermediate phase duration can be modeled as being zero (i.e., no intermediate phase).

If the projected dose does not reach the user-specified threshold, exposure pathways for groundshine and inhalation of resuspended material are treated.

Long-Term Phase Model and Exposure Pathways

In the long-term phase (e.g., 50 years of potential exposure), protective actions are defined to minimize the dose to an individual by external (groundshine) and internal (food consumption and resuspension inhalation) pathways. Decisions on mitigative actions are based on two sets of independent actions (i.e., decisions relating to whether land, at a specific location and time, is suitable for human habitation (“habitability”) or agriculture production (“farmability”)). Habitability is defined by a maximum dose and an exposure period to receive that dose. Habitability decisionmaking can result in four possible outcomes: (1) land is immediately habitable, (2) land

is habitable after decontamination, (3) land is habitable after decontamination and interdiction[1], or (4) land is not deemed habitable after 30 years of interdiction (i.e., it is condemned). Land is also condemned if the cost of decontamination exceeds the value of the land. The dose criterion for the MACCS2 modeling of individuals returning back to the affected (i.e., contaminated) area is a user input and is typically taken from the U.S. Environmental Protection Agency (EPA) protective action guides (PAGs).[2]

Decisions on decontamination are made using a decision tree. The first decision is whether land is habitable. If it is, then no further actions are needed. The population returns to their homes and receive a dose from any deposited radionuclides for the entire long-term phase. If land is not habitable, the first option considered is to decontaminate at the lowest level of dose reduction, which is also the cheapest to implement. If this level is sufficient to restore the land to habitability, then it is performed. Following the decontamination, the population returns to their homes and receives a dose based on the residual contamination for the duration of the long-term phase. If the first level of decontamination is insufficient to restore habitability, then successively higher levels are considered. MACCS2 considers up to three decontamination levels. If the highest level of decontamination is insufficient, then interdiction for up to 30 years is considered following the decontamination. During the interdiction period, radioactive decay and weathering work to reduce the dose rates that would be received by the returning population. If the highest level of decontamination followed by interdiction is sufficient to restore habitability, then it is employed and the population is allowed to return. Doses are accrued for the duration of the long-term phase. If habitability cannot be restored by any of these actions, then the land is condemned. The land is also condemned if the cost of the required action to restore habitability is greater than the value of property.

The decision on whether land is suitable for farming is first based on prior evaluation of its suitability for human habitation. That is, land cannot be used for agriculture unless it is habitable. Furthermore, farmland must be able to grow crops or produce dairy products that meet the requirements of the Food and Drug Administration (i.e., it must be farmable). If farmland is habitable and farmable, a food chain model is used to determine doses that result from consuming the food grown or produced on this land. The COMIDA2 food chain model is the latest model developed for use in MACCS2. COMIDA2 represents a significant improvement over the older food chain model embodied in the original MACCS code and used in NUREG-1150. The capability of bypassing (not modeling) the food chain/ingestion model has been recently implemented in MACCS2 because it is generally thought that food availability in the United States would preclude the need for individuals to consume contaminated food or water.

MACCS2 values of total long-term population dose and health effects account for exposures received by workers performing decontamination. While engaged in cleanup efforts, workers are assumed to wear respiratory protection devices; therefore, they only accumulate doses from groundshine.

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[1] In this context, interdiction generally refers to the period of time in which residents are not permitted to return to live on their property because the radiation doses they would receive (from external sources and inhalation) exceed the habitability criterion. Interdiction allows for radioactive decay, decontamination, and weathering to potentially bring these doses to a point where they would no longer exceed the habitability criterion.

[2] EPA developed the PAG Manual to provide guidance to State and local authorities on actions to help protect the public during emergencies. The manual can be found at http://www.epa.gov/rpdweb00/rert/pags.html.

Land Contamination Areas

Land areas contaminated above a threshold level can be calculated in several ways. The simplest is to report land areas that exceed activity levels per unit area for one or more isotopes. This is the approach used to report contaminated areas following the Chernobyl accident (i.e., land areas exceeding threshold levels of cesium-137 activity were reported). The process to estimate land contamination areas based on activity is very simple and depends only on the atmospheric transport and deposition modeling employed in the analysis. Currently, MACCS2 estimates such areas based on the Gaussian plume model; in the future, higher fidelity models will become available upon which to base land contamination areas.

MACCS2 also allows calculation of land contamination areas based on doses. For example, land areas can be calculated that exceed the habitability criterion. Land areas based on doses or projected doses are for a specific set of dose pathways. Habitability is generally based on two dose pathways, groundshine and inhalation of resuspended aerosols. Clearly, this approach is more complex than activity-based estimates and involves estimating doses for specific dose pathways. Finally, land contamination areas based on an economic model (e.g., areas that are decontaminated or condemned) are the most complex to evaluate and are tied to the assumptions and parameters in the economic model.

MACCS2 Economic Model

Current Model

The economic model in MACCS2 includes costs associated with various actions or modeling as follows:

- evacuation and relocation costs (e.g., a per diem cost associated with displaced individuals)
- moving expenses for people displaced (i.e., a onetime expense for moving people out of a contaminated region) and loss of wages, if chosen
- decontamination costs (e.g., labor, materials, equipment, and disposal of contaminants), *if* decontamination is cost effective
- cost from loss of land use of property (e.g., costs associated with lost return on investment and for depreciation of property that is not being maintained)
- disposal of contaminated food grown locally (e.g., crops, vegetables, milk, dairy products, and meat)
- cost of condemned lands (i.e., land that cannot be restored to usefulness or it is not cost effective to do so)

Nearly all of the values affecting the economic cost model are user inputs and thus can account for a variety of costs and can be adjusted for inflation, new technology, or changes in policy.

New Alternative Economic Model

The new and alternative economic model for MACCS2 is under development. The new model is based on the existing Regional Economic Accounting Tool (REAcct), which SNL developed for the U.S. Department of Homeland Security (DHS). REAcct uses an economic model that is built upon the well-known and extensively documented input-output modeling technique initially presented by Leontief [9] and more recently further developed by numerous contributors. The model is widely accepted and used within the community of economists. In response to SECY-09-0051, "Evaluation of Radiological Consequence Models and Codes," the Commission approved the staff's recommendation to enhance the MACCS2 code with insights that may be learned from the DHS/National Nuclear Security Administration (NNSA) economic consequence model recently developed for radiological dispersion devices. A comparison of the new and alternative economic model for MACCS2 with the DHS Radiological and Nuclear Terrorism Risk Assessment (RNTRA) economic consequence model is also underway.

REAcct is used to rapidly estimate approximate economic impacts for disruptions caused by natural (e.g., hurricanes) or manmade events. The tool estimates the following:

- The model estimates direct losses (gross domestic product (GDP) losses) within the grid using county-level economic-sector (e.g., manufacturing, tourism, and agriculture) data.[3]

- The model estimates indirect losses using the national-level Regional Input-Output Modeling System (RIMS) multipliers to estimate indirect GDP losses (representing the remainder of the United States outside the grid).

- The model can be used to account for potential multiple-year disruption to economy in terms of present value.

The metric of concern is reduction in GDP, which can be reported at the industry, region, and U.S. levels.

The cost of decontamination in the new model is the same as the old model and is computed separately. The cost of evacuation, relocation, and condemned land do not directly contribute to GDP losses and are not included in the new model.

An internal peer review for the new model is planned to evaluate the model developments. The work is being documented in the WinMACCS draft documentation [3]. Planned activities include review of draft documentation during the FY 2013 timeframe. A workshop will be conducted to introduce the modeling concepts to NRC users of MACCS2.

Table 1 through Table 3 below summarize (1) the basis for current and new economic models, (2) comparison of current and new economic models, and (3) databases used for current and new economic models.

The current schedule envisions a new version of MACCS2/WinMACCS during early FY 2014 that gives the user the option to choose the new economic model.

[3] GDP data are from the U.S. Bureau of Economic Analysis and can be found at http://www.bea.gov/regional/index.htm.

Table 1 Basis for Current and New Economic Models

Original MACCS2 Model	REAcct Model
Cost-Based Accounting of Losses	GDP-Based Accounting of the Effect Accident on Economy
Based on Model Dating Back to CRAC and CRAC2 Codes Developed for the NRC	Based on Input-Output Economic Model Developed by Economists
Accounts for Losses to Local Residents	Accounts for GDP Losses, Both within Region and to Entire Country

Table 2 Comparison of Current and New Economic Models

<table>
<tr><th>Original MACCS2 Model</th><th>REAcct Model</th></tr>
<tr><td>Evacuation & Relocation Per Diem Expenses</td><td>Excluded from Model—These Are Transfer Payments Which Do Not Affect GDP</td></tr>
<tr><td>Loss of Use of Property during Interdiction</td><td rowspan="3">GDP Losses*
Direct—Within MACCS2 Grid
Indirect—Impact on Rest of the Country</td></tr>
<tr><td>Condemnation of Property</td></tr>
<tr><td>Disposal of Contaminated Farm Products</td></tr>
<tr><td colspan="2">Decontamination of Property</td></tr>
<tr><td colspan="2">Cost of Population Exposure Estimated by Multiplying Population Dose by Cost per Person-Rem</td></tr>
</table>

* GDP losses in REAcct account for property that cannot be used, either temporarily or permanently. Permanent loss is over the entire time period treated by the REAcct model, which can be up to 30 years. Losses for each economic sector, including agriculture, are tabulated separately in the REAcct model and summed to represent the total economy.

(Note: Rows shown across the tables denotes that the value is accounted in both models.)

Table 3 Databases Used for Current and New Economic Models[4]

Original MACCS2 Model	REAcct Model
Fraction of Area That Is Land (i.e., Excluding Water Bodies)	
Fraction of Land Devoted to Farming	
Fraction of Farm Sales from Dairy	
Average Annual Farm Sales	
Average Farm Land Value	
Average Nonfarm Land Value	
	County-Level GDP Data (Direct GDP Losses)
	RIMS II Multipliers (Indirect GDP Losses)

References

[1] D. Chanin, M.L. Young, J. Randall, "Code Manual for MACCS2: User's Guide," NUREG/CR-6613, Vol. I, 1998.

[2] H-N Jow, J.L. Spring, J.A. Rollstin, L.T. Ritchie, D. Chanin, "MELCOR Accident Consequence Code System (MACCS): Model Description," NUREG/CR-4691, Vol. II, 1990.

[3] K. McFadden, N.E. Bixler, Lee Eubanks, R. Haaker, "WinMACCS, a MACCS2 Interface for Calculating Health and Economic Consequences from Accidental Release of Radioactive Materials into the Atmosphere User's Guide and Reference Manual for WinMACCS Version 3*," DRAFT NUREG/CR.

[4] G.D. Wyss and K.H. Jorgensen, "A User's Guide to LHS: Sandia's Latin Hypercube Sampling Software," SAND98-0210, February 1998.

[5] C.R. Molenkamp, N.E. Bixler, C.W. Morrow, J.V. Ramsdell, Jr., J.A. Mitchell, "Comparison of Average Transport and Dispersion Among a Gaussian, a Two-Dimensional, and a Three-Dimensional Model," NUREG/CR-6853, October 2004.

[6] N.E. Bixler and S.T. Ghosh, "NRC Staff Testimony Concerning the Impact of Alternative Meteorological Models on the Severe Accident Mitigation Alternatives Analysis in the Matter of Entergy Nuclear Generation Company and Entergy Nuclear Operations, Inc., Pilgrim Nuclear Power Station, Docket No. 50-293-LR," January 2011, ADAMS Accession No. ML110330544.

[7] J.V. Ramsdell, "NRC Staff Testimony Concerning the Impact of Specific Meteorological Conditions on the Severe Accident Mitigation Alternatives Analysis in the Matter of Entergy Nuclear Generation Company and Entergy Nuclear Operations, Inc., Pilgrim Nuclear Power Station, Docket No. 50-293-LR," January 2011, ADAMS Accession No. ML110330543.

[4] All data are from the U.S. Department of Commerce, Bureau of Economic Analysis and Census Bureau.

[8] A.M. Young, P.B. Abramson, and R.F. Cole, “ASLB Ruling Rejecting, Upon Remand, Pilgrim Watch’s Challenge to Meteorological Modeling in SAMA Analysis in Entergy’s License Renewal Application,” July 19, 2011, ADAMS Accession No. ML11200A224.

[9] Haimes, Y.Y., and Pu Jiang, “Leontief-Based Model of Risk in Complex Interconnected Infrastructures,” *ASCE Journal of Infrastructure Systems,* 7(1):1–12, 2001.

Consideration of Property Damage by External Organizations

The staff performed a limited review of how select external organizations address economic consequences arising from property damage (e.g. land contamination). Although the regulatory framework at the NRC is somewhat unique (e.g. existence of backfitting provisions and implementation of the adequate protection standard) the following were considered pertinent to this issue:

- **Federal agencies:** The Environmental Protection Agency (EPA) is a leader in developing and implementing cost-benefit guidance used in regulatory analyses. According to the National Center for Environmental Economics, EPA's *Guidelines for Preparing Economic Analyses* establish a sound scientific framework for performing economic analyses of environmental regulations and policies. They incorporate recent advances in theoretical and applied work in the field of environmental economics. The *Guidelines* provide guidance on analyzing the benefits, costs, and economic impacts of regulations and policies, including assessing the distribution of costs and benefits among various segments of the population.[1] Furthermore, In October 2011, the EPA published its *Handbook on the Benefits, Costs, and Impacts of Land Cleanup and Reuse*.

  The Department of Transportation (DOT) is also an active leader in the area of regulatory analyses, but has no specific guidance or policy on the subject of economic consequences arising from property damage due to radiological contamination. The Department of Energy (DOE) also does not have a formal policy in this area. The staff notes, however, that the DOE uses the MACCS2 code when conducting NEPA analyses and formulating Environmental Impact Statements.

- **IAEA and NEA:** The International Atomic Energy Agency (IAEA) and the Organization for Economic Cooperation and Development (OECD) Nuclear Energy Agency (NEA) provide little direct guidance to consider economic consequences of the unintended release of licensed nuclear materials to the environment. However, the following documents and information are pertinent to the discussion:

  - "Fundamental Safety Principles," Safety Fundamentals (SF) No. 1, 2006, describes IAEA's safety principles:
    - States that the fundamental safety objective is "…to protect people and the environment from harmful effects of ionizing radiation."
    - Provides a number of safety principles, one of which (Number 5) recognizes that in optimizing protection, economic, social, and environmental factors need to be considered.
  - "Safety of Nuclear Power Plants: Design," Specific Safety Requirements No. SSR-2/1, 2012, describes IAEA's specific safety requirements for nuclear power plant design:
    - Requires a comprehensive safety assessment that identifies all possible sources of radiation and evaluates possible doses to workers, members of the public, and possible effects on the environment.
    - Focuses on controlling/preventing release of radioactive materials (e.g., through defense-in-depth).

[1] http://yosemite.epa.gov/ee/epa/eed.nsf/webpages/Guidelines.html

- "Safety Assessment and Verification for Nuclear Power Plants," Safety Guide NS-G-1.2, 2001, describes IAEA's guide for nuclear power plant safety assessment:
  - States that Probabilistic Safety Assessment (PSA) results should be compared with probabilistic safety criteria defined for the plant, including (if defined) criteria for "off-site consequences such as land contamination and food bans" and that results should be provided to civil authorities to help them in their planning.
  - Does not say Level 3 PSA should be performed but does say that a Level 3 PSA should consider economic consequences. Does not mandate specific economic factors that should be included in the analysis.
  - Refers to IAEA guidance document 50-P-12 (see next) for details.
- "Procedures for Conducting Probabilistic Safety Assessments of Nuclear Power Plants (Level 3)," Document 50-P-12, 1996, describes IAEA's technical guidance document for Level 3 PSA:
  - Provides high-level procedures for conducting a Level 3 PSA, including consideration of economic impacts. However, this discussion is limited and dated; participants at a recent (July 2-6, 2012) IAEA Technical Meeting on Level 3 PSA agreed: (1) the document needs to be updated, and (2) additional guidance documents are needed to provide more detail.
  - At the IAEA Technical Meeting on Level 3 PSA, participants also agreed that there was a need for risk criteria associated with environmental contamination.
- A 2011 report on risk-informed decision making by the IAEA International Nuclear Safety Group (INSAG) titled "A Framework for an Integrated Risk Informed Decision Making Process," INSAG-25:
  - Acknowledges risks other than to public health and safety, but provides little discussion.
- "Improving Nuclear Regulation," NEA/CNRA/R(2011)10, 2011 is NEA's compilation of NEA Regulatory Guidance Booklets produced by the Committee on Nuclear Regulatory Activities (CNRA):
  - Contains considerable discussion on regulatory philosophy and approaches. The term "risk" appears to be generally used in relation to public health and safety (or surrogate notions like core damage).
- "Probabilistic Risk Criteria and Safety Goals," NEA/CSNI/R(2009)16, 2009:[2]
  - Reports on a survey of nuclear regulators and utilities
  - Identifies individual and societal risk goals, but none that directly address environmental or economic criteria.
- "Use and Development of Probabilistic Safety Assessment," NEA/CSNI/R(2007)12, 2007:[3]
  - Provides working group on risk (WGRISK) member survey information on probabilistic risk criteria and safety goals – some of this information was not included in the 2009 report mentioned above.
  - Does not seem to have any discussion on environmental or economic criteria.

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[2] http://www.oecd-nea.org/nsd/docs/2009/csni-r2009-16.pdf

[3] http://www.oecd-nea.org/nsd/docs/2007/csni-r2007-12.pdf

  - Contains some extended discussions on regulatory approaches to risk criteria and safety goals
- **ASME:** The March 2011 Fukushima accident prompted the formation of the ASME Presidential Task Force on Response to Japan Nuclear Power Plant Events[4], which reviewed the Fukushima events and contrasted it with previous nuclear accidents at Three Mile Island and Chernobyl. Following this review, the task force has called for a new "safety construct" or a "set of planned, coordinated, and implemented systems ensuring that nuclear plants are designed, constructed, operated, and managed to prevent extensive societal disruption caused by radioactive releases from accidents, using an all-risk approach." The term "all-risk" requires consideration of "all credible hazards in developing probabilistic risk assessments," including "rare but credible events" that threaten the safety of a nuclear generating station. According to the task force, this includes very low-probability events, such as extreme floods and other natural phenomena that are unprecedented but conceivable at a given site[5].

[4] During the March 2012 annual Regulatory Information Conference, the chair of the ASME Presidential Task Force, Nils J. Diaz, gave a speech entitled “Forging a New Nuclear Safety Construct.”

[5] June 2012, “After Fukushima, ASME Task Force Challenges Nuclear Industry.” http://www.asme.org/kb/news---articles/articles/nuclear/after-fukushima-asme-challenges-nuclear-industry

Coordination with Ongoing Initiatives

Any actions taken under Options 2 and 3 would have to be coordinated with ongoing initiatives, such as Near Term Task Force (NTTF) Recommendation 1 and activities conducted in response to NUREG-2150, "A Proposed Risk Management Regulatory Framework (RMTF)," issued in April 2012. For example, the NTTF recommended that the Regulatory Analysis Guidelines be modified to more effectively implement the defense-in-depth philosophy in balance with the current emphasis on risk-based guidelines. The NTTF concluded that the NRC's current approach to the issue of land contamination from reactor accidents is sound. The NTTF also believed that the Regulatory Analysis Guidelines could be modified by implementing some of the concepts presented in the technology-neutral framework (NUREG-1860) to better integrate safety goals and defense-in-depth (Recommendation 1.3). Current Recommendation 1 activities contemplate potential changes to the regulatory analysis guidance but do not currently consider changes with respect to offsite property damage, given the NTTF conclusion. The RMTF in NUREG-2150 also discussed updating regulatory analysis guidelines to ensure an effective cost-benefit analysis is performed by licensees when considering ways to address design-enhancement events. Recommendation PR-R-2 of NUREG-2150 states that the NRC should establish through rulemaking a design-enhancement category of regulatory treatment for beyond-design-basis accidents. This category would use risk as a safety measure, be performance-based (including the provision for periodic updates), include consideration of costs, and be implemented on a site-specific basis. Although not a formal recommendation, the RMTF stated in NUREG-2150, "At the point where Level 3 PRAs are available, the NRC's Quantitative Health Objectives or other societal measures could be directly considered as part of the event categorization criteria."